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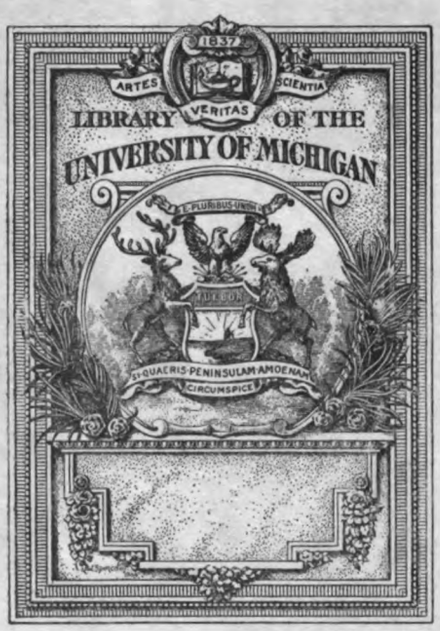

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NOTES.

NEW YEAR'S RESOLUTIONS.

A kindly correspondent writes: "What is your resolution to-day? Does the spirit of optimism which reigns supreme on the first day of the New Year, fill you with stern determination to make greater personal efforts to ensure better results than last year?" Well, that is an excellent spirit. Undoubtedly, if we all talked and thought Prosperity hard enough, we should be the better for it individually and as a community.

ADVERTISING ELECTRICITY.

Certainly those responsible for electricity undertakings in London and its suburbs—be they municipal or company ventures—are taking this attitude seriously and intend to make the merits of electricity widely known by means of electricity, thus letting in more light, and, consequently, joy and comfort, into life. The Associated Municipal Electrical Engineers (Greater London) have a scheme of advertising that thoroughly deserves success. The idea is to form, under the auspices of the Association, a Joint Publicity Committee, consisting of seven members from the municipal undertakings and seven from the companies, this committee to devise means for effectually placing the benefits of electricity before the greater London public. An effort is being made to raise a guaranteed income of about £1,000 for the first year, to enable experts in drafting advertisements—designers and advertisement writers—to be employed, so that the best form of leaflets, books, and newspaper announcements could be secured.

CO-OPERATION AND LOCALISATION.

The £1,000 is to be raised by subscriptions from the various local authorities and companies, approximately on a 1% of turnover basis. That is to say, any undertaking having an income of not more than £10,000 would pay £10; between £10,000 and £20,000, £20; between £20,000 and £30,000, £30; between £30,000 and £40,000, £40; between £40,000 and £75,000, £50; and over £75,000, £60. This £1,000 would be spent on a central office, where the "literature" would be prepared and printing arranged, but the actual local advertising would be carried out locally with additional funds. In this way the legal difficulty as far as concerns the municipalities would be overcome. The idea is a good one, and capable of wide extension. That there is plenty of work to be done is evident to everyone remotely connected with the supply of electricity for lighting, heating and power. One or two phases of the questions that have to be tackled are dealt with in this week's leading article.

A GOOD EXAMPLE.

Meanwhile Mr. W. A. Vignoles, the Chief Municipal Electrical Engineer, Grimsby, is setting an excellent example with his most artistically got-up "Electricity Consumers' Guide." The reading matter is divided up into convenient paragraphs, with explanatory headings printed in red. We are told that the corporation experts will give advice for very moderate fees, will undertake to supervise the local contractors' wiring, even pay the bill at once, and allow the customer to refund at leisure—in fact, over a period of three years. Other headings tell the consumer the "Procedure to obtain a Supply," "Service and Meter," "Notes on Wiring of Premises," includes paragraphs on "Main Switches and Fuses," "Distribution Board," "Fuses," "Systems of Wiring," "Distribution of Lights and Choice of Fittings," "Choice and Efficiency of Lamps," in the course of which the respective merits of arc lamps, carbon filament and metal filament (tantalum and tungsten) are discussed. Then follow notes on "Switches," "Special Plugs," "List of Installations" (with examples), "Heating and Cooking," "Rental System of Charging," "Annual Cost of Electricity" (with examples). The information, of course, is of an elementary character for the non-technical public, but it is adequate and, while concise, admirably lucid. From all of which it will be seen that the Grimsby Electricity Department is very much alive and determined "to ensure better results than last year."

ELECTRICAL AND MECHANICAL DRIVE.

As a result of the lively discussion that has arisen round the Bradford Engineering Society's Special Committee report on the electrical *versus* mechanical drive in textile factories, and the serious objections raised by Mr. Woodhouse, engineer to the Yorkshire Electric Power Co., and a member of the Committee, it has been suggested that the whole experiments should be repeated on a more elaborate scale. An effort is, we understand, being made to get together an impartial but sufficiently competent committee to devise a new plan for carrying out the trials on a scale, and over a period of sufficient length, to afford reliable data. The present idea seems to be that this body of men should be found this time in Lancashire. Certainly both Manchester itself and some of the other cotton spinning and weaving centres have had some experience of electricity as a motive power, and it should be easy enough to carry out observations under very varied conditions.

"WIRELESS" V. CABLE TELEGRAPHY.

While at first there were not wanting many who derided radio-telegraphy as a practical branch of science, others jumped to the extreme and declared that the "wireless" system was destined to bring ruin to the submarine cable telegraph companies. This latter view is not, however, that held by those most competent to know. To begin with, the capacity for expansion in overseas telegraphing is immense, practically incalculable at the rate of international trading and fraternisation that is now going on, and the "wireless" systems will have quite enough to do in absorbing part of this increasing business. What is likely to happen is an all-round lowering of cable-rates, which will bring about an acceleration of the growth of submarine telegraphing, so that existing cable companies will find plenty of work, and, under judicious guidance, prosperity. But it is probable that the laying down of new cables will become more rare as time goes on. That appears to be the view prevailing among the Post Office experts and also in the most reliable financial circles.

ELECTRICITY IN MINING.

Only a couple of weeks ago we announced that the Institution of Electrical Engineers was preparing evidence to lay before the Home Office Committee on the use of electricity in coal mines. The subject is attracting enormous attention up North, and to, perhaps, a less extent in Wales. Mr. Wilfrid L. Spence, M.Inst.Mech.E., in discussing the extent to which electricity is now used in coal cutting, conveying, hauling, winding, pumping and signalling, points out that one difficulty is that of earthing. He holds that it is absolutely necessary to protect all live conductors with metal casing, which means, of course,

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nine times out of ten, having to struggle with the problem of proper earthing underground. Mr. Spence is of opinion that the only method is to run a special earth wire down the shaft and along the workings to each piece of electric plant. This involves some expense, but it is a view gaining much favour with mining engineers who have had practical experience with earthing troubles.

CONVEYORS.

Mr. Spence discusses the mechanical conveyor for use in mines in an interesting manner. He shows that the ordinary type, consisting of a sheet steel trough carrying a long link, endless, electric driven chain with pusher bars every nine or ten inches, is not a success, being expensive to instal and difficult and correspondingly expensive to move each day up to the advancing face. Mr. Spence adds that: "Strenuous efforts are being made in Scotland to improve and to cheapen it, and perhaps not less than half-a-dozen varying types are working more or less experimentally in as many different collieries at the present time. Instead of providing a fixed trough with a travelling chain, the modern scheme is to haul the trough itself, originally on wheels and rails, but now as mere sledges on skids, thus following the same lines of evolution as in coal-cutting machines. No attempt is made to return the empty trough sections continuously to the starting point, which indeed would be an exceedingly difficult matter, but instead the whole conveyor trough is worked backwards and forwards like a shuttle train on a straight line route. This method involves another departure, namely, the provision of a single hutch road in the middle of the working face, instead of at one end, as with the chain conveyor. It appears that the intermittent operation is not objectionable, as the to and fro conveyor will deliver as much coal as can be taken away by the hutches."

ALUMINIUM.

Aluminium, although by no means an ideal metal for all-round service in electric engineering, is receiving increasing attention, for its merits in many branches are becoming more evident, the uncertainty of the copper market helping largely to strengthen the desire to find a substitute wherever possible. Much, too, is being done to place aluminium in suitable forms on the market. The British Aluminium Co. have accomplished excellent work in producing cables for electricity transmission, the present position of affairs being well shown in their latest leaflet in which they give particulars of cables for electrical transmission lines with copper equivalents. The particulars given are for hard drawn aluminium cables, and comprise data as regards number of wires, size of each wire s. w. g., diameter of wires in inches and milimetres, diameter of strand in inches, effective sectional area in square inches and square milimetres, resistance at 60°F. per 1,000 yards ohms and per mile ohms, weight per 1,000 yards and per mile compared with nearest standard of hard drawn copper cables. This leaflet may be regarded as a useful addition to that invaluable book, Coyle & Howe's "Electric Cables and their Construction and Cost." By the way, the same company also turn out aluminium not only in ingots, billets and rods, but in busbars, tubes and sheets.

ALUMINIUM SOLDER.

Another piece of evidence as regards the advance made in connection with this metal is shown by the latest departure of the Standard Alloys, Ltd., who are placing on the market a thoroughly effectual aluminium solder. One of the novel points about this new product is that soldering is carried out at a high temperature. The two sections to be joined, or the crack in casting to be filled up, are first thoroughly cleaned and then heated, by blow-pipe or other suitable means, to a temperature of 300°C., the solder being applied at that temperature. No flux is used with this "S. A. L." brand of solder, and it can be used in order to join aluminium with other metal. In this latter case, the other metal has generally to be "tinned" with ordinary tinman's solder as a preliminary.

A MAGNETIC WHEEL.

Mr. John O. Heinze, of Lowell, Massachusetts, has apparently succeeded in producing a magnetic traction wheel which should have a great future before it. These wheels contain four magnetic coils, outside of which are four segments comprising part of the tread of the wheel. A ring of 12% manganese steel is clamped between them and the wheel proper to send the magnetic circuit into the rail. The energizing of the magnets is so timed that each succeeding section of the wheel is attracted to the rail in advance of making contact with it. In this way, the wheel, besides giving increased traction, also assists acceleration. The current is cut off from each segment as soon as it is no longer in contact with the rail. Experiments show that coils wound with 50 lb. of No. 6 B. & S. wire produce the best results. Such a coil has a resistance of but ¼ ohm, so that the current consumption is practically a negligible factor. Repeated tests under widely varying load conditions show that the voltage at the axle commutators does not exceed 50 volts in starting, while the normal average under running conditions is about 25 volts. The absence of sparking at the brushes and the small number of segments make these commutators very simple and reliable.

LAWS CONCERNING VOLTAIC CELLS.*

By EDWARD H. LANDIS, B.S. in E.E.

(*Professor of Physics, Central High School, Philadelphia.*)

The purpose of this paper is to discuss some of the difficulties which have arisen in endeavouring to understand the fundamental phenomena of voltaic cells, and to discuss the solutions of those difficulties which have aided in securing a firmer grasp of that group of phenomena.

It will first be considered what transformations of energy are characteristic of those objects to which the name voltaic or galvanic cell has been given. Ostwald says: "We will give the name cell to any arrangement by means of which electrical energy can be obtained from chemical energy." Le Blanc gives a more comprehensive definition by calling "any arrangement" a galvanic cell, "which through chemical reaction or physical processes, such as diffusion, etc., is capable of producing electrical energy; whether the reaction takes place between a solid and a liquid, or two liquids, is of no account."

The statement of Ostwald can be found in many places, but the customary application of the name is unquestionably wider than this statement will allow. That of Le Blanc is more inclusive, but how much more is rather uncertain.

It seems advisable and convenient to include amongst voltaic cells series of conductors by which electrical energy can be generated from one or more of these transformations of energy: (1) of chemical energy; (2) of energy of solution; (3) of heat energy *when the series is at uniform temperature*; (4) of energy arising from changes in the volume of the conductors; (5) of kinetic and potential energy.

Des Coudres has made a study of cells in which kinetic and potential energy are transformed into electrical. A tube with the funnel contains mercury which cannot flow from the tube, because of a fine capillary at the lower end, this being placed in a large vessel containing a solution of a mercury salt. In this is a smaller closed vessel containing mercury. The current flows in the cell from the column to the smaller vessel. This is accompanied by a decrease in potential energy, since the height of the column decreases. The E.M.F. of such a cell is only .0000153 volts for a column of mercury 760 mm. high at 20° C.

It is with hesitation that photo-electric generators have been excluded from a place amongst voltaic cells. These generators have electrodes of the same substance in a solution; as copper oxide in a solution of potassium or soidum hydroxide. They generate electrical energy by the transformation of light energy, which is allowed to fall on one of the electrodes. Thermo-electric generators, in which heat energy is transformed into electric energy only when differences of temperature exist at different parts of a series of conductors, are excluded from amongst voltaic cells even when one of the conductors is an electrolyte.

* Paper read before the Franklin Institute.

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The most important attribute of a cell is that to which the name E.M.F. is given, but this name is not limited in its use to cells alone; we often speak of E.M.F.'s other than those of cells. It is, therefore, customary to give a general definition of E.M.F., and afterwards a specific definition of the E.M.F. of a cell. Since this is one of the commonest names in physics, agreement ought to exist in stating what is intended by it; but an examination of some of the best authorities reveals considerable difference of practice in this respect.

I shall endeavour to show that in the class of magnitudes known as differences of potential there exists a smaller class of magnitudes which possess certain characteristics not possessed by the other members of the class in which they are found. To the members of the smaller class convenience and precision join in dictating a more exclusive application of the name E.M.F. E.M.F.'s are, therefore, differences of potential of a certain variety; every E.M.F. is a difference of potential, but not every difference of potential is an E.M.F. If this task were attempted from the statements of physicists concerning the use of the name, the endeavour would appear rather difficult, for in their divergent views, of which at least three exist, there is nothing to suggest a consistency running through the use of this name, a usage which it would seem well to point out and advisable to follow.

One view is that E.M.F.'s are not differences of potential, but causes of differences of potential. It is said that "there must be cause (*i.e.*, a force present) which drives a certain quantity of positive electricity from one metal to another across their surface of contact, and permanently maintains one at a higher potential than the other. This force is named E.M.F." But some of those who give this definition qualify it by saying that E.M.F. and difference of potential are often used interchangeably. The authority just quoted in distinguishing between them says: "Potential difference and E.M.F. are very frequently used as identical conceptions. Strictly, they are not so, although both of these magnitudes are expressed by the same numbers in the same system of units. We define potential difference as that difference in the electrical state of conductors, in consequence of which a quantity of electricity is driven from one to the other. . . . Potential difference is the cause of that flow of electricity which tends to produce equilibrium of electricity and the same potential throughout conductors which are joined. As the E.M.F., on the contrary, we designate that *force* which disturbs the equilibrium and drives electricity from lower to higher potential. The magnitude of this force we measure by means of the potential difference it produces." It seems exceedingly confusing to measure a force by a difference of potential which is not a force. Moreover, if the difference of potential is the thing to which the name E.M.F. is nearly always applied, it is very misleading to present another use which is exceptional.

One authority turns this view around and states that difference of potential is the cause of E.M.F. "Just as in water-pipes a difference of level produces a pressure, and the pressure produces a flow as soon as the tap is turned on, so difference of potential produces E.M.F. and E.M.F. sets up a current as soon as a circuit is completed for electricity to flow through. E.M.F. may, therefore, be conveniently expressed as difference of potential and *vice versa*, but the student must not forget the distinction."

The third view is that E.M.F. and difference of potential are one and the same. Maxwell says: "When two conductors at different potentials are connected by a thin conducting wire, the tendency of electricity to flow along the wire is measured by the difference of potential of the two bodies. The difference of potential is, therefore, called the E.M.F. between them. E.M.F. cannot in all cases be expressed in the form of a difference of potential. These cases are, however, not treated of in electrostatics. We shall consider them when we come to heterogeneous circuits, chemical actions, motions of magnets, inequalities of temperature, etc." Maxwell is, therefore, only a partial adherent of this view, but he does not give any characterisation of those E.M.F.'s which cannot be expressed as differences of potential. J. J. Thomson says, in defining difference of potential, that "the electric potential at a point P exceeds that at a point Q by the work done *by the electric field* on a body charged with unit of electricity when the latter passes from P to Q;" and in defining E.M.F. from a point A to a point B, that it is the work done by electric forces on a unit charge of electricity in going from the point A to the point B. These definitions agree so closely, that it seems fair to take it that J. J. Thomson would use difference of potential and E.M.F. as equivalent terms.

Turning to the definition of the E.M.F. of a cell, we find that one of the authorities who adopts the first view says that the E.M.F. of a cell is the sum of the E.M.F.'s at the surfaces of contact of the conductors which constitute the cell. This is an error in that it locates all the components of the E.M.F. of all cells at these surfaces of contact. Maxwell says that the E.M.F. of a cell is the difference of potential between two conductors of the same substance attached to the terminals of the cell. J. J. Thomson gives a proof of this proposition, which Maxwell seems to consider as a definition of the E.M.F. of a cell. But he first deduces from the law of the conservation of energy an equation between the chemical energy which disappears in a cell and the heat energy which appears in the circuit in the same time t. The first is CWt, in which C is the current, and W is the mechanical equivalent of the chemical energy which disappears per unit of electricity. The second is $C^2Rt + C^2rt + PCt$, in which R is the external, r the internal resistance, and P is the heat in joules, which appears or disappears at the junctions of the dissimilar conductors per unit of electricity. These are equal if all the chemical energy which disappears reappears as heat, and we have $CWt = C^2Rt + C^2rt + PCt$. This is reduced to $W - P = C(R + r)$, and the quantity on the left-hand side of this equation is defined as the E.M.F. of the cell. It is left to the reader to find the relation between this definition and the general definition already given.

In proceeding from the view that E.M.F.'s and differences of potential are the same, to the view concerning their relation which will be presented in this paper, two other considerations are intimately involved: physicists have not distinctly set forth criteria by which we can recognise work done when a current flows from one part of a circuit to another; nor do they plainly distinguish between "work done *by* a current" and "work done *upon* a current." Nevertheless, both of these questions are of fundamental importance in forming clear and adequate conceptions of the processes occurring during the flow of electricity.

We will first consider one of the most important of those processes of which it is said, when they occur, that work has been done during the flow of a current. Such a process occurs when a current flows from one part A to another part B of a homogeneous conductor at constant temperature, and consists in a generation of heat which is non-reversible, in that there is no corresponding destruction of heat when the current is reversed. Only when the resistance of the conductor is constant for all currents are these quantities of heat proportional to the squares of the currents. In such a case it is said that *work is done by the current* in flowing from A to B in overcoming the resistance of the conductor. This work is measured by the heat generated. Further, it is said that a fall of potential exists in the conductor from A to B, which is measured by the work done per unit of electricity. Changes of potential in conductors of this kind differ from changes of potential in conductors of other kinds, in that all of this kind involve a consumption of electrical energy. None of them involve a generation of electrical energy. Nor can we in any way arrange conditions so as to cause them to involve a generation of electricity energy. It would seem that few physicists would maintain that these changes of potential, which always involve a consumption of electrical energy, are E.M.F.'s. For the sake of convenience, we may refer to them as *changes of potential caused by resistance.*

From this simple process, which occurs in a homogeneous conductor, we may proceed to the processes which occur between a part of one terminal conductor and a part of the other terminal conductor of a type of cell that can be very easily conceived, and to which a Daniell cell approximates, but which, as far as is known, does not exist. These are what may be called *simple chemical cells.* In them the only energy transformations which occur when they produce a current are transformations of chemical energy, and

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the generation of heat caused by the resistance of their conductors. Such a cell can have three or more conductors, but we will consider one like the Daniell, which consists of five homogeneous conductors. In the Daniell these are copper, zinc, an aqueous solution of zinc sulphate, an aqueous solution of copper sulphate, copper. At three of the junctions of such a cell chemical changes can occur. A chemical cell of this genus can belong to one of many species, but we will only consider several of them.

First, we will consider a cell in which, when it generates a current chemical energy disappears at all of the three junctions. In this case it would be said that *work is done upon the current* at each of the junctions, which is measured by the chemical energy which disappears, and that a rise of potential exists at each of them, which is measured by the work done per unit of electricity.* Besides these rises of potential, a fall of potential, caused by resistance, exists in each of the conductors of the cell. Each of the former involves a generation of electrical energy, and in this respect differs from the latter, which involves a consumption of electrical energy. Each of these rises of potential is called an E.M.F., and their sum is called the E.M.F. of the cell. The E.M.F. of this cell consists of three components.

A cell of another species is one in which chemical energy disappears at two of the junctions, say, the second and fourth, and appears at the third. Here work is done *upon* the current at junction two and four, and work is done *by* the current at junction three, and a rise of potential exists at each of the former, and a fall of potential at the latter. This fall of potential involves a consumption of electrical energy, just as do the falls of potential caused by resistance. But it is far more closely related to the rises of potential, which generate electrical energy by the consumption of chemical energy, both as regards the processes involved and the laws governing those processes. In view of this relationship and for the sake of convenience, this fall of potential and others like it are called E.M.F.'s, as well as those rises of potential to which they are related. And the E.M.F. of the cell is the sum of the rises of potential minus the related fall of potential.

These conventions laid down regarding the two simple chemical cells will apply to all of them, but some difficulties arise when what may be called *complex chemical* cells are considered. One genus of these comprises cells in which two chemical processes occur at the same junction; one of which involves a disappearance, the other an appearance of chemical energy. Two modes of interpretation are possible: either that each change of energy contributes its own change of potential, or that all or part of the energy of one process is converted directly into the energy of the other. It is unnecessary to discuss these two modes of interpretation here. Another genus of complex chemical cells comprises cells in which, besides the generation of heat caused by resistance, there are not only changes of chemical energy, but also changes in other kinds of energy, which, however, exactly counterbalance.

Therefore in every chemical cell producing a current there occurs, besides the generation of heat caused by resistance, a decrease in chemical energy; if any other changes of energy occur, they counterbalance. And the disappearance of this chemical energy with the flow is our fundamental ground for saying that work has been done upon the current, and that an E.M.F. exists in the cell. Further, the work is measured by the energy which disappears. And the E.M.F. of these cells when producing a current is the sum of all the portions of chemical work done upon the current, minus the sum of all the portions of chemical work done by the current per unit of electricity.

The question may well be raised whether these *conventions* regarding work done during the flow of a current are purely arbitrary. Is the law of the conservation of energy involved? Unquestionably the formulation of that doctrine was the chief cause in the development of greater clearness in the conception of the significance of the term E.M.F., and it is very likely if that law did not hold, if a portion of the chemical energy which disappears in a cell did not appear elsewhere, in any form whatever, that it would be said that the work done upon the current is measured by that fraction only of the energy which does reappear elsewhere. Another convention which has been proposed in regard to some of the energy changes which occur in a current bearing circuit is that a rise of potential does not exist in some cases at a region of the circuit where a portion of energy disappears, but that the electricity unites with this energy and carries it to another region of the circuit, disuniting with it there without a fall of potential. Unless such changes in terminology can be shown to correspond to radical differences in phenomena, and are appropriately applied to them, they cannot be looked upon as aiding in the advance of science.

We are now ready to consider that important law which in different forms is known as Thomson's law. It was first definitely formulated, and a mode of deduction given by Kelvin in 1851, following the prior consideration of it by Joule and Helmholtz. As stated by Kelvin, it is that "the intensity of an electrochemical apparatus is, in absolute measure, equal to the mechanical equivalent of as much chemical action as goes on with a current of unit strength during unit time." This proposition is erroneous, but the propositions which have been put in its place are not very much better. Nernst says: "It would follow from the law of the conservation of energy, if a galvanic cell neither rose nor fell in temperature when yielding a current, that is, if it neither gave heat to its surroundings nor withdrew heat from them," that its E.M.F. is equal to the decrease in chemical energy per unit of electricity. What he intends is, that if in a galvanic cell the heat generated by resistance be excluded from consideration, and if the sum of the other portions of heat generated is equal to the sum of the portions of heat destroyed, then the remainder of the proposition is true. But even this statement is erroneous unless we exclude from amongst galvanic cells all those cells which involve the generation of electrical energy by transformation of any other forms of energy besides heat and chemical energy. Nernst does not speak of this restriction, and in the absence of any good reasons, we may conclude that the restriction is unnecessary. Another statement is that if in a cell all the chemical energy is transformed into electrical, then Thomson's law holds. But this, too, is erroneous, since all the chemical energy and some other form besides could be transformed into electrical energy.

The correct form of this theorem is—*if in a voltaic cell, the only transformations of energy caused by a current, besides the generation of heat in overcoming resistance, are transformations of chemical energy, or if there are other transformations, they counterbalance; then the E.M.F. of the cell during the flow is the net change of chemical energy per unit of electricity which flows through the cell.* No complicated deduction of this theorem is necessary, it follows immediately from the conventions regarding the E.M.F. of a cell which have already been laid down.

So far, we have only considered criteria for the existence of changes of potential and the modes of measuring them in a cell which is bearing a current. Not one word has been said regarding a cell which is not bearing a current. Those phenomena caused by a current, those disappearances and appearances of certain forms of energy, which are the only grounds so far given for asserting the existence of changes of potential, and are the direct means of measuring them: all those phenomena cease when the current ceases. Nevertheless, we agree to say that a change of potential exists from one terminal of a cell to the other, even when no current flows through it, and we agree upon a mode of measuring it based upon phenomena which occur when a current does flow through it. Suppose that a steady current is flowing through a homogeneous conductor MN of the same substance as the terminal conductors of a cell C, and suppose that the positive terminal of the cell is joined to a part P of the conductor MN, while the negative terminal is joined to a part Q of the conductor, which is at a lower potential than P. The fall of potential in MN can always be made so great that, depending on the positions of P and Q, a current flows through the cell in the ordinary direction, or no current flows, or current flows through the cell in a direction opposite to the ordinary. Suppose the first of these cases exists. We can, by altering the positions of P and Q cause the current in the cell to diminish. From the law of the conservation of energy and Ohm's law it can be deduced that in such a case each fall of potential from P

* When it is said that a rise of potential exists at a junction it is to be understood that the current arrives there at a lower potential, and leaves at a higher.

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to Q in the conductor MN is more nearly equal to the E.M.F. of the cell than any which precede, and that they can be made as nearly equal to the E.M.F. as we please by making the current small enough. Therefore, when there is no current in the cell, we say that a rise of potential, which is an E.M.F., exists in the cell from the negative to the positive terminal, as when there is a current; and we can say that this E.M.F. is equal to the fall of potential from the part P to the part Q of the conductor MN to which the terminals of the cell are joined when no current flows through the cell.

We will now briefly recapitulate the views which have been presented concerning work done during the flow of a current and changes of potential in conductors.

First: Excepting those processes which are not caused by the current, such as local action in a cell; and those processes in which a portion of energy disappears at a part of a circuit and an equal portion of energy appears at the same part of the circuit; excepting these cases, whenever energy not electrical appears or disappears at a part of a circuit, we say that work has been done *by* the current or work has been done *upon* the current. This performance of work is our fundamental ground for asserting a change of potential at that part of the circuit at which it occurs. Further, the work performed is measured by the energy which appears or disappears, and the change of potential by the work done per unit of electricity.

Second: There are changes of potential caused by currents flowing against resistance. All of these involve a consumption of electrical energy, and we cannot in any way arrange conditions so as to cause them to involve a generation of electrical energy. These are not E.M.F.'s.

Third: There are changes of potential when a current is flowing, not caused by resistance, but arising from other causes. These involve either a generation or a consumption of electrical energy. Those which involve a generation of electrical energy are E.M.F.'s. Those which involve a consumption of electrical energy, although in this respect resembling changes of potential caused by resistance, are not classed with them, but are called E.M.F.'s too, because of their relationship to changes of potential, which involve the generation of electrical energy, both in regard to the processes involved and in regard to the laws governing those processes.

Finally: There are changes of potential when no current flows. These are not caused by resistance, and are called E.M.F.'s too, because of their relationship to the preceding changes of potential.

Before applying the general principles which have been laid down to particular cases, it will be advantageous to consider another type of voltaic cell besides the chemical cell. These are what may be called heat cells. In them the only transformations of energy which occur when they generate a current, besides the generation of heat caused by resistance, are transformations of heat energy, or if there are other transformations of energy they counterbalance. If in one of these cells the heat caused by resistance is neglected, and if the cell is isolated from all outside sources of energy, it will suffer a decrease in heat energy. If portions of heat equal to the portions which disappear are transmitted to the cell, it undergoes a process similar to the isothermal expansion of a gas. The E.M.F. of such a cell when producing a current is the net decrease of heat energy per unit of electricity neglecting the heat caused by resistance.

To this class approximate some of the members of that class of cells known as concentration cells. One of these consists of a weak amalgam of zinc, a dilute aqueous solution of zinc sulphate, a weaker amalgam of zinc. The current flows from the stronger to the weaker amalgam in the cell, the concentrations of the amalgams become more nearly equal, the concentration of the solution increases at the anode and decreases at the cathode. Another concentration cell consists of silver, a weak aqueous solution of silver nitrate, a stronger aqueous solution of silver nitrate, silver. The current flows from the weaker to the stronger solution; the silver decreases at the anode and increases at the kathode; the concentration of the weaker solution increases at the anode and that of the stronger solution decreases at the cathode. That these cells shall be heat cells, it is necessary for these changes in concentration to occur without any changes in chemical energy or energy of solution. These cells have E.M.F.'s of only about ·05 volts, but they are of much importance in the theories of Nernst regarding cells.

We will now turn to the processes which occur in a Daniell cell consisting of the conductors: copper, zinc, an aqueous solution of zinc sulphate, an aqueous solution of copper sulphate, copper—when the cell is producing a current. From a part of the negative terminal to its junction with the zinc there is a fall of potential caused by resistance. It is likewise with the other conductors, so that no further enumeration of these falls of potential need be made. At the surface of contact of the copper and the zinc two processes may occur: first, there may be caused a very slow union of the two metals with a corresponding decrease of chemical energy; and second, heat may appear or

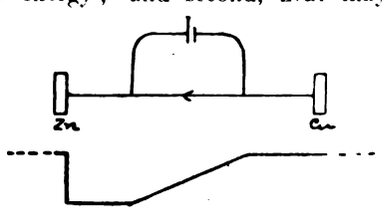

FIG. 1.

disappear. If the first of these processes occurs, it is so slight as to be negligible. The second is almost so. According to the experiments of Jahn, ·585 calories disappear per ampere per hour at the surface of contact of the copper and the zinc. Respecting the change of potential which occurs at this junction, two views have been put forward which have led to much controversy. It is the opinion of Chwolson, the author of one of the most recent text-books on physics which is gaining well-deserved recognition, that this controversy has not yet established either of these two views. One group of authorities, amongst whom are Maxwell, Lodge, Ostwald and Nernst, while not always explicitly stating it, start from the convention which has already been laid down as the fundamental ground for asserting the existence and as the only means of direct measurement of a change of potential at any part of a circuit conveying a current. This convention for this particular case is that, if during the flow of a current, energy disappears at such a junction, work has been done *upon* the current, which is measured by the energy which disappears, and a rise of potential exists there which is measured by the work done per unit of electricity. From this convention and the experiments of Jahn, it follows that a rise of potential of only ·00068 volts exists at the junction of the copper and zinc. Another group of authorities, including Kelvin, attribute to this junction a rise of potential varying from ½ to 1 volt. Kelvin takes his stand largely upon experiments of Erskine-Murray with discs of copper and zinc. One of these was attached to an insulating support, the other was uninsulated. They were placed facing each other about 1 mm. apart in dry air and joined to an electrometer. If they were also connected by wires of copper to a copper conductor, it was found that a fall of potential of about 0·65 volts must be produced between the points of the copper conductor to which the wires were attached by sending a current through the conductor, in order to obtain no difference of potential between the discs as determined by no deflection of the electrometer when the discs are separated. The changes of potential which Kelvin regarded as indicated by this experiment are shown in Fig. 1, in which the plates have

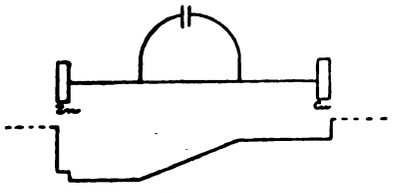

FIG. 2.

been separated for convenience in representation. Lodge has opposed Kelvin's interpretation, and gives instead Fig. 2. The advocates of the second view oppose the convention adopted by the advocates of the first view by maintaining that a theorem is deducible from the second

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law of thermodynamics, which asserts that if H is the heat in joules generated per unit of electricity at the junction of two metals, e the rise of potential there, and T its absolute temperature; we have $H = T\frac{de}{dt}$. Then only when e is proportional to the absolute temperatures does $e = H$. These two views cannot be further discussed except to say that Lodge has raised grave doubts concerning the validity of this theorem. A deduction of it can be found in the recent work of Chwolson. Of course it is plain that the second view is contradictory to views of changes of potential in conductors presented in this paper. Turning to surface of contact of the zinc and zinc sulphate solution, there is a gram equivalent of zinc transformed from the solid state to the state of zinc in an aqueous solution of zinc sulphate per 96,540 coulombs, accompanied by an increase in the concentration of the solution. At the surface of contact of the two solutions a part of a gram equivalent of zinc sulphate in aqueous solution replaces an equal part of copper sulphate in aqueous solution which may or may not be accompanied by changes in concentration. At the junction of the copper sulphate solution and the copper a gram equivalent of copper is transformed from the state of copper in an aqueous solution of copper sulphate to the solid state accompanied by a decrease in the concentration of the solution. Finally, heat may appear or disappear at each of these junctions. No method has as yet been found for determining the values of the changes of chemical energy and solution energy at these junctions. The values of the portions of heat energy which appear and disappear at these junctions are still uncertain, nor has the total heat in the cell, apart from resistance, been directly measured. Therefore, no direct determination of these component changes of potential can be made. But an approximate value of the resultant rise of potential from the zinc to the copper can be obtained from the resultant decrease of chemical energy which occurs by neglecting all other transformations of energy. For every 96,540 coulombs which pass through the cell there is a net decrease of chemical energy of 25,050 calories or 105,000 joules, so that the E.M.F. of a Daniell cell is about 1·09 volts. The most accurate measurement of the E.M.F. of a cell is, when no current is flowing, by the convention already laid down; or, when a current is flowing, by finding the product of the current and the resistance in the circuit outside the cell. This second method is worth considering. It rests upon the doctrine of the conservation of energy and Ohm's law in its *fundamental* form. As often stated, Ohm's law asserts either directly or indirectly that the current in a conductor or in a circuit is equal to the E.M.F. between the ends of the conductor or in the circuit divided by the resistance of the conductor or the circuit. Sometimes it is required that the current must be steady, but this is often omitted. It is frequently maintained that the important point of the law is that the ratio of the E.M.F. to the current is constant for all currents with the same conductor at the same temperature. But the form which has been given contains not the slightest intimation of this important point; and, indeed, as far as that form goes the ratio of the E.M.F. to the current could vary and the law still be true. If this ratio did vary the resistance would vary with the current. It is greatly to be deplored that these differences exist in the conceptions of the import of this fundamental law of electricity, even if the computations made by it lead to no errors. All forms of Ohm's law either rest upon, or are nothing more than a statement of the convention that the resistance of any conductor, from a part A to a part B, to a current flowing from A to B, is the fall of potential, caused by resistance, divided by the current. It is to be particularly noted that this proposition is a convention, and, like all conventions, cannot be subjected to proof. It can only be examined from the point of view of convenience in studying phenomena. It leaves open the question whether the resistances of the same conductor at the same temperature are or are not equal for all currents. Experiments of the highest accuracy enable us to answer the question affirmatively for solid conductors, non-electrolytic liquid conductors, and electrolytes which are not parts of cells for all currents having the same distribution in the conductor. From this short digression on Ohm's law, we will now return to the measurement of the E.M.F. of a cell by means of the current in its circuit and the resistance external to the cell. Starting from the convention which has just been stated, we have for a circuit that the total fall of potential caused by resistance, V_r, divided by the current I, is equal to the sum of the external and internal resistance of the circuit, $R + r$. Or $R + r = \frac{V_r}{I}$. This equation does not as yet contain the E.M.F. of the cell. But *if the net decrease of energy in the cell, apart from the heat caused by resistance, is the only transformation of energy in the circuit besides the generation of heat caused by the resistance of the entire circuit*, we have by the law of the conservation of energy that the former is equal to the latter, and the E.M.F. of the cell E is equal to the fall of potential caused by resistance. This gives $R + r = \frac{E}{I}$ from which E can be obtained by making R so large that r is negligible and measuring I and R. The equation $R + r = \frac{E}{I}$ with the accompanying restriction constitutes the form of Ohm's law, involving only the E.M.F. of the generator.

One of the difficulties which arises with voltaic cells is in regard to the manner in which Ohm's law applies from one terminal to the other of a cell through the cell. In the general equation for Ohm's law $C = \frac{E}{R}$ what does E represent when the equation is applied to this particular case? The customary definitions of E.M.F., with the usual statements of Ohm's law, give not the slightest clue as to what E represents. This difficulty is overcome immediately by means of the fundamental form of this law which has been put forward. A direct application of this form of the law to the particular case under consideration would be to measure the heat caused by resistance in the cell per unit of electricity, which is the fundamental mode of measuring a fall of potential caused by resistance, and then to find the ratio of this fall of potential to the current. This ratio is the resistance of the cell. This would be an application of Ohm's law to the cell. The experimental difficulties of this method of measuring the resistance of a cell are well nigh insurmountable; and, as far as I know, no attempt has ever been made to overcome them. Therefore, some indirect method must be established.

One of these, which was much in vogue until about a decade ago, and has not yet been relegated to its proper place in all text-books, is Mance's method. Two conditions must be satisfied in this method: the E.M.F. of the cell and its resistance must be constant for two widely differing currents.

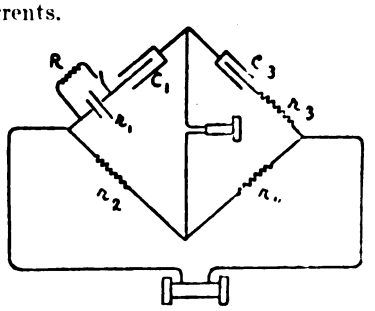

FIG. 3.

A far better method is to measure the rise of potential through the cell from the negative to the positive terminal, when a current, which can be found, is flowing through it; and immediately after opening the circuit, before disturbing changes in the cell can occur, to measure the rise of potential through the cell when no current is flowing. The first rise of potential will be denoted by e; the second rise of potential, which is the E.M.F. of the cell with no current, will be denoted by E; the current will be denoted by I. The rise of potential through a cell when a current is flowing is less than the E.M.F. of the cell with that current by a magnitude which is the fall of potential caused by resistance. *Hence if the E.M.F. of the cell with a current is equal to its E.M.F., immediately upon the cessation of the current*, $E - e$ is the fall of potential in the cell caused by resistance, and the ratio of this to the current flowing through it is, by the convention already stated, *the resistance of the cell*. If r is the resistance of the cell, we have $r = \frac{E-e}{I}$.

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Carhart has developed a particular mode of carrying out this general method. He measured the rises of potential in the cell by charging a condenser attached to the terminals of the cell, and discharging it through a galvanometer. By this method Carhart found that the resistance of a Daniell cell decreased from 5·56 ohms with a current of ·024 amperes to 4·80 ohms with a current of ·190 amperes. It can be urged against these experiments that the E.M.F. with no current, which was measured before, instead of after, measuring the rise of potential in the cell with a current, was too great, and that this error was greater for the smaller currents.

Ayres has devised a modification of the method of Kohlrausch. A Wheatstone bridge is used with the cell and a condenser for one arm, a condenser and adjustable resistance for another arm, and two adjustable resistances forming the remaining arms. The junction of the first two arms is joined to the junction of the last two arms by a conductor attached to a telephone. The current for the bridge is supplied by an induction coil joined to the other pair of junctions. This arrangement permits the measurement of the resistance of the cell through a wide range of current. The current from the cell flows through an auxiliary conductor attached to its terminals. A diagram of the bridge is shown in Fig. 3. The limits of this paper will not permit a discussion of the theory of this bridge. The equations which hold when there is no current in the telephone are

$$\frac{r_1 R}{r_1 + R} = \frac{r_2}{r_4} = \frac{C_3}{C_1}$$

r_3

The deduction requires that the E.M.F. of the cell and the resistance are constant for the slight currents added by induction coil to the current of the cell. Ayres found that the resistance of a Daniell cell did not vary more than a few thousandths of an ohm from 1·600 ohms, for currents from a few thousandths to about one-fifth of an ampere. These results are to be expected in view of the experiments made with electrolytes which are not parts of cells.

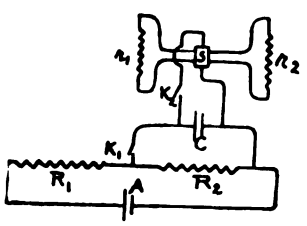


FIG. 4.

I have performed a series of experiments with a Daniell cell to determine whether the disagreement between results of Carhart and of Ayres aries from errors in the experiments of Carhart, or whether they demand another explanation. The method of these experiments differs from that of Carhart merely in the manner of measuring the rises of potential in the cell with and without a current. Instead of a condenser an auxiliary circuit was used. The rises of potential were measured by balancing against a fall of potential in that circuit caused by resistance.

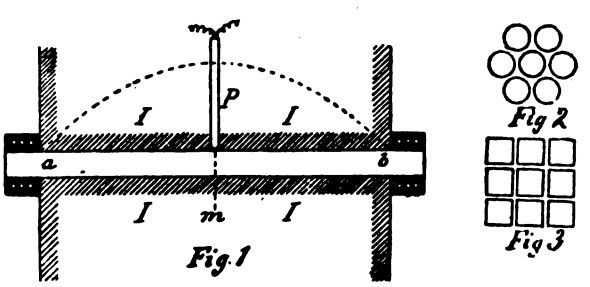
Fig. 4 is a diagram of the arrangement of the apparatus. The rises of potential in the Daniell cell C were measured by the fall of potential in a resistance R_2 in which a steady current was flowing from a storage cell A. This current was maintained steady by keeping the temperature of the storage cell constant and keeping the sum of the resistances R_1 and R_2 in two boxes always equal to that of one of them with all the plugs removed. The resistance in each of these boxes was, of course, varied for each adjustment. The current through R_1 and R_2 was measured before and after a series of measurements by balancing a Clark cell across R_2. The Daniell cell had a cylindrical sheet copper electrode 11 cm. high and 8 cm. in diameter which rested upon the bottom of the containing vessel. A saturated solution of copper sulphate was 3½ cm. deep in this vessel. A porous cup was placed centrally inside the copper cylinder, and a zinc rod 1 cm. in diameter was placed centrally with its lower end upon the bottom of the cup. A saturated solution of zinc sulphate in the cup had its level in coincidence with the level of the solution outside. The rise of potential in the Daniell cell was first measured before any current had been taken from it, except a trace in adjusting the resistance R_2 to balance the E.M.F. of the cell. Then a circuit was closed containing the cell and the box r_1 with a resistance of 15 ohms in it. When the cell had reached a *constant state*, the rises of potential in the cell were measured while the current was flowing and immediately after opening the circuit momentarily at the key K_2. The rises of potential of the cell in *the same state* were measured immediately after momentarily disconnecting r_1 from the cell and connecting r_2 to the cell with resistances of 60 ohms and 200 ohms successively. This was done by the switch S. A d'Arsonval galvanometer, not shown in the diagram, was used in obtaining the balances. At the beginning and end of one set of experiments the Clark cell with an E.M.F. of 1·4413 volts was balanced by a resistance of 7957·5 ohms in R_2, showing a remarkable constancy of the storage cell. The current in R_2 was ·00018112 amperes. The E.M.F. of the Daniell cell before taking any current from it was 1·0981 volts.

Accordingly a slight decrease in the resistance of this cell, beyond the errors of measurement, exist according to this method. This can be explained in another manner, which will bring the results of the method of Ayres and this method into agreement. The equation for this method depends upon the assumption that E.M.F. of the cell immediately upon the cessation of a current is equal to the E.M.F. with that current. In the equation for the resistance of the cell $r = \frac{E - e}{I}$, if E, the E.M.F. of the cell immediately upon the cessation of the current, is smaller than the E.M.F. of the cell with the current, the value of the resistance of the cell obtained from the equation will be less than its true value. An increase of the E.M.F. of the cell with the current is therefore all that is necessary to explain the contradiction between the results of this method and those of Ayres, and there seems to be no reasons which can be raised with our present knowledge against this explanation. Further experiments with other concentrations of the solutions are desirable, accompanied by the simultaneous application of the method of Ayres and this method.

ELECTRODE LOSSES IN ELECTRIC FURNACES.

By CARL HERRING.

The object of this paper is to find by experiment mean conductivities which should be inserted in the receive formulas in order to find the best ratio of length to cross-section of an electrode. The test is as follows, the arrangement being shown in Figs. 1 to 3 :



FIGS 1 to 3.—MEASUREMENT OF CONDUCTIVITIES.

Let *ab*, Fig. 1, be a rod of the electrode material to be tested, embedded in a heat-insulating material I, except at its ends, which are water-jacketed or otherwise cooled and kept at a constant known relatively low temperature. The refractory material I is assumed to be a perfect heat insulator. The cross-section of the rod is S square inches, and the length of the embedded part is L inches.

Let a relatively large electric current be passed through this rod from end to end. This will raise the temperature of the embedded part, the highest being at the middle section m, and it will fall toward the two ends to the temperature of the water-cooled ends. A pyrometer P is introduced at the middle point.

When the constant current has been passed for a sufficient length of time, so that the stable state is reached, that is, until the pyrometer ceases to rise, then it is evident that

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all the heat generated in the rod electrically, flows out only at the two ends, as the heat insulation is assumed to be perfect. When this state has been reached, the temperature at the centre and at the water-cooled ends, the current and the voltage between the two terminals, should be measured. The product of the current and the voltage gives the heat flow in watts W which is leaving at the two terminals. It is not necessary to measure the heat absorbed by the cooling water, as this heat flow is determined much more readily and probably far more accurately by means of an ammeter and voltmeter.

The heat conductivity of this material is then determined from the following formula :

$$k = 0\,02986 \frac{W\,L}{T\,S}$$

in which k is the mean heat conductivity in gram calories per second per sq. in. for one degree C. per in., and T the difference in temperature in centigrade degrees between the maximum at the middle and that at the water-cooled ends.

From the same readings of the volts E and amperes C in this test the mean electrical resistivity for that same range of temperature is readily calculated from the formula

$$r = \frac{E\,S}{C\,L}$$

in which r is the resistivity in ohm, cubic inch units. This method is based on the assumption that the heat insulation of the test rod is perfect. This may be accomplished with probably no appreciable error by surrounding the test rod by a tube of the same or a similar material, which is electrically insulated from it, and which is also heated by a current to the same temperature at its middle part and cooled to the same temperature at the ends. The two heat gradients in the test rod and in the surrounding tube will then be the same, hence no heat will leave the embedded part of the test rod except the very slight amount which flows longitudinally through the cylindrical shell of heat-insulating (and therefore non-conducting) material surrounding the rod and escapes at its outer ends. If this shell is made very thin, just thick enough to insulate electrically, and the rod be made relatively large in cross-section, and long, the heat which is thus lost through this insulating material may be made extremely small, especially if the material is loosely fibrous or granular, so that the actual heat insulation is practically due to the air in the interstices. Moreover, only one-half of this small heat loss comes from the test rod, the other half coming from the tube.

Instead of using a tube for obtaining this heat insulation, which may at times be difficult to do, it is much simpler and probably quite sufficiently accurate for all practical purposes, to surround the test rod with a number of similar rods embedded in the same insulating material and placed parallel and as near as possible to the test rod about as shown in Figs. 2 and 3, in which the middle one is the rod under test. The ends of each are water-jacketed like the test rod. These can then all be connected electrically in series with each other and with the test rod so that the same current heats them all; if then they are all of the same size and material, the temperature can be safely assumed to be practically the same in them as in the test rod, and it is then unnecessary to use a second pyrometer on the outer row of rods to see that the temperature is the same as that of the test rod.

BRADFORD ELECTRICITY HEADQUARTERS.

Mr. Thomas Roles, City Electrical Engineer and Manager, informs us that the offices of the Bradford Corporation Electricity Department have been removed from the temporary premises at Whitaker Buildings, Victoria-square, occupied for some years past, and are now in the extension to the Town Hall, which has recently been completed.

The new premises are much better adapted to the needs of the staff, which has augmented considerably as a natural consequence of the growth of the Department. A small showroom has been fitted up adjacent to the enquiry office, so that all callers cannot fail to see the exhibits of fittings, motors, heating and cooking apparatus, for use on direct and alternating current circuits, which it is intended to display there. Mr. Roles will be glad at all times to receive particulars regarding new apparatus for the utilisation of electrical energy, and to introduce these to local consumers, should they, on being tested by the department, meet with their approval.

In this connection it may be interesting to state that the department have already made arrangements to illuminate the large general office with the "Moore" yellow vacuum tube light, and that the apparatus in connection with this system of lighting is now being fixed, and will shortly be in operation. A further installation of the "Moore" white light for colour matching is to be fixed up in another room, should the installation of the yellow light prove satisfactory. This should prove an invaluable departure, not only for shopkeepers, but for wholesale warehousemen and manufacturers. Mr. Roles is to be congratulated upon the success that has crowned his efforts in connection with this ever-increasing department.

ELECTRIC INSTALLATION IN ITALY.

By ARTHUR MORRIS.

Concluded from page 925.

The largest part of the energy obtained is consumed in driving three synchronous 300 h.p. 12-pole motors. They are fed direct by the high voltage current, and make 205 revolutions. Each motor drives a wood grinding mill, in which the wood is forced on to the stone by an hydraulic pressure of 10 atmospheres at two points. The three grinders grind up 635 cubic feet of Italian poplar and Tyrol pine in 24 hours. The motors are started by means of an oil-cooled resistance with a 450-volt current. The ring is then closed and the brushes removed. Starting takes about 1 min. The other motors in the mill are fed with a 220-volt current by two 180 kw. transformers in the engine room. These are air-cooled by two 3 h.p. fans. Only one transformer is at work at a time. One phase of the transformer at work (*i.e.*, 125 volts) serves for lighting purposes.

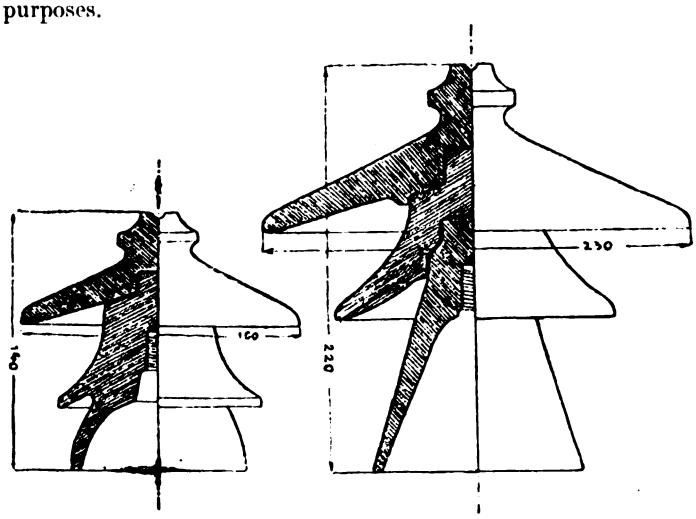

FIG 3.

On the first storey of the main building are 3 beating engines and a rotary filter, driven by a 120 h.p. motor. Four wood mills are driven by transmission from a 100 h.p. motor. An 84 h.p. Siemens-Schukert motor, regulable within the limits of 70 and 145 amperes, drives, by means of a friction coupling, a satinising calendar with 12 rollers. There are also motors for a reeling machine (30 h.p.); for a cutting, a folding, and a ruling machine (20 h.p.); for two centrifugal pumps delivering 20,000 gallons an hour (15 h.p.); for a sawing, a barking, and a wood chopping machine (6 h.p.); for workshop use (15 h.p.); and also two 8 h.p. and 3 h.p. motors.

There are two boilers, each used in turn; they have automatic stokers and an electric feed pump, but a steam feed pump is kept ready when wanted.

Right in front of the paper mill is a silk weaving factory, the Tissitura serica di Toscolano. This is supplied by the same power cables as the paper mill. It is worked and lighted by two 50 kw. transformers used in turn, and giving a current of 120 volts. There are the following small motors: one of 30 h.p., for the main transmission (belt driving, etc.); one of 14 h.p., for a pump; and 25 smaller motors.

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FIRE ALARMS AND RISKS.

Electricity being as yet little understood by the general public, and still less by the "half-penny journalist," is usually put down as the cause of every conflagration which is not obviously due to some other agency. "Fused electric wires," "broken glow lamps and falling red-hot filaments" make excellent scare headings for the "live" sub-editors of the sensational press. That these wild divergences from truth have to be constantly rectified matters little to the scaremonger. But the unfortunate part of the affair is that a lie generally travels faster and wider afield than a half-hearted retraction, printed in small type and placed in an out-of-the-way corner. And a lie, even of a notorious, oft-detected offender, has a long and tough life. Thus much harm is done. Two notorious cases have happened of late. The burning down of the Britannia Pier Pavilion, Yarmouth, and the lamentable fire at a drapery establishment at Clapham. We were told that "the only possible explanation" for the Yarmouth disaster was "that an electric wire fused." It has been proved that this could not have been the cause, as adequate precautions had been taken not only as regards insulation, but also as regards the cutting off of the current at the land end of the pier when the Pavilion was not in use. But the "fused wire" system still persists to the detriment of electricity. The Clapham fable is even worse. It was said by a halfpenny paper claiming an enormous circulation that the fire had been caused by an umbrella falling against an incandescent glow lamp, the red-hot filaments falling on celluloid goods, which were promptly set alight. This circumstantial "tale" was vouched for by the newspaper's "expert," with the result that many people all over the country were rendered suspicious of the metallic filament lamp. Any number of electrical lighting engineers might, like Mr. Edgcume, of Kingston-on-Thames, explain that the thing was impossible, that the "moment the vacuum

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globe was broken the air rushed in, and you could catch the broken filaments in your hand without feeling the slightest discomfort." The suspicion lingers on, to the retardation of progress. The necessity for enlightening the public becomes daily more apparent. Electricity is, due precautions having been taken, far safer than any other form of illuminant. It is true that this demonstrable safety does occasionally lead to foolhardy acts. We must face the fact that electric lights may become a source of danger owing to two faults which, unfortunately, seem to be rather on the increase. To begin with, the popularising of electricity has brought about a certain amount of that familiarity which breeds contempt in the half-enlightened mind. There is a tendency for the incompetent tradesman to rush in and undertake internal wiring of houses and shops. Carelessness in these matters is particularly noticeable in connection with temporary wiring, generally for purposes of decoration. This danger will, no doubt, gradually disappear as more men are trained in technical classes, or otherwise, in the elementary work. But it is a danger that has to some extent justified the demand in some quarters for compulsory licensing of wiremen, and renders supervision essential. Then, again, the consumer of electricity has, by experience and observation, become convinced of the superiority of electricity as regards safety over gas and petroleum, and finding that an incandescent glow lamp radiates comparatively little heat, treats it with a lamentable disregard of all common-sense precautions. Mr. S. J. Castle Russell says that in his capacity of electrical adviser to fire insurance companies, he has found that the unreasonable practice of placing electric lamps in contact, or in positions where they may easily come into contact, with combustible materials, prevails largely and is not infrequently a cause of fires. Less precautions are required with electricity than with any other illuminants, but some are necessary, and it is for the expert to show how easily and cheaply these can be applied. In this matter of fire alarms and risks, then, two things are needed: the education of the public as to the safety of electricity, and the insistence upon the fact that such safety can best be secured by the employment of experts in this as in other sciences.

CORRESPONDENCE.

TO CORRESPONDENTS.

All communications intended for the Editor should be addressed "The Editor, 149, Fleet Street, London, E.C." Anonymous communications will not be noticed. Letters should reach the Editor not later than Tuesday afternoon to be included in that week's issue of the Journal.

The Editor is not responsible for, nor does he necessarily endorse opinions advanced by correspondents.

LIGHTNING CONDUCTORS.

Sir,—Mr. Barton's description of damage to the Wesleyan Church, Brisbane is not sufficiently explicit to enable me to grasp the details with certainty, but if I am right in supposing that the conductor was carried down, say, a flagstaff or pinnacle on to a lead roofed tower and then up and down over a high but not very thick parapet wall, it would not be very surprising if a spark perforated the wall, but the occurrence would be dependent upon the relative height and thickness of the parapet. With lead flashing let into the wall on both sides (as sometimes happens) the occurrence would be still more probable.

I have not come across such an occurrence in this country probably because conductors are rarely fixed in such a way and also because such parapets are not usually very high in proportion to their thickness. The Lightning Rod Conference Report (1882) says: "In no case should the length of the rod between two points be more than half as long again as the straight line joining them," and in "Scientific Protection," I have said that it should not be more than twice the distance between the two nearest parts of the conductor in a straight line, which is still well within the margin of safety. The genuine report of the Lightning Research Committee (1905), quotes the Conference rule with the addition of, "The straighter the run the better," which, for a scientific pronouncement, is remarkably vague.

That a spark will occur across a gap in a loop is a well-known fact, but the loop has to be very large in proportion to the gap for this effect to be obtainable. It does not necessarily imply that the discharge is taking a short cut for Mr. Wimshurst showed, by means of an ingenious arrangement he called an analyser, that the discharge across the gap was in the opposite direction to that sent through the lead and that therefore it was probably merely a local effect, the original current taking the path of least resistance round the longer course of metal.

This matter of the "loop" has a very important bearing on the subject of protection from lightning, but more as regards loops formed by other metals about the building than in the conductor itself. It is, however, irrelevant to the point I raised, viz., that an abrupt bend in a conductor does not increase self-induction and consequent liability to side-flash.

Yours, etc.,

ALFRED HANDS.

DIARY.

WEDNESDAY, JANUARY 5.

INSTITUTION OF ELECTRICAL ENGINEERS. (Birmingham Local Section).—At 7.30 p.m., at the University, Birmingham, ordinary meeting.

SATURDAY, JANUARY 8.

ASSOCIATION OF ENGINEERS IN CHARGE.—At the St. Bride Institute, Fleet-street, 7.30 p.m., social evening.

TUESDAY, JANUARY 11.

INSTITUTION OF ELECTRICAL ENGINEERS (Manchester Local Section).—At 7.30 p.m., at the Physical Laboratory, University of Manchester, "The Testing of Rubber for Electrical Work," by Professor A. Schwartz, M.I.E.E.

INSTITUTION OF ELECTRICAL ENGINEERS (Glasgow Local Section).—At 8 p.m., at the Lecture Hall, Bath-street, ordinary meeting.

NATIONAL ELECTRICAL MANUFACTURERS' ASSOCIATION.—At 2.30 p.m., at Balfour House, Finsbury Pavement, E.C., Committee meeting.

ILLUMINATING ENGINEERING SOCIETY.—At 8 p.m., at the Royal Society of Arts, "Glare: Its Causes and Effects," by Dr. J. Herbert Parsons, F.R.C.S.; Prof. S. P. Thompson, F.R.S., in the chair.

WEDNESDAY, JANUARY 12.

ASSOCIATION OF ENGINEERS IN CHARGE.—At 8 p.m. at the St. Bride's Institute, London, "Heating and Ventilating," by Mr. T. W. Aldwinkle, F.R.I.B.A.

THURSDAY, JANUARY, 13.

INSTITUTION OF ELECTRICAL ENGINEERS (Dublin Local Section).—At 8 p.m., at the Royal College of Science, ordinary meeting.

INSTITUTION OF ELECTRICAL ENGINEERS.—At 8 p.m. at the Institution of Civil Engineers, Great George-street, London, S.W. Second Lord Kelvin Lecture: "Lord Kelvin's Work in Telegraphy and Navigation," by Prof. J. A. Ewing, C.B., F.R.S., Member, Director of Naval Education.

JUNIOR INSTITUTION OF ENGINEERS.—Meeting, 7.30 p.m., at Royal United Service Institution, Whitehall, "The Creation and Development of a Successful Port," by Mr. R. H. Hammersley Heenan, M.Inst.C.E. (Hon. Member).

TUESDAY, JANUARY 18.

INSTITUTION OF ELECTRICAL ENGINEERS (Manchester Local Section, Students' Section).—At 7.30 p.m., at the Municipal School of Technology, "The High Tension Spark Discharge in Air," by P. Kemp, M.Sc.Tech., and W. A. Stephens, M.Sc. Tech.

WEDNESDAY, JANUARY 19.

ROYAL SOCIETY OF ARTS.—At 8 p.m., "The Japan-British Exhibition, 1910," by Count Hirokichi Mutsu, C.V.O.

FRIDAY, JANUARY 21.

NORTHAMPTON INSTITUTE ENGINEERING SOCIETY.—Visit to the Board of Trade Laboratory, Whitehall.

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PUBLICITY.

In this Section of "The Electrical Engineer" we give Publicity to New Inventions and Specialities.

Visit to the Foster Arc Lamp and Engineering Co.'s Works.

E. KILBURN SCOTT.

The works of this progressive firm are situated at Wo'pleroad, Wimbledon, and there are several features which the writer is especially pleased to record.

The Company specialises in a few particular lines—Arc lamps, auto-transformers, automatic switches to cut off auto-transformers and metallic filament lamps. By giving their whole attention to the above, they are able to turn out first-class work; and, what is so important at the present day, can give immediate delivery.

The three directors know their work at first hand. Mr. Grote is an expert electrical designer, Mr. Ely is a business man of standing in Wimbledon, and Mr. Dobson manages the works. They are ably assisted by Mr. Jones, Mr. Bagnall, and Mr. Hill, heads of departments.

The firm is eight years old, and employs 130 hands, but progress has been so rapid lately, that the present works, which have only been occupied 18 months, are already too small. New works, capable of accommodating 500 hands, as a first instalment, are now being built. Talking about hands; the firm is entirely British; there are no Germans or American college boys in the place.

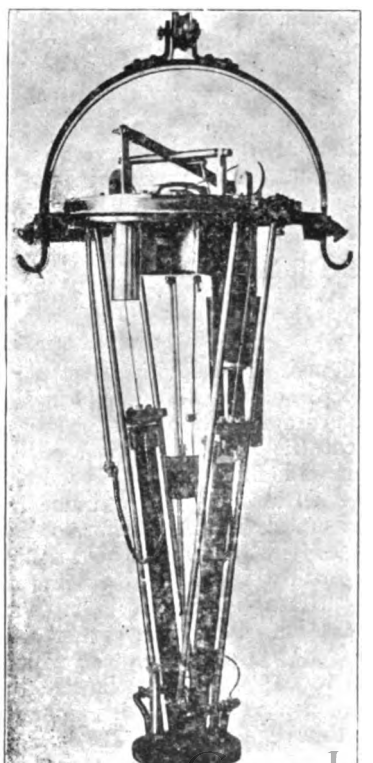
When the firm first started they made the Foster hot wire lamp, which is unique amongst arc lamps in not having a solenoid. It says much for the excellence of the design that the lamp is still being made in large numbers almost exactly as first designed. When the above lamp was fairly under weigh, the firm brought out a midget arc lamp, and although small arcs have gone out of favour, the writer noticed that several midgets were being tested. There were other arc lamps, but the one which took the writer's attention was the new Q type flame arc.

FLAME ARC LAMP.

As compared with old type arc lamps, especially of the enclosed pattern, flame arcs have been handicapped in having very thin, high-resistance carbons, which required frequent renewal.

The Foster Company are using carbons consisting of two and four round carbons moulded into one. It will be easily understood that a carbon so shaped will carry the current without having a wire embedded in it, and at the same time it is mechanically strong. The greatest advantage is, however, that the time between trims is lengthened, for whereas a single 10 m.m. carbon will burn for only 16 hours, a duplex carbon has a life of 25 to 30 hours, and a quad carbon 40 to 50 hours. The carbons are more expensive, it is true, but that is nothing compared to the cost of trimming.

At the lower end the carbons pass through an economiser, which looks like burnt magnesite. It is similar to that used in other flame arcs, except that there is no shutter arrangement for striking the arc. The carbons simply fall by their own weight until they touch, and the arc is struck by the series solenoid drawing them up and apart. It will be easily seen that a duplex or quad carbon has an advantage in this respect over single carbons, which, if they did not happen to fit tight in the economiser, might slip down too far. As each carbon weighs about $\frac{1}{4}$ lb. when first put in, the decreasing weight as it burns away must be allowed for, and this is done by passing the supporting wire over a scrowl drum, so as to shorten the leverage as the carbon burns away. Above the economiser there is a blow magnet, with two coils carrying the main current of 7 amperes for a D.C. lamp. The lamp is differential with series and shunt coils pulling on a rocking lever attached to a brake drum. As the carbons burn away the arc gets longer, and having an increasing resistance, more current passes through the shunt coil and the carbons feed together. The brake consists of a steel fusee chain passed completely round a gun metal drum about 4 in. in diameter, and having a gripping device controlled by the two solenoids. It is a stout mechanical job. The D.C. lamp works best with 45 volts 7 amperes at the arc, but it will work with only 35 volts. Soft carbons enable lower voltages to be used. The alternating arc takes 45 volts 10 amperes, and both the carbons are 9 m.m. The globe is opalescent mushroom-shaped, about 9 in. in diameter and 8in. deep. It is held to the casing by a bayonet joint, a space being left all round for the fumes to get out. This is important, for if the space is too great air gets in too freely, and the carbons burn away quickly. On the other hand, if the globe fits too tightly, the arc shortens and gives decreased light, and at the same time there is a deposit on the inside of the globe which cuts off the light. Long-burning hours are of no advantage in flame lamps if there is a deposit on the globe.



FLAME ARC LAMP (MECHANISM).

As the fumes of yellow flame arcs attack brass, all the brass work at top of lamp is cut off entirely.

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Auto-Transformers.

The transformers' department is in charge of Mr. Bagnall, an old Johnson & Phillips' (where auto-transformers were first introduced) colleague of the writer's, and wha he does not know about auto-transformers is not worth much. The business that has sprung up in these useful adjuncts to the metallic filament lamps is shown by the fact that this firm alone supplies over 6,000 a year, and amongst their clients is one of the largest German factors in London. They are made to standard as far as possible, so that the firm can keep up its reputation of delivering the same day as ordered, whatever the sizes, voltage or output. There is a single coil usually wound with two sizes of wire joined together. The layers as they are wound, are painted with a special compound having the properties of high electrical resistance, but good heat conductivity. The result is that the interior coils have about the same temperature as those outside. Considering the smallness of these transformers,surprisingly high efficiencies are attained. The iron loss is, of course, the one to keep down, and for this purpose Stannos steel is used, the line density being 7,000 to 10,000 lines per sq. cm.

AUTOMATIC TRANSFORMER.

The following are some particulars of an auto-transformer of 200 to 100 volts and 35 amperes. The winding is two No. 12 S.W.G. wires in parallel, working at a current density of 1,000 amperes per square inch.

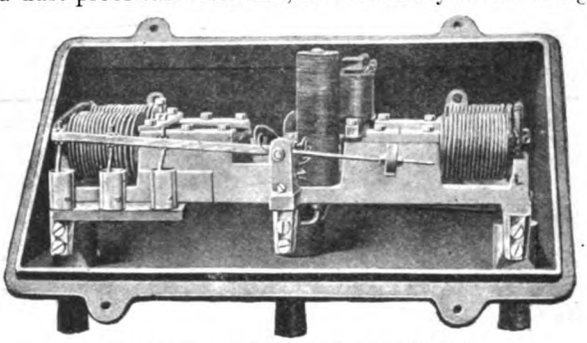
No load (iron) loss	42 watts.
Full load (copper) loss	22 ,,
Drop	1%
Efficiency	98·1%

BELL TRANSFORMER.

In the bad old days of house-to-house transformers an efficiency of 70% would have been thought good. Everybody knows what a nuisance it is to have to keep recharging Leclanch5 batteries for bell work. Mr. Bagnall has devised a small transformer giving 6 to 8 volts on the secondary, which is listed at 15s. It costs practically nothing to fix, and it will keep the bell going full blast for any length of time.

Auto-Transformer Switch.

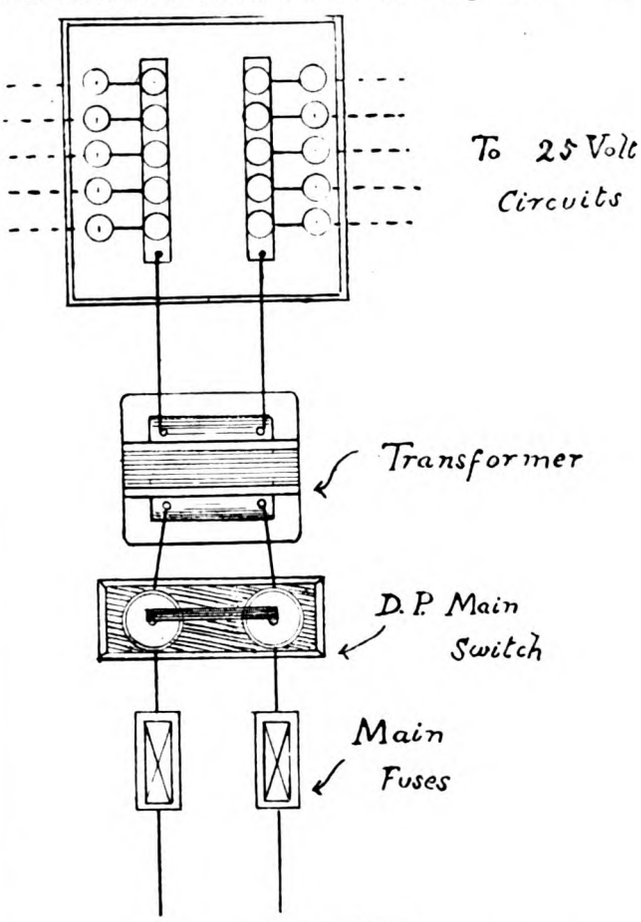
Although the writer has just pointed out that the efficiency of auto-transformers is high, yet at the same time there is ample justification for an automatic switch which will cut the auto-transformer out of circuit directly the last metallic filament lamp is switched off. To show what this iron loss going on continuously means in a year, we will assume a case. A transformer has a secondary capacity of 30 amperes at 100 volts, and the number of hours during the year in which no light is being used, but during which the transformer is in circuit, is 7,760 hours. The current consumption of the transformer alone would be approximately 310 B.O.T. units, which at 5d. per unit comes to £6 9s. 2d. As the listed price of the switch is only about two-thirds of this amount, its cost is more than covered in the first year. The chief points to be considered in designing an automatic switch are absolute reliability in working, silence. a low minimum current to operate, the absence of voltage drop over the secondary circuit when in use, and the avoidance of any subsidiary apparatus such as batteries, which may require constant attention. It should also automatically cut the transformer *in* or *out* with the current taken by one 10 c.p. metal filament lamp. This is a pretty large order, but the Foster automatic switch fills the bell in every particular, and being enclosed in a dust-proof cast-iron case, its continuity factor is high.



AUTOMATIC SWITCH, WITH COVER OFF.

The switch consists of a pivoted lever, with an armature at each end. Each armature is embraced between the poles of an electro-magnet wound with wire capable of carrying the full secondary current of the transformer.

Above one of the armatures is a smaller electro magnet, wound with very fine wire, and having in series with it a resistance of about 6,000 ohms. The rocking lever has an extension, carrying at one end two plungers dipping into mercury pots, and at the other end an adjustable weight. When current is switched on to one lamp the fine wire



PLAN OF WIRING.

electro magnet is energised in series with that lamp, and its pull tilts the rocking lever so that the plungers make contact with the mercury. The first plunger connects the auto-transformer to the high tension mains, and the second plunger short circuits the fine wire coil resistance

Metallic Filament Lamps.

In addition to the above, the firm has recently started making metallic filament lamps, and this is the only part of their works where female labour is employed. It is the firm's intention to follow out their policy and turn out an all-British product, every part made at their own works.

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TECHNICAL PROBLEMS, WITH SOLUTIONS BY PRACTICAL MEN.

Owing to our steadily increasing circulation and the ever widening interest taken in these Technical Problems, it has been found necessary to revise the old regulations.

The new Rules have been framed in order to encourage fresh talent to enter the field; at the same time it is hoped that the progressive lines adopted will meet with the cordial approval and support of our old and valued correspondents.

It is to be noted that these Rules only apply to Questions 1213 and onward. The first replies under the new conditions will appear in our issue of January 7, 1910.

RULES.

Under the above heading we insert questions of a practical character relating to power stations, electrical railways and tramways, mining installations, electric power in workshops, electro-metallurgical plant, and electrical engineering work generally.

QUESTIONS.—For each suitable question we offer one shilling. Questions of a practical character stand a better chance of acceptance than those of a theoretical nature. Questions may be sent in at any time.

WEEKLY PRIZES FOR SOLUTIONS.—For the best solution of any question we offer a cash prize of *seven shillings and sixpence.*

For the second best solution (if published) we offer a prize of *five shillings.*

For the third best solution (if published) we offer a prize of *two shillings and sixpence.*

QUARTERLY PRIZES.—No competitor will be awarded more than three third prizes, two second prizes, or one first prize during any one quarter. But, in adjudicating upon the merits of the various solutions, marks will be allotted to the four best solutions to each question, and at the end of each quarter extra prizes will be awarded to those competitors receiving the highest aggregate number of marks.

These prizes will be awarded in kind, the winners being at liberty to choose any book advertised or reviewed in our columns, or any instrument or appliance manufactured by any advertiser in our pages. These quarterly prizes will be of the value of *one guinea, half-a-guinea* and *five shillings.* Winners may, if they should so desire, order through us books or appliances of a higher value than their prizes, by forwarding to us the difference in price.

MSS. AND SKETCHES.—All answers to problems must be sent in within fourteen days of the question appearing in our columns. Replies should be concise and ought not to exceed one thousand words in length.

Quarto paper (10 in. by 8 in.) should be used, only one side being used, a margin 1½ in. wide being provided on the left side of each sheet. The number *only* of each question should be written legibly at the top left-hand corner of each solution. The solution should be signed with initials or pseudonym, and the name and full address of the contributor must be appended. Any formula should be set out on a line by itself; all letters and symbols in the text should be clearly written, to make them conspicuous.

Loose sketches should bear the *number* of the question and the author's name and pseudonym, and should be pinned to the MS.

Sketches must be drawn in ink, with good solid lines. Squared paper may be used, but as the faint blue lines are not reproduced by the photographic process, all horizontal or vertical lines to appear must be inked in with heavy, full dotted or chain dotted lines as required. Column width blocks are preferred, so it is well to draw sketches 6½ in. wide, for reduction to one-half.

Copyright of all solutions awarded prizes becomes the property of The Electrical Engineer, Ltd.

QUESTIONS.

Question No. 1214.—Discuss the best arrangement of a photometric testing room for a supply corporation to test consumers' lamps; also recommend the points to be observed in choosing a photometer for laboratory use.—"C. B."

Question No. 1215.—What is the trade method employed to produce permanent magnets of high magnetism such as are employed for magneto generators? And should one of these magnets lose its magnetism, how may this be restored? Direct current at 550 volts and 110 volts obtainable up to 200 amperes.—"*East London.*"

REPLIES.

Question No. 1212.—Owing to the great improvements that have been made this last few years in metallic filament lamps and their manufacture for H. V. circuits and large and small candle powers, a great many supply undertakings are seriously considering the advisability of changing over their street lighting from arc lamps to that of some kind of cluster of metallic filament lamps placed on lower posts and at more frequent intervals, thus giving a more even distribution of light (although, perchance the total c.p. may be less). State the pros and cons of street lighting by metallic filament lamps V. open type, 10 amp. arc lamps, and give, if possible, a list of towns where arc lamps have been changed over.

Answer to Question No. 1212 *(awarded* 10*s.).*—The whole problem being mainly a financial one, it will be best to first consider the cost of installation and operation of two alternative schemes suitable for a small town or for back streets of a large town. It is only in such localities that it is necessary to employ *small* arc lamps, and it is only with small arcs of, say, 700 c.p. or under, that incandescent lamps can at all effectively compete for street lighting.

Let it be assumed that the minimum illumination (which will occur midway between lamps) is to be 0·03 candle-foot. Also let it be assumed that the law

$$I = \frac{C.P. \times \sin 3\alpha}{h^2}$$ may be used where

C.P. = mean hemi-spher. C.P. of source; h = height suspension of lamp on feet; I = illumination at point A of minimum illumination, and α = angle between horizontal and the line joining the lamp to the point A, which is distant x feet from the base of the lamp pillar.

Further, assume 600 c.p. arcs and two 50 c.p. metallic filament lamps per post in the two schemes considered, the height *h* may be 30 feet for arc lamps and 11 feet for glow lamps.

Now $\sin^3 \alpha = \frac{h^3}{(x^2 + h^2)^{\frac{3}{2}}}$ hence for the *Metallic Filament Lamps*:—

$$(x^2 + (11)^2)^{\frac{3}{2}} = \frac{11 \times 100}{0{\cdot}03}$$

whence x = 31·3 feet, *i.e.*, pitch of poles = 2 × 31·3 = 63 feet

∴ 84 poles are needed per mile..... (1)

Similarly for *Arc Lamps*:—

$$(x^2 + (30)^2)^{\frac{3}{2}} = \frac{600 \times 30}{0{\cdot}03}$$

whence x = 78·9 feet, *i.e.*, pitch = 2x = 158 feet, hence 34 poles are needed per mile.....(2)

In considering the installation costs, there are two cases for the metallic filament (henceforth called m.f.) lamps (a). Existing gas lamp poles and lanterns may be utilised (b); New poles and lanterns may have to be provided.

The latter will cost about £2 apiece, while arc lamp poles, 30 feet high, will cost about £5 each. A 600 c.p. shunt-coil arc burning 14/9 mm. carbons and having burning hours = 10, will cost, complete with cover, about £4 5s. Hoisting gear and such accessories will cost a further £2. A suitable switch for an arc lamp can be procured for about 7s., while the m.f. lamps will need a weather-proof switch costing, say, 3s. 6d. Cable suitable for m.f. lamp wiring will run out about £6 10s. per mile, while a heavier make for the arcs will cost £20 per mile. Suitable arc lamp carbons ("Apostle") cost about £5 5s. per 1,000 feet, positive and negative; this allowance covers waste, breakages, etc. An allowance of ¼ hour per arc per day at 8d. hour covers ordinary trimming and cleaning, while for m.f. lamps an allowance of three or four hours per lamp-post per annum covers a monthly cleaning of bulbs and lantern and renewals when necessary. Unless a separate main be laid for the arcs, switching on and off costs will be practically the same in both systems, and may be reckoned at ¼d. per lamp per day on the above assumptions, and assuming both arcs and m.f. lamps to be connected to the ordinary supply mains, the additional cable required being 1½ miles per mile of street for the arc system (groups of 5 in series), and ½ mile per mile of street for the m.f. lamp system, the probable cost of installation and working would be as follows:—

Installation costs per mile of street.

Metallic Filament Lamps.							600 c.p. arc lamps (D.C. open).		
Case I.			Case II.				Case III.		
£	s.	d.	£	s.	d.		£	s.	d.
3	5	0	3	5	0	Cable	30	0	0
nil.			168	0	0	Poles	170	0	0
16	16	0	84	0	0	Erection and Connection	85	0	0
42	0	0	42	0	0	Lamps	144	10	0
21	0	0	84	0	0	Fittings ‖ Hoisting Gear, etc.	68	0	0
14	14	0	14	14	0	Switches	11	18	0
21	0	0	21	0	0	Miscellaneous	34	0	0
118	15	0	416	19	0	Total per mile	543	8	0
1	8	4	4	19	4	Total per post	15	19	8

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Allowing 5% interest and 5% depreciation, and assuming a life of 1,500 hours for the m.f. lamps (see ELECTRICAL ENGINEER, December 3, 1909, page 775) at an efficiency of 1¼ watts per c.p., and an efficiency of 0·6 watts per c.p. for the arcs, the operating costs will be as shown in the next table. Note that in Case I. it would, perhaps, be fairer to allow for interest and depreciation on the capital cost of the converted gas standards. The cost of energy is assumed at 2d. per kw. hour.

Operating costs per mile of street per annum.

Case I.			Case II.				Case III.		
£	s.	d.	£	s.	d.		£	s.	d.
11	17	6	41	14	0	Interest + Depreciation	54	7	0
175	0	0	175	0	0	Energy (2d./B.T.U.)	204	0	0
28	0	0	28	0	0	Renewals or Carbons	23	16	0
5	0	0	5	0	0	Attendance (Cleaning, Trimming, etc.)	104	0	0
20	0	0	20	0	0	Switching "on" and "off" (say)	20	0	0
239	17	6	269	14	0	Total per mile per year	406	3	0
2	17	1	3	4	3	Total per lamp per year	11	19	0

It is, obviously, unwise to draw too definite conclusions from such an example as the above. Every case will present its own peculiarities, influencing the results; but on the above quite reasonable assumptions it is clear that m.f. lamps are greatly superior to arc lamps for the lighting of small towns and for lighting the smaller streets of large towns. To obtain the best results from arc lamps, really large units (of over 1,000 c.p.—preferably nearly 2,000 c.p.) of the "flame" type should be employed. To fully utilise these necessitates that the streets are wide and that high (50 feet) centre poles can be used. Small towns or unimportant streets do not justify the installation of such lamps—with which a mean illumination of 1·5 to 2 candle-feet is common. The arcs erected so very sparsely in many small towns and back streets would be much better replaced by double the number of lower poles each carrying one or two m.f. lamps (to the total c.p. of about 100 c.p.). Though I cannot quote off-hand any town in which arcs have been replaced by m.f. lamps, I know of many shops and business premises, etc., which have effected the conversion with excellent results, and of several towns where, but for the advent of metallic filament lamps, small arcs would probably have been employed.—"L. C."

NATAL ELECTRIC TRAVELLING CRANES.

Messrs. Vaughan & Son, of West Gorton, Manchester, have supplied two exceptionally large travelling cranes for the Natal Government's new railway workshops at Pietermaritzburg. Four similar, but somewhat smaller, travelling cranes had previously been supplied for the Government railway workshops at Durban.

The two new cranes supplied for the Natalian capital are of 35 tons capacity each, have a span of 46 ft., and are 28 ft. high above the floor-level to the gantry rail. There is an auxiliary hoist for 5-ton loads. The speeds of lifting are 6 ft. per minute for the full load, or 12 ft. per minute with the quick gear in use, while the auxiliary hoist works at a speed of 25 ft. per minute. Lighter loads can be raised at still higher speeds than this. The rates of longitudinal travel and cross transverse, with full load, are 200 ft. and 70 ft. per minute respectively. Four separate motors, by the Electric Construction Co., are used to operate the different motions. They are of the three-phase type, and take current at 200 volts and 60 cycles. Running at 720 revolutions per minute they will all develop the following powers for one hour continuously, with a temperature rise of not more than 80° Fahr., or double these powers for from 10 to 15 minutes without undue heating or other injurious effects. In this case the speed is 700 revolutions per minute. At the higher speed the main hoisting motor gives 16 h.p. and the auxiliary motor 10 h.p. The longitudinal travelling motor is of 16 h.p. and the cross traversing motor of 5 h.p. Thus, it will be seen, the motors have respectively, in the same order, maximum outputs of 32, 20, 32, and 10 h.p.

MR. GEORGE WESTINGHOUSE.

Mr. George Westinghouse has been elected President of the American Society of Mechanical Engineers. He was born in 1846, his father being a manufacturing engineer at Schenectady, New York. Young George spent most of his time in his father's machine shop, and invented a rotary engineer in his fifteenth year. He took part in the war, serving in the Union Army cavalry. Then he became assistant engineer in the United States Navy, retiring in 1865, mainly to devote his time to mechanical invention. One of the first of these was a railroad frog for replacing derailed carriages and waggons. His next big invention was the air brake, which he has since vastly improved. Then he became interested in electricity, with the result

of the introduction of electro-pneumatic railway signalling. He took a prominent part in the introduction of the alternating-current system for transmission for lighting and power. His success as a manufacturer, organiser and financier in the electrical industry is only equalled by his inventiveness and his ability to help other inventors, such as Stanley and Tesla with their alternating current-work, Walter Nernst with his glow lamp, Peter C. Hewitt with his mercury-vapour lamp, and Bremer with his flaming arc. He occupies a unique position not only in the American but the international electrical world of industry and finance.

ELECTRICAL PLANT FOR SINGAPORE.

In order to bring Keppel Harbour, Singapore, in line with Hong Kong in the matter of accommodation for shipping, the Straits Settlement Government, some months ago, took over the business of the Tanjong Pagar Dock Co., and appointed a Board of Management. The Board at once set about making improvements, and these included the erection of modern machinery from which will ultimately proceed the electrical energy to drive the workshop machinery, and the dock pumping plant at the new works at Keppel Harbour and at the existing works at Tanjong Pagar; to operate cranes and coal-handling plant on the new wharves; and to light the whole of the docks, workshops, go-downs and wharves belonging to the Dock Board. The building is of a very substantial nature, built of brick and steel, and has been erected and equipped departmentally, under the superintendence of Mr. F. R. Marsh, the Board's chief electrical engineer. The buildings are large enough to hold the necessary plant for a further 2,000 b.h.p., the plant at present installed having a total capacity of 1,700 b.h.p. At the inaugural ceremony, Mr. J. R. Nicholson, Chairman of the Dock Board, stated, in order to give some idea of the extent of the improvements in progress, that there were daily employed on the undertaking between 8,000 and 9,000 men—not including the contractors' men, who numbered a further 5,000. The wage bill was about £22,000 a month, and this staff was supervised by about one hundred Europeans, whose salary list, in round figures, amounted to £40,000 a year.

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ELECTRICAL PROGRESS AT HOME & ABROAD

FROM OUR SPECIAL CORRESPONDENTS.

TYNESIDE NOTES.

NEWCASTLE-ON-TYNE.

As Newcastle-upon-Tyne is practically upon the borders of England and Scotland it participates in the festivities of both nations; as a result, both Christmas and New Year have been honoured with the customary north-country heartiness, and there is very little in the nature of business which can be reported upon. At the same time there are one or two indications that enterprise is still the order of the day. A recent electrical installation which is of some interest has been completed for Messrs. Robson & Sons, one of the best-known furnishing firms of Newcastle. They have recently equipped a cabinet-making and furniture manufactory with electrically-driven machinery, and the installation, the consulting electrical engineer for which was Mr. F. Hanks of Newcastle, is a very good example of work in this direction. In Sunderland a most important flour milling installation has been carried out by Messrs. Christie Bros., of Chelmsford. This mill is owned by Messrs. E. C. Robson & Sons, and an important feature of the work is that it is, I believe, the first instance where a power supply at a high tension has been taken into a consumer's premises within the Sunderland area of supply. The switchboard for this purpose was supplied by Messrs. A. Reyrolle & Co., Ltd., of Hebburn, and is of somewhat special interest.

Newcastle Amusements.

Mention must not be omitted of a new and interesting feature in the provision of amusements for Newcastle. It has long been a matter of complaint that the city has been most inadequately equipped as regards premises for the holding of large concerts, political and other meetings, as the Town Hall is of somewhat antiquated design and the main hall has approaches which would not be regarded as altogether safe in the event of fire or panic. A new hall, which is now nearing completion, and which is to be called the "White City," will afford means of filling this want, as it is considerably over 200 ft. in length and some 40 or 45 yards wide. As a meeting hall it will be capable of holding nearly 7,000 people, and when it is not required for this purpose it is to be used as a skating rink. One of the outstanding features of the hall is the lavish use made of electricity for illuminations, the number of lamps utilised inside the building running into thousands, without reckoning the means of attracting the public outside. The builders and contractors for this erection are Messrs. J. Parkinson, of Blackpool, who have been responsible for similar buildings in other great cities.

Progress in Marine Engineering.

The local press is now busy analysing and recording the progress made in the industries of Tyneside during the past year. One of the most important of these industries is marine engineering, and as electric power supply is utilised most freely by the Tyneside engineering undertakings the report of work done is an indication of the success of the electrical undertakings in this area. From the columns of one of these the following figures are taken: Messrs R. W. Hawthorn, Leslie & Co., Ltd., have supplied turbine machinery to the British Admiralty to a total of 41,500 h.p.; the Parsons Marine Steam Turbine Co., Ltd., have built turbine machinery of 36,500 i.h.p. total; the Wallsend Slipway and Engineering Co., Ltd., have engined vessels to a total horse-power of 55,800 and have supplied new boilers to vessels representing a total of 6,960 h.p.; the North-Eastern Marine Engineering Co., Ltd., have built engines having a total of 83,897 i.h.p., the largest powered boat being the twin-screw *Protesilaus*; the Palmer Shipbuilding and Engineering Co., Ltd., have, in addition to an amount of naval work, built engines for the mercantile marine totalling 7,800 h.p.; in addition, Messrs. Baird Bros., The Shields Engineering and Dry Dock Co., Ltd., and Messrs. John Readhead & Sons, Ltd., have done a large amount of engine building so that the work in 1909, while still showing the effects of trade depression, must be considered satisfactory.

Mining Electrical Engineering.

The same journal gives publicity to a very interesting letter received by the Right Hon. T. Burt, M.P., from a consulting and inspecting engineer and colliery expert in this area who has had considerable experience in the application of electricity to mines. He suggests that: (1) Certificates should be obtained by colliery mechanical engineers in charge of the electrical plant; (2) it is useless to appoint electrical inspectors who are purely electrical engineers, as considerable experience of actual colliery practice is necessary; (3) the miners themselves should appoint their engineer to attend inquests, make reports on fatal accidents, and suggestions for their prevention, for the use not only of the miners, but of the owners when installing electric plant; (4) that such records would do much to remove the present feeling against the use of electricity in mines. A clause in the letter is especially interesting, which points out that the Home Office rules were drawn up by men who had no knowledge of mining conditions, and that therefore some of the rules are bad and even dangerous. This letter is an indication of the strong interest which is being taken in this subject in the North-Eastern area.

MIDLAND NOTES.

BIRMINGHAM.

On all the electrical tramways in the Midlands under the control of the British Electric Traction Co., the farthing stage principle of charging fares came into operation on Saturday last. So far the change has worked smoothly, though there were to be found passengers who regarded it with suspicion, and others who found it diffiuclt to understand that the penny minimum had not been superseded by one of something less, either a farthing or a halfpenny. The fact that while 1½d. tickets were issued, 1¾d. ones were refused, was at first somewhat perplexing to passengers, though the majority of them found compensation in the fact that the twopenny fare, which is the next above the three-halfpenny, covers ten farthing stages. The only friction of any moment has arisen in relation to workmen's fares. Some of these have been reduced *pro rata* by the new arrangement, but a few have been increased, the workmen's fare stages in some sections having up to the been abnormally long.

Birmingham and Aston Electricity.

Electric rivalries continue to figure very prominently in the Greater Birmingham Inquiry, and the keenest fighting has throughout been over the relative positions of the various undertakings. A curious feature has been the independent testimony given by outside accountants and experts. For example, Mr. William Cash, a well-known London accountant, made a detailed comparison between the electric undertaking of Birmingham and Aston, in which he pointed out that the margin of profit on the lighting business in Aston was extremely small, because the total cost in Aston, including interest and sinking fund, was 1·16d., while the price they were getting for their lighting and current was only 1·242d., and it seemed to him that Aston would have to put aside sums shortly for renewal fund and reserve. The Aston increase was largely in lighting, which was comparatively unremunerative, while a large part of their profits was apparently due to the high price they were getting for electricity for traction purposes. This witness pointed out that in five years the price of electricity had been reduced in Birmingham 55% as against 14¾% in Aston. A somewhat similar view of Aston's position was taken by Professor S. S. Dawson, another accountant, who declared that in Aston there was no profit on the sale of current and that they were living on their meter rents. He went into con-

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siderable detail with regard to the Aston scheme. The meter sales, he said, had gone up since 1904 from 420,000 units to 2,700,000, and the price had gone down from 1·879d. to 1·2426d. The contract sales price was 1·5 throughout, but the sales had only increased from 631,000 units to 1,316,000 units. The increase in the meter sales during the last five years had been 2¼ million units, and in contract sales, two-thirds of a million units. He declared that it was only in the traction sales that there was a slight profit to be made.

Handsworth.

The same witness made a somewhat close scrutiny of the Handsworth electricity undertaking, under which, he said, in 1907-8 the cost of production per unit was 2·508d. and in the following year 2·07d. Making every allowance for development, and assuming that the present output would be doubled, he estimated that in 1912-13 1,500,000 units would be produced at a cost of 1·7d. per unit.

Future Profits.

Still another view of the Aston undertaking was furnished by Alderman Frederick Smith, chairman of the undertaking, who declared that within the next seven or eight years the electricity undertaking of Aston will be able to furnish relief for the rates to the extent of 1s. in the pound, and he declared that he had received expert advice to that effect.

LANCASHIRE NOTES.

MANCHESTER.

The New Year opens with good prospects of a prosperous year for the local electrical engineering firms. The outlook in the other trades is satisfactory and leads one to anticipate considerable developments in the use and application of electrical power during the coming year. The application of electricity in mining in the Lancashire area has proceeded during the past year with remarkable rapidity. On going through the various electrical shops in the district one cannot but be convinced, from the large proportion of the work in hand for collieries, that here is an enormous field for development. Lancashire alone can provide hundreds of mines where in a few years' time electric winding will be installed. Local supply authorities agree that it is only a matter of educating the mine owners and proving by the successful and economical working of simpler apparatus electricity's advantages, aided by the wearing out of the present plant, to bring about a great increase in the number of electric winding plants in this country. In his recent address at Manchester, Mr. Maurice pointed out that many colliery generating plants rivalled in capacity those of the average municipality; when one considers how little has yet been done towards popularising the use of electricity for all services in all mines, some idea is obtained of the amount of plant required for this work in the future.

Prospects of Mill Electrification.

It is unfortunate that the cotton market is at present in such an unsatisfactory state, for it, to a considerable degree, controls the local business in other trades. Thus, owing to the demand for castings for textile machines falling off, several foundries have had to shut down, while the local iron trade has also been adversely affected. The mining industry has suffered to some extent, owing to the reduced demand by cotton mills for coal. Textile machinery makers here say that the reorganisation of plant in the older Lancashire mills is a necessity which cannot be long delayed. They look to this work being started on in a pretty general way during the coming year and expect in consequence to make up for the poor state of their trade. This is a golden opportunity for electrical engineering firms to secure the conversion from steam to electric driving. It is generally admitted by those mill-owners who have already changed over and have taken accurate records before and after the change, that the only satisfactory way of modernising old mills is by putting in the electric drive. It was confidently expected that the year just past would have seen enormous progress made in the conversion of the old mills, but the difficulties of cotton spinners have been too absorbing to allow them yet to devote attention to this matter. However, as soon as the cotton market is to some extent recovered steps will be taken to bring the mills up to their maximum efficiency. The prejudice formerly entertained against electricity has been almost entirely broken down, largely by the good position electrically driven mills have been able to get in the market, as a result of their good spinning. It has been suggested here, that owing to the disagreement among the Bradford Committee and the consequent uselessness of their report, the Manchester Association of Engineers should appoint a Committee for the purpose of impartially reporting on the best driving power for cotton mills. Such a committee formed here would have no difficulty in obtaining exhaustive information and tests on the spot.

FRENCH NOTES.

PARIS.

I regret to announce the death of M. Pellat, Professor of the Faculty of Sciences of the University of Paris, and President of the International Society of Electricians. M. Pellat was widely known by electricians in most countries, and had accomplished much original research work in this branch of science.

Extension of the Fayet-Martigny Line.

An extension of the electric railway between Fayet and Martigny has recently been opened. The French section, between Le Fayet and Chatelard, is owned and worked by the Paris, Lyon, Meditarrannée Railway, and attains an altitude of 4,567 ft. at a point between the stations of Montroc and le Buet. This part of the line is a three rail one, the current (generated by water power from local waterfalls), is transmitted to the insulated middle rail, the outer ones being utilised as return conductors, being connected at four points with feeders having direct connection with the stations. The current is delivered at a tension of between 550 and 580 volts. There are two generating stations, that at Servoz, near Le Fayet, equipped with continuous current dynamos, and that of Chavants, near Chamonix, having both continuous current dynamos and others generating high tension alternating three-phase currents, the latter being transmitted to two sub-stations. At these sub-stations the current is transformed from high tension alternating to low tension continuous current and serves the third rail at the fifteenth and twentieth miles, respectively. The Swiss section is also worked by electricity, low tension continuous current being used. Between Vernayaz and Salvan the third rail is replaced by a toothed rack rail, the current between Vernayaz and Martigny being transmitted by means of an overhead wire. Between Vernayaz and Chatelard, the third rail is dispensed with, and one of the side rails is made the conductor. It will thus be seen that it is necessary for passengers to change carriages at Chatelard. On the Swiss side electricity is generated by the waterfall of Pissevache at Vernayaz. By an ingenious attachment to the leading motor carriage it has been found possible to clear the rails from ice even in mid-winter. When snow falls, a mixed train is made up, composed of a snow plough, motor van, luggage van and passenger cars, each with its own motor.

Electrolytic Calcium Carbide.

The Société de Carbure et des Produits Chimiques, which controls the calcium carbide trade in France, is practically a branch of the Lonza Electrical Works, Gampel, which manufactures calcium carbide and alloys by electrolysis. This latter company also owns the majority of shares in the Société Niçoise d'Electro-Chimie, and has an interest in the Bosnian Electrical Co., of Vienna. It is, with the Electro-technical Works, of Hasslund, a member of the Syndicate of Electro-Chemical Industry, of Nuremberg. In spite of this combination the Lonza company has made a loss during the past year of 474,995 francs, as compared with a profit of 724,234 in the previous year.

The Lille-Roubaix-Tourcoing Railway.

The Lille-Roubaix-Tourcoing Railway, recently opened, derives its current from an overhead cable, supplied from the generating station at Wasquehal. The current, which is a three-phase one of 10,000 volts with a periodicity

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of 50, is transformed at sub-stations to a continuous current of from 550 to 600 volts. The carriages are of two types, small rigid cars, and bogey cars, the latter having a 30 kw. motor over each spring, that is four motors giving 120 kw. In spite of sharp curves the rate attained is about 38 miles an hour.

Electrical Ploughing.

M. Fillet has given demonstrations of a new system of electrical ploughing, specially suitable for colonial work. The plough, capable of making four furrows at a time, was shown at work at Mitry-Claye. It received its energy from a compound three-phase alternator on the Boucherot system, set in motion by a small 75 Lanz locomotive, with compound superheating and air condensing. The experiments were considered very successful.

GERMAN NOTES.

BERLIN.

A mixed carriage (third and fourth class), driven by benzole, and made by the joint efforts of the Allgemeine Elektrizitats Gesellschaft and the Gasmotorenfabrik Deutz, is now running in the Cologne district. The combustion motor gives 90 h.p., working up to 650 volts. The current from this works the motors that drive the carriage. Thus the carriage is mixed in two senses, as the combustion motor serves merely to generate current for the motors. Three more carriages of the same kind have been ordered, so that this novel departure is evidently very successful.

Electric Stage Lighting.

A new system of stage lighting, invented by Signor Mariano Fortuny, of Spain, has just been exhibited to a select party at the new Royal Opera House at Berlin. It professes to secure a diffusion of the electric light hitherto unattainable, and to prevent glare and black shadows; in short, to secure a perfect imitation of diffused sunlight. Arc lamps are used, but the light from them reaches the stage only after reflection from stretched endless silken fabrics, kept in constant motion over rollers in different directions. The same ingenious gentleman has patented movable clouds. The usual painted clouds in scenery are too stationary, but Signor Fortuny paints his clouds on movable mirrors, on which the reflected electric light falls. He may have remedied the omission of stage moons to work according to the law of gravitation in an orbit in the same way. The experts present considered that the idea was a great forward step from every point of view. It is claimed that an enormous saving of current is effected, as the same current may be made to give five times as much light as it can under the old system, so that less current will serve.

Current Notes.

The Weimar works of the Siemens Elektrische Betriebe A.G., Berlin, is still making steady progress, having made a net profit for 1908–9 of 519,937 marks, as against 512,537 for the previous year. The dividend remains at 6%, absorbing, therefore, 450,000 marks; 24,978 marks are passed to reserve, and 27,500 marks are carried over for next year. The company has a capital of 7½ million marks, and is in the extremely favourable and also exceptional condition of having no creditors.

A less successful concern is the Continental Telegraphen Compagnie A.G. of Berlin. The profit fell from 122,040 marks in 1907–8 to 101,663 in 1908–9, and the dividend has fallen from 11·5% to 9·6%. The directors seem to have a weakness for decimals. The carry over is the vast sum of 779 marks. The capital is a million marks.

According to the *Schlesische Zeitung*, the Breslau electrical companies have undertaken to extend their operations beyond the town, so as to supply a radius of 30 miles within the next five years, and to charge the environs at least 10% less than the prices levied in Breslau itself.

The Elektrische Schuckert Gesellschaft fur Elektrische Industrie, A.G., of Mannheim, made a net profit for 1908–9 of 310,437 marks. A 7% dividend will be paid on the capital of 4 million marks, while 18,068 marks are passed to reserve and 150,053 marks are carried over to next year's account. The company is greatly extending the sphere of its operations, and is in a highly prosperous condition all round.

Electric Light and the Eyes.

As with every other sense action, the perception of light is attended with destruction of nerve matter, and if the light is too brilliant or too sudden, the destruction goes beyond the recuperative power, and loss of the sense temporarily or permanently is the inevitable result. No one can look at the sun without a natural or artificial protection for the eyes, and a powerful electric light is so far like the sun. Recent researches by Drs. Schanz and Stockhausen have shown that the blinding action of powerful sources of light is not due entirely to the light as light, and that it is largely assisted by the ultra-violet rays which all such highly illuminating white lights contain. If the light is passed through a fluorescent liquid which converts these rays into light, the eye can stand the increased light better than it can resist the mixture of luminous and non-luminous rays, unless, of course, the luminous rays are too powerful for the human organ under any circumstances. This indicates a method whereby the dazzling action of the electric light may be diminished without impairing its value as an illuminant.

The Barff Process by Electricity.

F. S. Barff has long disappeared from among us, and his process for preventing iron from rusting has nearly passed into oblivion with him. It seems, however, likely to be revived, for its only, but sufficient fault, the expense for fuel necessary for its execution, can now be avoided by producing the protective coating of magnetic oxide (Fe_3O_4) by electrolytic methods without heating the iron to be protected. The electrolytic bath requires very little heat to make it, as it is simply hot water at about 80° C. The anode consists of the iron to be protected, while the cathode may be of carbon or iron, or may consist of the cell wall itself. The current used must be as weak as possible, so long as it can pass and cause chemical action by establishing a circuit. When, and so long as, the current exists, nascent oxygen is produced from the water and combines with the iron at the anode, forming the well-known adhesive coating of the magnetic oxide. If the current is too strong, the coating becomes unreliable as regards durability, and also as regards uniformity. It is said that the rust on ordinarily rusted iron can be quickly changed to the protective coating in the same bath.

Cadmium Accumulator.

Gernsback, in the *Zeitschrift fur Schwachstromtecknik*, recommends a form of secondary battery which, he says, is far superior to the ordinary lead battery, especially for laboratory use. It is made by taking an ordinary accumulator completely discharged and replacing the negative plate by a thin piece of sheet lead. If the battery is then charged, the positive plate only becomes electrified, while the thin lead now taking the place of the negative pole remains unchanged, as it is not porous. If now a plate of cadmium is dipped in the electrolyte, care being taken to make good contact between it and the thin lead, we have an element possessing an E.M.F. of about 2½ volt. So long as the lead and the cadmium are in contact, the cell can be discharged in the usual manner, the cadmium passing into solution at the rate of about one kg. per thousand ampere-hours. When the cell is not in use, the cadmium must be taken out, when the discharge ceases, as there is practically no interchange between the still charged positive plate and the thin sheet lead. If the positive plate is discharged, the thin lead plate acts as a negative pole, when the battery is again charged. The cadmium only affects the voltage at the binding screws, and not the capacity of the cell.

Electric Welding.

There are two sorts of electric welding, the resistance and the arc weld. The former is, on the whole, the best welding method known. It gives a homogeneous union without overheating the iron. It saves much bolting and overlapping. The arc is used chiefly for welding thick plates lengthways and for curing broken or defective castings. For resistance welding, alternating currents alone are used, for the powerful direct currents now supplied would suffer too much loss on their way. For arc welding the direct current is employed, on account of the necessity for reversing the direction when necessary, and also because of

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the high temperature differences. As shunt wound dynamos are unsuitable, a special Crossfield dynamo has been invented by the Allgemeine Elektrizitats Gesellschaft of Berlin. This is so constructed that the unavoidable short circuit does very little harm.

Company Notices.

A new company has been started at Ludwigsburg under the title of Elektrizitatswerk Beihingen Pleidelsheim, E.G., with a capital of 2½ million marks. The object of the undertaking is to supply current for all purposes in the immediate neighbourhood. It is financed partly by the municipalities and partly by the Schwarz bank of Stuttgart, and by already existing electric concerns. It is expected that Stuttgart will take 35% of the shares.

A very large electrical undertaking at Aulendorf, in Wurttemberg, has been started. A canal is to be made to take water power from the river Iller. Starting near Rappertsweiler, the canal will supply a head of water averaging 110 yards, which is expected to yield about 14,000 h.p. By this project the supply of electric power throughout Upper Sevabia will be made very nearly complete.

The report for 1908–9 of the Siemens & Halske, A.G., of Berlin, has just been issued. In spite of general depression in business, the result of the year's trading have been very satisfactory. The net profit has increased from 9,688,264 marks in 1907–8 to 11,429,000 marks, allowing a dividend of 12% on the capital of 63,000,000 marks. A million-and-a-half of marks has been passed to reserve, and 650,000 marks have been allotted as gratuities to the various employés of the company.

The balance sheet of the Siemens Schuckert Werke, G.m.b.H. Berlin, bears emphatic testimony to the increasing use of electricity in every department of industry, for in spite of bad trade generally and falling off on the whole in the price of their products, the company finds that it cannot exactly grumble. The net profit was 10,267,877 marks, as against 10,194,911 for 1907–8, and a 10% dividend will be paid on the capital of 9,000,000 marks just as last year.

The Elektrische Licht und Kraft Anlagen A.G., of Berlin, pays a 7% dividend for 1908–9 as for 1907–8. The net profit is 1,704,200 marks, as against 1,697,097. The dividend absorbs 1,312,500 marks, and 169,258 marks are carried over to the current year's account.

The A. G. fur Elektrizirätsanlagen, of Berlin, has made a net profit for 1908–9 of 538,629 marks, an enormous increase over the 410,814 marks of 1907–8. A 6% dividend will be paid, and 118,629 marks are passed over to new account.

The Reiniger, Gibbert & Schall A.G. pays this year a dividend of 12% on its capital of 1½ million marks. This company is in great favour in Germany, and an extra half-million marks of capital has been eagerly and totally taken up by the already existing shareholders.

AMERICAN NOTES.

NEW YORK.

Electrical circles here are discussing a great new enterprise attributed to the General Electric Company. Some three or four years ago commissioners representing that incorporation, bought an immense tract of land, about 700 acres in extent, near Erie, Pa., with the intent that the site should be used as the location for a great new plant. The company has its plans perfected, but their execution was delayed because of the conviction of the directorate that the Niagara frontier would be a superior site possessing far greater advantages than Erie. In the consideration of the purchase of such a site it may be accepted as a fact that no information would leak out until after the required land was secured. This much, however, is known authentically: That agents representing the General Electric Company have canvassed the entire Niagara frontier from Buffalo to Tonawanda Creek. While this canvass was in progress the prices asked for some of the land were regarded as prohibitive, and while these matters were under discussion the announcement was made of the purchase of the Erie site. Then negotiations were broken off, but at a later date were resumed. At this time the agents of the General Electric Company dealt with Fenton M. Parke of Parke, Hall & Company, now the secretary of the Chamber of Commerce. Mr. Parke had just located the Lief M. Eriesson Telephone & Electrical Appliance Company and several other industrial enterprises when he was called upon by Mr. Emmons of the General Electric Company to make the canvass of the Niagara frontier. Plenty of information and some options were secured when the matter was abruptly terminated. Report now has it that the Erie movement was merely made to bring to time some property owners on the Niagara frontier who were hanging out for too much money. That this purpose was achieved and that the desired land has been secured is now very generally declared to be the fact.

New Electric Railway.

Incidental to this rumour comes the incorporation of a local railway with the names of several General Electric stockholders on the directorate. With its capital stock placed at $500,000, articles, of incorporation have been filed by the Central Dock & Terminal Railway Company. The directors are S. S. Jewett, J. J. Albright and F. H. Snell of Buffalo; George J. Magee, John Lang, Daniel Beach, John Magee of Watkins; C. M. Depew, H. J. Hayden, J. M. Tousey and Theodore Voorhees of New York; Austin Corbin and A. A. McLeod of Philadelphia. According to papers of incorporation the road is to be five and three-quarters miles long. It will begin at a point near Georgia-street and Lake Erie, running northerly parallel with the Niagara Falls branch of the New York Central, to a point just north of Dearborn-street; thence easterly connecting with the Belt Line of the New York Central; to a point near Grider-street, and east to Cheektowaga and connecting with the main line of the New York Central in Cheektowaga.

Control of Wireless.

A dispatch from Washington states that the creation of a wireless telegraph board for the control of the air is proposed by a resolution introduced in the House by Representative Roberts of Massachusetts. There is the greatest need for such control, Mr. Roberts said, as the activities of amateur operators has been such as not only to make necessary a change from "C. Q. D." as the distress signal, but to interfere seriously with the operation of all governmental and private service. Mr. Roberts's resolution authorizes the appointment of a board of seven members to prepare a comprehensive system of regulations to govern the operation of all wireless plants afloat and ashore, with due regard alike for government and commercial interests.

The Great Telephone Merger.

The Joint Legislative Committee, which is taking evidence here to decide whether or not the telegraph and telephone business shall come under the control of the New York Public Service Commission, has heard a long statement as to the practical side of the telegraph and telephone business under the control of a single concern from Mr. Theodore N. Vail, president of the American Telephone and Telegraph Company. His explanation followed an affirmative answer to a question from the committee's counsel, Ephraim J. Page, in which the examiner asked whether the merger would result in public benefit. The two businesses were distinct, Mr. Vail said, but with a common head the wires of each could be utilized for the other. At least 75% of the telephone trunk lines could be used for telegraph purposes and 50% of the telegraph trunks could be used for two purposes simultaneously. The whole trouble with telegraphing in this country now, Mr. Vail continued, was in the delay getting messages to and from the offices. If every subscriber were to be placed in direct communication with a telegraph office and this arrangement were extended over the whole system of the telephone company, Mr. Vail thought the service rendered would be almost instantaneous. In fact he testified that it had been with this idea in mind that the 'phone people had gone to the pains of perfecting the system and making it as nearly complete as possible. This was taken by many of the committee to mean that the telephone concern had been intending to take over the Western Union much longer than was generally supposed.

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Mr. Morgan's Telephone Deal.

The advent of Messrs. J. Pierpont Morgan & Company into the telephone business is the subject of much comment. With the assistance of Mr. James S. Brailey, Junr. (at the present moment the most abused man on the North American Continent) Mr. Morgan appears to have purchased for $10,000,000 the control of six independent telephone companies in Ohio and Indiana. In addition to the acquisition of the stocks of the United States Long Distance and Cuyohoga Telephone companies, J. P. Morgan & Co. has purchased for its own account a majority of the stocks of the Toledo Home Telephone Company, the Citizens' Telephone Company of Columbus, the Dayton Home Telephone Company, the Indianapolis Telephone Company, the New Long Distance Telephone Company of Indiana, and the New Telephone Company of Indianapolis. It is declared officially that these properties were purchased by J. P. Morgan & Company with its own funds as an investment, without consultation or arrangement with any other interests. The companies have an aggregate capitalization of $12,500,000 bonds, $4,500,000 preferred stock, and $11,000,000 common. The actual value of the property is estimated at $23,000,000.

The Bell Interests.

On the other hand it is affirmed that in reality the Bell Company is behind Mr. Morgan in this deal and it is in this connection that Mr. Brailey is getting into hot water. His reply is as follows: "Morgan & Company will operate these companies permanently as their own property. There will be no new general holding company. The companies included in the deal are the cream of the independent telephone properties of the country, being located in the Middle West, where the independents made their greatest headway against the Bell in its Central Union district." The system acquired embraces 101,500 telephones and 40,000 miles of long-distance lines, covering Ohio, Indiana and Michigan, according to Mr. Brailey. The amount of stock purchased is not given, but it is said to constitute a large margin of control.

Electricity and Turpentine.

Interesting details are published here concerning the electric distillation of turpentine at Vancouver, B.C., where a company claims to obtain from selected mill refuse six to eight gallons of turpentine per cord treated, and a much larger return from wood obtained from other sources, such as very resinous woods, that are not fit for mercantile lumber. Much of the Douglas fir grown in this province, it appears, is cut, leaving a stumpage of six to ten or more feet on account of the base of tree being very resinous. The turpentine has been pronounced by leading authorities as chemically pure and far superior to the article generally sold. They estimate the cost of erecting a mill at $1,500 per cord to be treated, after making liberal allowances for contingencies, and estimate that it would take twelve men to operate a 10-cord mill. The present wholesale price of turpentine in Vancouver is $8·10 per cask. The by-products, tar, oil, resin, pitch and charcoal, all find a ready market, the resin especially being in great demand for use in the manufacture of cheap soap.

Single-phase Motor Starter.

An ingenious method of rendering a single-phase induction motor self-starting under full-load torque, is the subject of a recent patent granted to Messrs. Lamme, Feicht and Garcelon. The rotor of the machine is arranged to revolve independently of the shaft during the starting period. The arrangement is such that the rotor starts from rest with the machine operating as a split-phase motor. As the speed increases a centrifugal device first opens the auxiliary starting circuit, then short-circuits the added starting resistance in the secondary circuit and finally clamps the rotor upon the shaft, thereby bringing the shaft with its load up to the full-load speed of the machine.

New Large Power Project.

The purchaser of the property of the McCall Ferry Power Company, under foreclosure, is Mr. W. M. Barnum chairman of the bondholders' reorganization committee, which represents every outstanding bond. The new company, which takes over the property, will be called the Southern Pennsylvania Power Company, and will have an authorized issue of $12,500,000 of 5% bonds and $8,500,000 of stock. Some 300 men are now at work on the construction of a dam and power house on the Susquehanna River, and the latter will be sufficiently completed early in January to be ready for the installation of machinery. The hydraulic machinery will be furnished by the I. P. Morris Company, Philadelphia, and the electrical apparatus by the General Electric Company. It is eventually contemplated that there shall be ten wheels and generators, with a peak-road rating of 13,500 h.p. for each wheel. The price paid by Mr. Barnum was $2,000,000.

Current Items.

The Utica Southern Railway Company has been authorized by the public service commission to build a twenty-seven mile extension of its trolley line, from Hamilton, Madison County, to Norwich, Chenango County, through Earlville and Sherberne. Additional capital of over $1,000,000 will be raised.

The Denver City Tramway Company has begun improvements that will involve an expenditure of $1,000,000. Work has already been begun on a system of terminal tracks leading to the round houses.

The work of electrifying the Columbus and Lake Michigan Railway between Lima and Defiance, Ohio, is nearly complete. The road is owned by the Ohio Electric Railway Company.

The Chelan Electric Company, a subsidiary of the Great Northern Railroad Company, is contemplating the construction of a large dam across the Chelan River gorge at a point near Cape Horn, between Chelan and Chelan Falls on the Columbia River. It is estimated that about 80,000 h.p. can be developed at a cost of about $5,000,000.

The Niagara, Lockport & Ontario Power Company has closed a contract with the American Locomotive Company to supply power to the latter company's works at Dunkirk, N. Y. The Power Company's contract with the Buffalo, Lockport & Rochester Railway has been extended from three to twenty-five years in conjunction with an arrangement by which the power company will use the railway company's 60,000-volt line from Lockport to a point within six miles of Rochester.

The Gold Seal Champagne Company, of Buffalo, N.Y., have constructed a very large electric sign on the top of a large building in the centre of the city. It is of a grape design in the shape of a horse-shoe, and studded with thousands of red, green, purple and white bulbs. It is about 100 ft. high and about 40 ft. wide. The lettering in the centre is about 3 ft. high and 2 ft. wide.

Justice Marcus has handed down a decision in favour of the State Franchise Tax Commission in the suit with the Niagara Falls Hydraulic Power Company. Last year the special franchise assessment was $184,000 and the ruling was that the franchise is worth more than $700,000.

Construction work on the transmission lines of the Central Georgia Power Company on the Ocmulgee River is now under full headway. Right-of-way through several counties to Macon has been secured, 100 ft. in width, steel towers to be erected at a distance of 500 ft.

The City Council of Richmond, Virginia, has voted an additional sun amounting to $65,000 to be used in the construction of the distributing system of the new municipal electric lighting plant, now in course of completion. This is in addition to $250,000 for paying for the electric light plant proper, and $100,000 for water pumps to be electrically driven by power from the new power house.

The engineering work which is being promoted in San Francisco by H. V. Gates, of Oregon, is declared to have no equal in the Pacific Northwest. The project is to drive a tunnel 7 miles long, tapping Pitt River and cutting off 21 miles of the rapid stream. The fall is 100 ft. to a mile and will furnish one of the biggest electric systems this side of the Rockies. He claims that when completed they will take to San Francisco 200,000 h.p. at a cost of not to exceed $10 per h.p. per annum. John Hays Hammond has, it is stated, an option on the proposed system, and is taking the survey to New York. It is estimated that the system will cost $12,000,000.

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BUSINESS NOTES AND NEWS.

LIGHTING AND GENERAL—Home.

BISHOP STORTFORD.—The local gas company are promoting in the next Parliament a Bill for the amalgamation of the Bishop Stortford, Hadham, Newport, Harlow, Sawbridgeworth, and Ongar Gas Cos., and to empower them to provide electric light in the Bishop Stortford urban district. In view of the Urban District Council's proposal to adopt an electric lighting scheme of their own, formulated by Messrs. May and Hall, as already explained, the Council is being urged to oppose the Bill.

CAMBERLEY.—Some local opposition is being organised as regards the Urban District Council's proposal to put their Electric Lighting Order in force. It is suggested that a private company should be induced to take over the order, the Council reserving the right to take over the undertaking after a period on terms to be agreed. It will be remembered that the Council's consulting engineers, Messrs. Medhurst and Brewer, estimated the capital expenditure at £31,220, the revenue at £4,280, and the expenditure at £4,154.

DERBY.—The Elementary Education Committee are considering the advisability of substituting electric for gas lighting in the Ashbourn-road and Traffic-street Schools.

DUBLIN.—The Joint Hospital Board are about to instal electric lighting in their new Sanatorium at Brittas.

EDMONTON.—The Edmonton Union have accepted the tender of the Edison and Swan United Electric Light Co., Ltd., for the supply of cables and switch-boxes, the amount being £574 13s. This is the lowest British tender. A special allowance of 10% was made in favour of British as against foreign competitors.

GOVAN.—The Town Council propose to apply for permission to borrow £6,062 for extension of the electric undertaking.

GRIMSBY.—Mr. W. A. Vignoles, Chief Engineer, Corporation Electricity Department, has issued a handsomely printed and carefully compiled "Electricity Consumer.' Guide," which should have the effect of greatly extending the Department's clients.

GUERNSEY.—The State Council have decided to erect two electric cranes at St. Peter's Harbour.

HULL.—At the annual social gathering of the Corporation Electricity employees, Mr. Alderman Hanger, chairman of the Committee, spoke upon the successful year's work, and said that the time was approaching when the electricity department would need an extension of their plant and works. He thanked Mr. Bell and his staff for having provided such an excellent entertainment.

GRANGEMOUTH.—Negotiations are proceeding between the Grangemouth Town Council and the Scottish Central Electric Power Co., Ltd., with a view to the latter taking over the Council's Electric Light Order and working under it.

LONDON: SHOREDITCH.—The Borough Council have reduced the charge for electricity used for lighting arc lamps and signs outside shops, etc., to a flat rate of 2½d. per unit. A special circular is being distributed to advertise the reduction.

MORECAMBE.—A special meeting of the Town Council has been held for the purpose of interviewing Mr. W. R. Wright, consulting electrical engineer, with regard to the Corporation supplying electricity to Messrs. T. W. Ward, Ltd., of Morecambe, who had offered to take a supply of electricity from the Corporation at 1½d. per unit, and to guarantee to use 1,000 units per week for a certain period. This increased supply meant additional expenditure upon the electric light works. The matter came before the Electric Light Committee, and they decided to spend the money, but the Council rejected their resolution. Thereupon a special meeting was called. Mr. Wright explained in detail the capacity of the electrical sub-stations, and said that the Council were asked to spend £2,500 now, whereas they would be called upon at an early date to spend much more. He recommended that the Council should supply Messrs. Ward, because they (the Council) had everything to gain by the arrangement. The resolution to accept Messrs. Ward's offer was rejected by 14 votes to 7.

ROCHDALE.—A review of the working of the Electricity Department during the past year shows that the output for power and lighting purposes is in excess of that at this time last year. Additional consumers have been obtained, with the result that whereas the maximum load last year was less than that of the previous year, this year it is 39% greater than in 1908-9, and about 15% in excess of 1907-8, exclusive of tramway supply. The use of electricity for power has grown considerably. For heating, which is charged for at the same rate as power, the demand is increasing. Additional cables, both as regards feeders and distributors, have been laid to deal with the development of the business, and have also been arranged so as to extend the area of supply. The quantity of current taken for tramway purposes up to the present has been less than for the same period last year. The negotiations with the Littleborough Urban District Council for the supply of electricity in bulk have been proceeding throughout the year, and the coming year will, it may be assumed, see the scheme in operation. The development of the undertaking makes the provision of additional plant at an early date essential, and the Electricity Committee already have the matter in hand with a view to ascertaining what will be the most suitable form for the extensions. They are taking the necessary steps to obtain sanction from the Local Government Board to borrow the money required.

SUNDERLAND.—There is every prospect of an early resumption of work at Sir James Laing & Sons' shipyard. The Electricity and Lighting Committee of Sunderland Corporation have had an application from a local firm of solicitors for the re-instalment of electric power at the yard on similar terms as obtained prior to the failure. The letter asked that the power should be put in immediately. It will take about a month to replace the plant, but the Committee are anxious to facilitate matters as far as they can.

LIGHTING AND GENERAL—Overseas.

CONCEPCIÓN (Chile).—The Chile Telephone Co., Ltd. (Concepción) have obtained a concession to extend their Concepción and Talcahuano telephone service to San Rosendo, Yumbel, Los Angeles, Santa Fe, Coigué, Renaico, Angol, Mulchen, Sauces, Collipulli, Traiguén and Victoria.

DACCA.—Mr. R. J. Browne, Electrical Inspector to the Bengal Government, has been here and at Shilling in connection with certain proposed Government electrical installations, his services having been lent for the occasion.

FORT STEELE, BRITISH COLUMBIA.—The Bull River Falls Power & Light Co. are building a flume here which will provide a minimum of 10,000 h.p. The company will supply light and power to the towns in the Pars county from Michel to Moyie, and will also exploit an electric railway between Fort Steele and Jaffay.

SANTIAGO (Chili).—Eulogio C. Lorca and José Constantino, of Santiago, have obtained a concession for the use of water-power from the Colina river for the generation of electricity with which to work the Valparaiso-Llaillai-Santiago and Llaillai-Los Andes railway.

VALPARAISO.—Señor Eugenio de Toro has undertaken to supply Limache, Quillota, Peña Blanca, Villa Alemana and Quilpué with electric light from his generating station at Tabolango (Province of Concepción.)

TRACTION—Home.

LEEDS.—Mr. W. Baxter has given notice that he will move: "That the Tramways and Electricity Committee be recommended to fix, as an experiment, a screen on the platforms of one or more cars for the purpose of protecting the driver in stormy weather, as in use at Dublin, Burnley, and other places."

LONDON.—The North-East London Railway Bill for next Session contains provisions for a working agreement between that company and the Metropolitan Railway Co. The real intention is for the North-East London line to be worked by the Metropolitan Co. as part of their own system, but on behalf of the other.

NEWCASTLE-ON-TYNE.—The North and South Shields Electric Railway Co. have deposited a Bill for introduction into Parliament next session. Under this Bill the company ask for a revival of the powers for the construction of the railway under the River Tyne between North and South Shields, which was originally granted in 1902 and revived in 1906. It is now proposed that the land necessary for the scheme may be purchased during but not after a period of two years from the passing of this Act," and that the railway should be completed by the 31st July, 1913.

YORK.—The City Surveyor has reported that the tramway track is now completed from the terminus at Fulford to a point opposite the *Adelphi Hotel* in Railway-street, and, with the exception of the junction at Holgate-road, it is also completed between the city boundary at Dringhouses to the top of Queen-street; and that the permanent way is laid and concreted and about one-half of the paving is completed for a length of tramway between Rougier-street and Queen-street Bridge. To complete the connection between the Fulford and Dringhouses routes there is yet 175 yards of permanent way to be laid in Railway-street and Rougier-street, and 290 yards in Queen-street and over Queen-street Bridge. A commencement has been made with railway No. 5 (Haxby-road), and the permanent way is now laid for a length of 507 yards. A length of double track railway is also completed in Holgate-road. The erection of the car shed is well advanced, and the roofing is being proceeded with, but the stormy weather is interfering with its progress.

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TRACTION—Overseas.

BUENOS AIRES.—The Mayor has forwarded to the City Council the *ad referendum* contract with the Anglo-Argentine Tramway Co. for the construction of a system of Tubes. The contract is accompanied by a lengthy and carefully studied report, recommending its approval.

RIO DE JANEIRO.—The *Diario Official* contains a decree approving the plans submitted by the Rio de Janeiro Tramway, Light and Power Co., Ltd., for the electrification of the Corcovado Railway.

COMPANIES' MEETINGS AND REPORTS.

SUNDERLAND DISTRICT ELECTRIC TRAMWAYS.

The report of the Sunderland District Electric Tramways for the year ended October 31 last states that, after providing for interest on the Prior Lien bonds and First and Second Mortgage Debentures and loans, namely, £9,730, the accounts show a loss on the year of £780, bringing the loss to date up to £14,600. During the year the traffic receipts fell off by £1,319, but against this a saving was effected in working expenses of £2,108. This decrease in traffics is attributable to the exceedingly unsatisfactory state of trade in the district served by the company during the past year following on the long shipbuilding strike of the previous year. In addition, the unfortunate weather of the past summer contributed to the decrease. Signs of improving trade are now discernible in the district, and the directors are hopeful that the coming year will show a very considerable improvement in the company's position. During the year Prior Lien bonds have been issued at par for cash to the value of £4,500, bringing the total issue up to £10,500. Out of this money the item of sundry creditors for £5,486, as shown in the last balance sheet, has been reduced to £1,278. The rolling stock has also been put into good order.

COMPANIES REGISTERED.

BURKS & Co., LTD.—Capital £10,000 in £1 shares. Objects To acquire the business carried on at 37, Port-street, Manchester, and elsewhere by F. Burks & Co., and to carry on the business of electricians, electrical engineers, manufacturers of electrical instruments, machines, telephones and other apparatus and devices, etc. Private company.

ISAAC BRAITHWAITE & SON, ENGINEERS, LTD.—Capital, £30,000, in £10 shares (600 Preferred Ordinary, 650 Deferred Ordinary and 1,350 Preferred or Deferred Ordinary). Objects: To acquire the business carried on at Kendal, Westmoreland, Garlick Hill, E.C., and elsewhere, as Isaac Braithwaite & Son; to adopt an agreement with C. L. Braithwaite, T. Braithwaite and E. O'Brien, and to carry on the business of ironfounders, mechanical and electrical engineers, manufacturers of domestic, trade and agricultural machinery and implements, etc. Private company. The first directors (to number not less than two nor more than seven) are: I. Braithwaite (chairman), E. O'Brien (managing director) and F. A. Dixon (all permanent, subject to holding 100 shares). Qualification, 50 shares. Registered office, Kendal, Westmoreland.

PEEL-CONNER TELEPHONE WORKS.—Capital, £124,000 (120,000 £1 pref. and 80,000 1s. ordinary). To adopt agreements (1) with the General Electric Co., Ltd., of 71, Queen Victoria-street, E.C., and (2) with M. S. Conner; to take over the business of manufacturers of and dealers in electric machinery and appliances, and especially telephones, telephonic apparatus, wires, cables, etc., formerly carried on by the said General Electric Co., Ltd., at Peel Works, Adelphi, Salford; to construct or lease telephone installations and apparatus and other electrical systems in any part of the world, etc. Minimum subscription, half the shares offered. Purchase consideration, £3,400 in ordinary shares. First directors (not less than three nor more than nine): G. Byng, H. Hirst, and M. S. Conner. 500 shares. Remuneration (except managing director, if any), as fixed by the company. Secretary, P. P. Kipping. Registered office, 31, Copthall-avenue, E.C.

SCOTTISH POWER CO., LTD.—Capital, £160,000, in £1 shares. Objects: To purchase, hold, turn to account and dispose of all or any part of the share capital of the Scottish Central Electric Power Co., and all or any of the liabilities of the said company to construct, purchase, lease, or otherwise acquire public or private undertakings of all kinds in the United Kingdom, including in particular light or other railways, electric or other tramways, electric lighting and power supply works, telephonic, telegraphic, gas, water and hydraulic power works, drainage and sanitary works and the like. The first directors (to number not less than three nor more than seven) are: A. W. Tait, J. Walker, G. Balfour and H. Brown. Qualification, 100 shares. Remuneration, as fixed by the company.

CONTRACTS OPEN.

HOME.

BELFAST.—Corporation. Tramways and Electricity Committee. One 1,500 kw. continuous current turbo dynamo. January 10.

DUBLIN.—Joint Hospital Board. Electric light installation at the Brittas Sanatorium. Particulars from Clerk. January 14.

ECCLES.—Corporation. One 150 kw. steam engine and d.c. dynamo. Particulars from the Electric Engineer, Cawdor-street, Patricroft. January 15.

STEPNEY.—Electricity Supply Committee.—(*a*) The Supply and Erection of 3 Water-tube Boilers, with Accessories; (*b*) The Supply and Erection of One 2000 kw. Turbo-Generator and Accessories, Converting Machinery, Switchgear, etc. Copies of General Conditions, Specification, Form of Tender, and Drawings may be obtained from Mr. W. C. P. Tapper, A.M.I.E.E., Borough Electrical Engineer and Manager, No. 27, Osborn-street, Whitechapel, E.; deposit Five Guineas each section. Copies of the specification and drawings may be inspected at the above-mentioned address by appointment. Tenders on the form supplied endorsed "Tender for Section 'A,'" or "Tender for Section 'B,'" as the case may be, must be delivered, signed, sealed and addressed to the Chairman of the Electricity Supply Committee, at No 27, Osborn-street, Whitechapel, E., not later than noon on January 24, 1910.

OVERSEAS.

MADRID.—Public Works Department. Construction and exploitation of electric tramways in Barcelona. Particulars from the Ministerio de Fornento, Direccion de Obras Publicas. January 8.

SAMARKAND.—Municipality. Electric tramways. March 14.

LAUNCESTON (Tasmania).—Municipal Electric Tramways.—Rails and fastenings. February 7 (*see advertisement*).

MADRID.—The *Gaceta de Madrid* of December 24 announces that the adjudication will take place at noon on February 28 of tenders for the construction and working of an electric tramway from Fernández del Campo-street to the Santander-Bilbao railway station at Bilbao. A deposit of 1,645 pesetas (about £60) will be required with each tender. The "Compañía del Tranvia Urbano de Bilbao" has certain preferential rights as regards the concession.

TENDERS ACCEPTED.

ABERDEEN.—At a meeting of the Electricity Committee the following tenders were accepted for the ensuing year: Ironmongery, Messrs. Glegg & Thomson; painting and glazing, Mr. A. Macdonald and Messrs. Farquhar & Gill; timber, Messrs. John Fleming & Co., Ltd.; drysalters, Mr. James Jamieson; ropes, etc., Messrs. Gray, Watt & Co.; brass, lead, etc., Messrs. John Blaikie & Sons; cast-iron, Messrs. James Abernethy & Co.; carting, Messrs. John M'Adam & Sons; tubes and fittings, Messrs. D. Richmond & Co.

BARROW-IN-FURNESS.—The Council have placed with the D. P. Battery Co., Ltd., an order for the renewal of one of their storage batteries and its maintenance for a term of ten years.

DARTMOUTH.—The Urban Electric Supply Co., Ltd., have accepted the D. P. Battery Co.'s tender for the renewal of their batteries and their maintenance for ten years, both at Dartmouth and Newton Abbot.

LONDON COUNTY COUNCIL.—The following tenders have been received: For the supply of special track work required in connection with the construction of the authorised tramways from Beresford-square, Woolwich, to Eltham, Hadfield's Steel Foundry Co., Ltd., Sheffield (accepted), £113 15s; Edgar Allen & Co., Ltd., Sheffield, £122. For the execution of the roadwork and platelaying in connection with the re-construction of the tramways in Woolwich-road, Albion-road and George-street between Rainton-road and Chapel-street, and the construction of the authorised tramways in Farringdon-road between Clerkenwell-road and Charles-street, and for certain works outside the tramway tracks in connection with widenings of Woolwich-road: Dick, Kerr & Co., Ltd., Abchurch-yard, E.C. (accepted), tramway works, £40,209 17s. 11d.; retaining walls, etc., for street widenings, £582 14s. 8d. For the execution of roadwork and platelaying in connection with the construction of the authorised tramways from Beresford-square, Woolwich, to Eltham: Alex. Stark & Sons, Glasgow (accepted), £32,528 4s. 6d.; Dick Kerr & Co., Ltd., Abchurch-yard, E.C., £33,226 1s. 6d.; Robert W. Blackwell & Co., Ltd., Westminster, S.W., £36,662 16s. 9d.; John Mowlem & Co., Ltd., Westminster, S.W., £36,725; R. C. Brebner & Co., Edinburgh, £37,332 1s. 6d.; Kirk & Randall, Woolwich, S.E., £38,331; W. Manders, Leyton, £40,040 10s. 10d.; William Griffiths & Co., Ltd., Bishopsgate-street Without, E.C., £40,190 11s. 1d.; Daniel T. Jackson, Barking, £40,196 16s. 11d.; G. Percy Trentham, Handsworth Birmingham, £42,455 3s. For the manufacture, supply, and

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erection of overhead electrical equipment required in connection with the construction of the authorised tramways from Beresford-square, Woolwich to Eltham: British Insulated and Helsby Cables, Ltd., Prescot (accepted), £5,760 1s. 4d.; Sydney G. Smith, South-place, E.C., £5,870 0s. 9d.; Robert W. Blackwell & Co., Ltd., Westminster, S.W., £5,900 14s.; Dick, Kerr & Co., Ltd., Abchurch-yard, E.C., £5,908 15s. 6d.; The National Electric Construction Co., Ltd., Westminster, S.W., £6,056 9s. 7d. For electric insulating materials: George MacLellan & Co., Glasgow Rubber Works, Maryhill, Glasgow, and Whiteley Bros., Slitheroe Mill, Richworth, near Halifax. For electric lamps: The Maxim Lamp Works, Shernhall-street, Walthamstow.

For the supply of electric fittings: The British Electrical & Manufacturing Co., 1, St. Nicholas-buildings, Newcastle-on-Tyne; Dorman & Smith, Ordsal Electrical Works, Salford, Manchester; the General Electric Co., Ltd.; Siemens Bros. & Co., Ltd.; Siemens Bros. Dynamo Works, Ltd.; Veritys, Ltd.

TENDERS INVITED.

LONDON COUNTY COUNCIL invites tenders for the purchase of machinery, engines, boilers, etc., lying at the Tramways Depôt, Highgate-hill, N. The goods may be inspected at the place above-named between 10 a.m. and 4 p.m. on any day from January 3 to 7, 1910, both days inclusive, and particulars and forms of tender for the purchase of all or any of the articles may be obtained on application, personally or by letter, at the County Hall, Spring-gardens, S.W., or at the Tramways Offices, 62, Finsbury-pavement, E.C. Each tender is to be enclosed in a sealed envelope, addressed to the Clerk of the London County Council, Spring-gardens, S.W., and marked on the outside "Tender for Purchase of Machinery at Highgate-hill," and is to be delivered not later than 11 o'clock a.m. on Monday, January 10, 1910.

CATALOGUES AND LISTS.

Messrs. A. Reyrolle & Co., Ltd., have just issued a useful illustrated price list of their L. T. Tubular Fuses, giving drilling dimensions and code words.

The Westinghouse Brake Co., Ltd., have brought out a pamphlet on the Morse Patent silent rocker-joint chain driver. Apart from much technical information, the publication contains a number of fine illustrations, showing the application of the drive to various types of machines, motor 'buses and cars, aeroplanes, and so on.

The Armourduct Manufacturing Co., Ltd., have ready a pamphlet dealing with their "Gral" metal filament lamp fixtures. These include various types of lamps, lampholder-husks, reflecters and clusters, ampere-meters with meters, shock absorbers and adaptors, auto-transformers, etc.

An illustrated leaflet dealing with an exhaust steam turbine installation at Nobel's Explosive Co.'s Works, Stevenston, N.B., comes to us from the contractors, Messrs. the Mirrlees Watson Co., Ltd., of Glasgow.

Among the recent issues of the Foster Arc Lamp and Engineering Co., Ltd., are the following: "Q" type of Foster Flame Arc Lamp, illustrated; Electric Bell Transformers; and Illuminated Road Signs.

The M. & C. Manufacturing Co. have issued an illustrated price list of their transformers.

PUBLICATIONS.

The current copy of *The National Telephone Journal* contains the first part of a fully illustrated paper by Mr. J. Hyde, of Sheffield, on "Automatic Exchange Equipment." This latest phase of telephone development is dealt with in an interesting and comprehensive manner. He points out that the "disadvantages of the automatic system, such as, for instance, inadaptability to consumer battery working having been eliminated," common automatic exchanges have now been in successful operation for some time.

The *Clarkson Bulletin*, of the Thomas S. Clarkson, Memorial School of Technology, Potsdam, New York, for October, only just to hand, contains a lengthy "Sketch of the Commercial Development During the Last Three Hundred Years," *apropos* of the Hudson-Fulton celebration. In the course of the remarks on electricity the author, speaking about hydro-electrical equipments, says: "The theoretical power of the streams of the United States aggregates about 230,000,000 h.p., of which about 5,250,000 h.p. is now utilised."

Among the principal articles in *The Physical Review*, we may mention Mr. J. C. McLennan's "On the Electric Charges Acquired by Insulated Potassium Salts and other Radioactive Substances in High Vacua," Mr. Harold E. Melomb's on "Dispersion of Electric Double Refraction and Ordinary Dispersion in Liquids," and Mr. C. A. Skinner's on "Dispersion of Magnetic Double Refraction in Liquids Compared with that of Electric Double Refraction."

FINANCIAL NOTES.

In its review of the past year, the *Newcastle Journal* says that electric stocks have fluctuated a good deal, especially those of the Newcastle Electric Supply Co. When this company passed its dividend earlier in the year, the shares were depressed, and fell to 3½. After the annual meeting of shareholders, a more confident feeling was manifest, and soon afterwards the price recovered to 5. The company again paid no dividend in August, and caused much disappointment. As a consequence, the Ordinary stocks speedily reacted to 80s., and have remained more or less dull at about this figure. The Newcastle and District Electric Light shares have not been very active, and neither have those of the Durham Electric Co. If the leading manufacturers of the district become more active next year, all electric companies should likewise benefit, and the inquiry for electric shares in the past few weeks is evidently in anticipation thereof.

Warrants in payment of the interest on the 5% First Debenture Stock and the 4½% Second Debenture Stock of the City of London Electric Lighting Co., Ltd., for the half-year ending December 31 last, have been posted.

EDUCATIONAL.

PORTSMOUTH.

At the School of Electric Lighting, Portsmouth, a class in electric light duties is to open on January 15 for officers, non-commissioned officers and men of the Territorial Force, and extend over 48 days, which will be divided into two periods of 24 days each.

LONDON UNIVERSITY COLLEGE: FACULTY OF ENGINEERING.

In addition to the Postgraduate Course of Lectures by Professor J. A. Fleming on "The Theory of the Propagation of Electric Currents in Telegraph and Telephone Cables and in Electric Conductors" already announced, two other Postgraduate Courses have been arranged, namely (1) "The Ideal Arch, Metal and Masonry, Theory and Design," by Professor Karl Pearson, beginning on January 21; (2) "Steam Turbines," by W. J. Goudie, B.Sc., A.M.I.Mech.E., and E. G. Izod (of Messrs. Willan & Robinson), beginning on January 21.

PERSONAL.

Mr. John Grahame, main superintendent and manager, of the Brisbane City Electric Lighting Co., has been appointed manager of the Rockhampton (Queensland) ways.

Mr. T. D. Berrington, Director-General of Indian Telegraphs, will proceed almost immediately on two years' furlough, at the end of which it is understood he will retire from the service. It may be mentioned that the Secretary of State in Council is considering a proposal to reorganise the superior Staff of the Telegraph Department.

Mr. J. J. McMahon, Electrical Engineer to the Manchester Corporation Tramways, has been elected an Associate Member of the Institution of Civil Engineers of Ireland.

THE ELECTRICAL ENGINEERS (London Division).—Orders for week ending January 15, 1910: Officer Commanding, Col. R. E. B. Crompton, C.B. Monday, January 10, "A" Company, Technical Drill, 7 to 9 30 p.m.; Tuesday, January 11, "B" Company, Technical Drill, 7 to 9.30 p.m.; Wednesday, January 12, Gymnasium, 6.30 to 9.30 p.m.; Thursday, January 13, "C" Company, Technical Drill, 7 to 9.30 p.m.; Friday, January 14, "D" Company, Technical Drill, 7 to 9.30 p.m.; Saturday, January 15 no week-end run. (Signed) P. H. Campbell, Capt. R.E., Adjutant for O.C., E.E., L.D.

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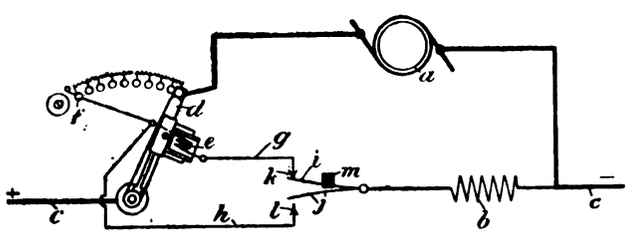
PATENTS.

Electro-magnetically Controlled Electric Switches.

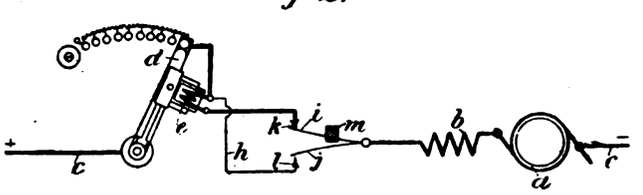
2217.—1909. A. CURTIS, ADAMS MANUFACTURING CO., LTD., Bedford. This is an improvement in switches of the kind in which the switch arm or contactor is held in a closed position against the action of a spring or the like by a retaining electro-magnet or solenoid, which is used as a no-voltage release or retaining magnet. Where it is necessary to open the switch from one or more distant points, a difficulty has been found in de-energising the electro-magnet without interrupting the field or other inductive circuit in which the coil of the electro-magnet is generally placed. Fig. 1 is a diagram of connections for a no-voltage release coil in the field circuit of a shunt wound electro-motor arranged to permit the no-voltage release coil to be de-energised without interrupting the field circuit. Fig. 2 is a diagram showing similar connections for a no-voltage

Fig. 1.



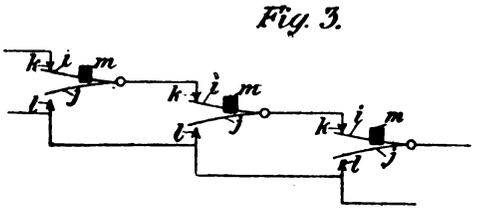
release coil in the field circuit of a series wound electro-motor. Fig. 3 is a diagram of connections. *a* is the armature of an electro-motor, *b* are the field windings, *c* the line wires, *d* is the arm of a starting resistance switch or controller, and *e* is a no-voltage release coil by which the arm *d* is held when the line circuit is closed and all the starting resistance is cut out. As shown in Fig. 1, the field windings *b* of the armature *a* of a shunt wound electro-motor are connected to the first contact *f* of the starting switch by two lines, *g*, *h*, in parallel, either of which can be cut out of circuit by a two-way push button switch provided with contact arms *i*, *j* to close on the branch terminals *k*, *l*. When the push-button switch is in its normal position the line *g* is in circuit, and the line *h* cut out. The push-button switch is so constructed that when in its normal position, if the button *m* is operated the arm *j* is first brought into contact with the terminal *l* after which the arm *i* is moved away from the terminal *k*. When the

Fig. 2.



arm *d* is moved to close the circuit and has been brought into the full on position, the retaining magnet energised by the current flowing through the line *g* to the coil *e* holds the arm *d* in this position. On operating the push-button *m*, the arm *j* is brought into contact with the terminal *l* thus short-circuiting the coil *e*, and a further movement of the button *m* will cause the arm *i* to move away from the terminal *k*. The circuit being thus broken through the no-voltage release coil, the arm of the switch will fly back to the off position, and at the same time leave a closed field for the path to discharge itself in the ordinary way, or through a discharge resistance if desired. As will be seen, this obviates the necessity of any auxiliary resistances, and enables the push-button or other device to be fitted to stop a motor from one or more distant points. This device can be added to any existing installation without any alteration to the starting switch or similar device. It is obvious that the present improvements can be applied in

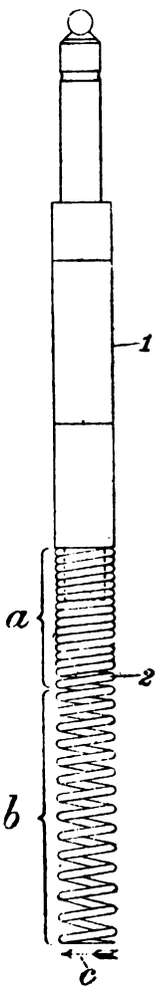
Fig. 3.



cases in which any usual method of exciting the no-voltage release coil in series with the field windings is employed, other than the method in which the coil is arranged between the field windings and the first contact of the starting resistances switch as shown. In the case of small series motors of fairly constant load, where the hold-on coil is placed in the main circuit, a substantially similar arrangement can be provided as shown in Fig. 2. As here shown, the coil *e*, lines *g*, *h*, and push-button switch arms *i*, *j*, are included in the main circuit. It is obvious that a number of two-way push-button switches may be provided in series, as shown in Fig. 3, whereby the de-energising of the hold-on magnet coil can be effected from different stations at a distance.

Switch Plugs for Telephone Exchanges.

18326.—1909. SIEMENS BROS. & CO., LTD., Westminster. Connecting plugs for telephone exchanges have been described in which the connecting cord at the part where it enters the plug is passed through a helical spring. In the present improvement the helical spring is wound so that the first few turns near the plug are wound under tension in close contact with each other, but subsequently the remaining turns of the spring are wound with a gradually increasing pitch, by which means the desired increasing flexibility is obtained. The diagram shows a connecting plug. At the end of the plug where the cord enters, the helical spring 2, is fixed the part *a* of which i wound under tension with its turns in close contact. The remaining part, *b*, for example, being wound with the turns of a gradually increasing pitch. If the spring is bent in the direction shown by the arrow, the compression side of the spring will offer an increased resistance to bending, since the turns of the part *a* are already in close contact, and at the same time the tension side of the spring will offer a greater resistance to opening.



Electric Burglar Alarm.

24453.—1909. H. B. COLLIER, Prairie Grove, U.S.A. The circuit closer for the alarm circuit comprises a pair of contacts, one having a normal tendency to separate from the other, and a member actuated by a movable element in connection with which the circuit closer is used to move the first-named contact into position against the other contact.

Electric Locking Device.

15991.—1909. G. LAHMEYER, Strasburg. In this device the locking and unlocking is effected by an armature operated by a two-way switch. The armature is guided parallel with the axis of the magnet, and terminate in a locking pin which engages in a bore in the latch of the lock.

Arc Lamps.

14505.—1909. SIEMENS SCHUCKERTWERKE, G.m.b.H., Berlin. This is an improvement in lamps having carbon electrodes resting on supports against which they are pressed. These electrodes have been constructed with slots in the sides, into which a core of specially soft carbon is firmly fixed. The improved core is composed of potassium silicate and carbon, or sodium silicate and carbon, and is arranged in such a manner that the pressure between the electrode and support is transmitted through this substance.

Electric Time Alarm.

12195.—1909. W. RAUSCH, Düsseldorf. Contact pieces are arranged at intervals of time with plates extending from the contact pieces and adapted to receive plug contacts leading to the localities to be called up.

Wireless Signalling.

25305.—1908. R. A. FESSENDEN, Brant Rock, U.S.A. The object is to secure absolute secrecy and freedom from neighbouring installations in the transmission of wireless messages. Dots only are sent, and these are interpreted as dots and dashes according to the time of receipt at the receiving station. The method of sending is by generating oscillations continuously and producing a signal by varying the frequency.

Trolley Heads for Electrically Propelled Vehicles.

1077.—1909. E. M. MUNRO, London. This trolley head collects current from two or more overhead conductors, and is so constructed as to be rotatable freely in relation to the trolley arm.

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TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns per week.			Increase or decrease.		Miles of track open.		Accounts for past year.						Cost per car mile.
	Ending	1909-10.	1908-9.	Week.	Current year.	1909.	1908.	Ending	Total receipts.	Passengers carried.	Car miles run.	Receipts per Passenger.	Receipts per Car mile.	Receipts per Mile of track.	
		£	£	£	£				£						
Aberdeen Corporation	Dec. 29	1,280	1,022	+ 257	— 829	27½	27½	May 31	71,930	17,517,304	1,566,119	·98	11·02	4,940,	5·93
Ayr Corporation	Sept. 18	671	562	+ 108	—	8	8	—	—	—	—	—	—	—	—
Baker Street and Waterloo Ry.	Nov.	8,141	6,070	+2,071	—	4·25	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	Dec. 26	1,171	1,066	+ 105	— 380	24·003	13·52	—	—	—	—	—	—	—	—
Birmingham Corporation	Dec. 25	7,139	7,059	+ 80	—	56·792	58·52	—	—	—	—	—	—	—	—
Blackburn Corporation	Oct. 6	1,100	1,293	— 173	— 1,036	24·53	28·3	—	—	—	—	—	—	—	—
Blackpool Corporation	Aug. 26	2,152	2,050	+ 102	+ 732	—	—	—	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams	„ 8	2,304	2,309	— 24	—	—	—	—	—	—	—	—	—	—	—
Bolton Corporation	Oct. 10	2,416	2,337	+ 79	— 259	42	42	Mar. 31	117,799	25,492,902	2,492,147	1·1	11·34	2,804	6·50
Bournemouth Corporation	July 21	1,681	1,723	— 42	— 23	29½	29½	„ 31	86,225	13,991,328	1,766,068	1·47	11·71	2,912	7·22
Bradford Corporation	Dec. 25	4,554	4,837	— 283	+ 5,880	98	54·81	„ 31	235,258	47,839,569	5,331,007	1·17	10·59	2,378	—
Brighton Corporation	Dec. 26	837	850	— 13	+ 1,619	9·5	—	—	—	—	—	—	—	—	—
Bristol Tramway Company	Dec. 31	6,684	5,219	+ 1,465	—	57	51½	Dec. 31	265,362	46,652,389	5,756,842	—	—	—	—
Burnley Corporation	Jan. 1	1,434	1,067	+ 367	—	19½	19½	Mar. 31	64,261	12,355,958	1,202,330	1·23	12·83	5,971	7·92
Burton Corporation	Jan. 2	295	260	+ 35	— 179	6½	6½	„ 31	14,918	3,221,595	430,913	1·04	8·30	1,460	5·85
Cardiff Corporation	April 3	2,000	1,957	+ 43	—	—	—	„ 31	109,979	25,058,146	2,497,169	—	10·57	—	—
Carlisle Tramways Company	June 19	170	175	— 5	— 89	—	—	—	—	—	—	—	—	—	—
Central London Railway	Jan. 1	4,924	5,385	— 461	—42,301	6·32	5·77	Dec. 31	350,150	41,898,378	1,456,781	2·01	5·769	55,404	30·27a
Charing X, Euston, & Hamp. Ry.	Nov.	6,822	6,092	+ 730	—	7·75	—	—	—	—	—	—	—	—	—
City and South London Railway	Jan. 2	3,814	3,872	— 58	+ 3,121	7·26	7·26	—	—	—	—	—	—	—	—
Colchester Corporation	July 14	200	219	— 39	—	8	—	Mar. 31	10,983	2,308,721	349,539	1·09	7·74	1,477	6·56
Cork E. T. and L. Company	Dec. 31	539	402	+ 137	— 580	9·89	9·89	Dec. 31	24,044	5,737,478	896,945	—	6·43	—	4·43
Croydon Corporation	Dec. 17	1,521	1,334	+ 187	+ 5,422	11½	—	Mar. 31	74,132	16,277,418	1,884,137	1·06	9·56	3,703	7·109
Darwen Corporation	Oct. 1	239	256	— 17	— 201	7·23	7·23	„ 31	13,899	2,557,654	245,584	1·30	13·68	1,922	9·40
Dover Corporation	Sept. 18	230	252	— 22	— 395	7	—	„ 31	11,593	2,697,672	316,754	·98	8·78	—	—
Dublin and Lucan Electric Ry.	Dec. 31	115	95	+ 20	+ 26	7	7	—	—	—	—	—	—	—	—
Dublin U.T.	Dec. 31	5,071	5,145	— 73	+ 2,058	54½	54½	—	—	—	—	—	—	—	—
Dundee City Tramways	Oct. 6	1,332	1,305	— 27	— 569	—	26½	May 15	60,573	16,367,911	1,281,552	·875	1·9	2,371	7·46
East Ham Corporation	Jan. 1	1,090	907	+ 183	+ 4,836	15	15	Mar. 31	47,430	15,355,703	1,091,586	·73	10·26	—	6·96
Glasgow Corporation	Dec. 25	16,581	16,942	— 361	— 9,811	189	181	May 31	907,494	226,948,290	20,766,722	·96	10·49	5,080	5·89
Gloucester Corporation	Oct. 6	395	425	— 30	+ 535	15	—	—	—	—	—	—	—	—	—
G.N., Piccadilly and Brompton	Nov.	13,429	9,354	+ 4,075	—	9·25	—	—	—	—	—	—	—	—	—
Halifax Corporation	—	—	—	—	—	52·574	37	Mar. 31	81,872	20,378,672	1,786,390	11·40	11·13	1,528	8·40
Huddersfield Corporation	Dec. 4	1,613	1,357	+ 256	+ 2,663	28	28½	„ 31	84,704	16,200,020	1,960,329	1·29	10·37	2,421	5·10
Hull Corporation	Jan. 1	3,011	2,531	+ 480	+ 4,569	29	26	„ 31	128,722	30,964,254	3,022,844	1·	10·22	—	6·04
Ilford Corporation	Dec. 28	523	503	+ 20	+ 1,392	10	10½	„ 31	25,328	6,385,466	634,446	·87	9·58	2,066	6·42
Ilkeston Corporation	Dec. 29	135	117	+ 18	— 235	4	4	„ 31	7,214	1,968,850	198,415	9·1	7·9	1,803	7·04
Kirkcaldy Corporation	Sept. 5	259	266	— 7	—	7½	7½	May 15	14,993	4,874,199	459,066	·711	7·838	1,856	5·26
Lancashire United Tramways	Dec. 29	1,362	1,220	+ 142	— 819	39	39	Dec. 31	68,904	12,554,593	2,244,344	—	—	—	—
Leeds Corporation	Sept. 18	6,896	6,624	+ 272	+ 3,662	108	96½	Mar. 31	340,368	75,734,083	7,694,989	1·06	10·62	3,527	5·51
Leicester Corporation	Sept. 11	2,162	2,130	+ 32	—	—	—	—	—	—	—	—	—	—	—
Liverpool Corporation	Nov. 6	10,803	10,687	+ 116	— 1,977	109	104	Dec. 31	572,822	124,043,239	12,231,799	1·108	11·24	5,508	7·94
Liverpool Overhead Railway	Dec. 26	1,261	1,208	+ 53	— 110	6·65	2·40	June 30	79,004	11,171,515	1,106,386	—	—	—	—
London County Council	Dec. 18	38,767	35,379	+ 3,388	+ 68,369	128½	120	Mar. 31	1,274,660	279 166,461	25,591,028	1·08	11·74	—	6·79
Lowestoft Corporation	Dec. 11	155	150	+ 5	+ 30	3½	—	Sept. 30	11,399	2,645,206	370,320	1·03	7·36	2,279	6·12
Maidstone Corporation	Dec. 25	168	182	— 14	—	5½	—	—	—	—	—	—	—	—	—
Manchester Corporation	Sept. 11	15,631	15,297	+ 334	— 2,871	183	181	—	—	—	—	—	—	—	—
Metropolitan District Railway	Jan. 1	10,609	9,499	+ 1,110	+ 16,540	24	24	—	—	—	—	—	—	—	—
Metropolitan Railway	Jan. 2	17,357	16,734	+ 623	+ 672	24½	24½	June 30	680,357	99,846,735	—	1·46	—	—	—
Nelson Corporation	Oct. 16	151	131	+ 20	+ 7	2½	2½	Mar. 31	7,362	2,060,712	204,740	·85	8·63	1,907	—
Newcastle-on-Tyne Corporation	Dec. 25	4,057	4,443	— 386	— 1,599	60½	59½	„ 31	211,085	46,203,164	4,411,745	1·10	11·48	3,504	6·36
Newport (Mon.) Corporation	Oct. 9	663	638	+ 25	— 311	14½	14½	„ 31	35,531	8,174,003	798,029	1·04	9·89	2,450	7·21
Oldham Corporation	Jan. 24	1,778	1,516	+ 262	— 386	—	—	—	—	—	—	—	—	—	—
Portsmouth Corporation	Oct. 10	2,046	1,809	+ 237	—	28½	28½	Mar. 31	97,741	21,247,048	2,309,439	1·10	10·15	—	—
Reading Corporation	Dec. 30	696	522	+ 174	— 79	13½	13½	„ 31	32,769	7,933,572	915,481	—	8·93	—	4·65
Rochdale Corporation	Dec. 26	1,240	1,126	+ 114	+ 746	20·9	20·93	„ 31	56,558	10,196,148	1,252,925	1·32	10·83	2,693	6·47
Rotherham Corporation	Feb. 4	555	587	— 32	—	—	—	—	—	—	—	—	—	—	—
Salford Corporation	Sept. 27	4,596	4,662	— 66	— 3,326	78	74½	Mar. 31	244,065	45,771,611	5,486,150	1·25	10·67	3,185	—
Scarborough Tramways Co.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Sheffield Corporation	Dec. 26	6,107	6 910	+ 97	+ 2,425	39½	37	Mar. 25	289,745	17,568,686	7,065,380	·896	9·842	4,225	5·04
Southampton Corporation	Dec. 22	1,058	1,110	— 51	— 356	18	18	„ 25	52,647	10,121,887	1,157,451	1·25	11·33	—	7·30
Southend-on-Sea Corporation	Aug 21	995	557	+ 438	+ 1,483	—	—	—	—	—	—	—	—	—	—
Stockport Corporation	—	—	—	—	—	25	25	Mar. 31	52,004	9,155,172	1,335,911	1·34	9·342	1,830	4·75
Sunderland Corporation	Jan. 27	1,310	1,336	— 26	— 7,984	—	—	—	—	—	—	—	—	—	—
Swindon Corporation	Dec. 11	126	114	+ 12	—	—	—	—	—	—	—	—	—	—	—
Torquay Tramways	Aug. 26	630	647	— 30	—	8·41	—	Dec. 31	15,065	2,880,420	353,297	1·40	1·023	—	—
Wallasey U.D.C.	Jan. 1	894	740	+ 153	+ 793	12·68	12·45	Mar. 31	43,823	8,331,038	891,540	1·2	11·79	3,453	7·72
Warrington Corporation	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
West Ham Corporation	Dec. 23	2,541	2,616	— 74	+ 5,066	27	14·7	Mar. 31	122,881	35,502,836	2,556,854	·789	10·95	4,417	6·79
Wolverhampton Corporation	Nov. 3	841	823	+ 18	— 206	21¾	—	„ 31	44,432	9,440,369	975,714	—	10·929	2,190	6·509

a Train Miles. *h* Half-year's figures.

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THE
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NOTES.

"LIGHT OF THE WORLD."

Under the above alluring title, the daily Press of New York and London have been discussing Signor Tesla's latest pronouncement on his achievements in the development of lighting by electricity. Having regard to the great amount of work that has been done in the way of testing various gases stored in air-tight glass globes for the production of some phenomena equivalent to incandescence (as in the case of mercury vapour lamps), and also the not altogether unsuccessful experiments of transmitting electricity by means of air-borne waves to filament lamps placed at a distance, one must hesitate to declare the clever Italian to be a visionary. We must, however, await an official statement from the inventor before attaching great importance to the subject in its present phase. All that Signor Tesla requires are hermetically sealed glass bulbs enclosing a rarified gas, and a central station where electricity would be generated, and then sent by means of his special "wireless" transmitter through the air, in order to energise the imprisoned gas into emitting light. His light would be diffused light, as soft and generalised as the sun rays.

TESLA'S METHODS.

If he has been correctly reported, Tesla is on the eve of creating a revolution in electric lighting that will cause the metallic filament lamps to pale their ineffectual fires, and give rise to more trouble among central station men than they have ever known before. He would not hesitate to undertake the lighting of the whole of the United States by means of his wireless transmitters, and rather longs to have a shot at illuminating New York harbour, for a hundred miles or so from one station, by means of lamps that will burn for ever.

ISOLATED HOUSE LIGHTING.

Meanwhile, Tesla proposes to come to the rescue of those who live isolated, far from city conveniences. To use his, or the reporter's, words: "I am intending chiefly to supply isolated dwellings which cannot be conveniently reached by wires or lighted in any of the ways heretofore used. In this system of distribution there is absolutely no difference where the dwelling is located. The force of the current is the same. The house might be 12,000 miles away from the plant or 12 ft., it would be the same. The plant consists of only a little transformer, which could be easily carried in the pocket, and will be sufficient to light the whole house. The current may be conveyed to the individual lamps either by wires, or all wires might be dispensed with and the lights rendered portable. The current used is a 'vibrating' one, and can be used for other purposes. Among other things, the current can be utilised for carrying the human voice or the telegraphic code. One plant will do all this without interference of one action with the other. This is done by the use of an invention which I have called the 'art of individualisation.' This is a method and an apparatus for making signals or messages non-interferable, and it is based on the use of a number of vibrations in combination."

THE LAMP OF THE FUTURE.

On our own part, we must bear in mind that even so reliable an exponent of popular electrical science as Mr. William Duddell has been explaining to an infantile audience that one of the principal lamps of the future will be a glass tube containing gas, through which electricity will be passed. But even these lamps, though, speaking in a commercial spirit, more formidable than metallic filament lamps, would not be everlasting. For the only thing known to our finite minds at all approaching this is radium, which is both too costly and too dangerous for use as a means of general illumination. Moreover, if we do reach a stage when filamentless, gas containing tubes are used, new and difficult problems will have to be faced. The mercury vapour lamp is not ideal for general purposes, and with it, as probably would prove to be the case with other luminescent gases, the electro-chemical influences on biochemical phenomena, will have to be taken into consideration.

PAYING POINT OF WATER POWER.

In view of our leading article and the important document issued by the Ontario Attorney-General, which we reproduce elsewhere, some remarks by Mr. Henry L. Doherty on "Development and Operation of Hydroelectric Plants," read before the American Institute of Electrical Engineers, appear particularly opportune. Discussing the question of how to figure the amount of power it would pay to develop, Mr. Doherty said: "Eventually, hydroelectric companies will develop and sell all of the power that can be generated economically. To do this, in the absence of extensive reservoir capacity, will necessitate a heat-engine auxiliary plant to supplement the hydraulic plant during low-water periods. Let us assume a hydroelectric development having simply a dam from which the water immediately enters the turbines and is immediately discharged to the river below the dam without any expensive canals, flumes, etc. In this character of development, hydraulic apparatus can be installed for carrying the peak load at a very much lower cost per kilowatt of capacity than by the use of steam. Not only this, but in this character of development all inequalities of load should be taken care of in the hydraulic plant; and if it is necessary to run the steam plant, the steam load should be run for such time, and at a uniform rate, as will secure the most economic generation of steam power. Steam plants or steam units can be started up and shut down only at considerable expense, while water units can be started up and shut down at practically no expense. In the character of development used above as an example, with a market which far exceeds the water supply, and where fuel is relatively high, the hydraulic capacity installed can be equal to the maximum four days' supply of the stream."

DEPRECIATION.

The question of depreciation was also touched upon by Mr. Doherty, and as the principle is of far wider application than to hydroelectric plant only, his soundly economic remarks will bear reproduction here. He dwelt on the fact that practically all of the present assumptions for depreciation are too high. Figures applied to depreciation are used in a general sense without regard to what the plant consists of. The character of construction will largely influence the rate of depreciation. It is manifest that a plant having 10% of its investment in wooden poles and 20% of its investment in a masonry dam will have a higher rate of depreciation than the plant which has only 2% of its entire investment in wooden poles and over 50% of its entire investment in a masonry dam.

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ANOTHER ALUMINIUM SOLDER.

Last week we gave some particulars of a solder for aluminium, of which we have heard excellent reports from practical users. Another brand is the "Premier" (manufactured by C. Ruff & Co.). This, too, is used without flux. The metal is first cleaned by scraping away the oxidised surface, and then heat is applied uniformly by means of a blow-lamp or Bunsen burner, until sufficiently hot to melt the stick of solder when placed on the surface. The solder should flow freely, and is then scratched over with a scratch brush in order to obtain a perfectly "tinned" surface. Then the metal is heated afresh, sweated together, and held tightly in place until quite cool. But this cooling process must be gradual; there must be no application of water or of a cold draught of air. The solder is made in three conditions, for use where high temperatures can be obtained, for use with medium temperatures, and for use with the copper soldering bit.

WRONGFULLY ACCUSED.

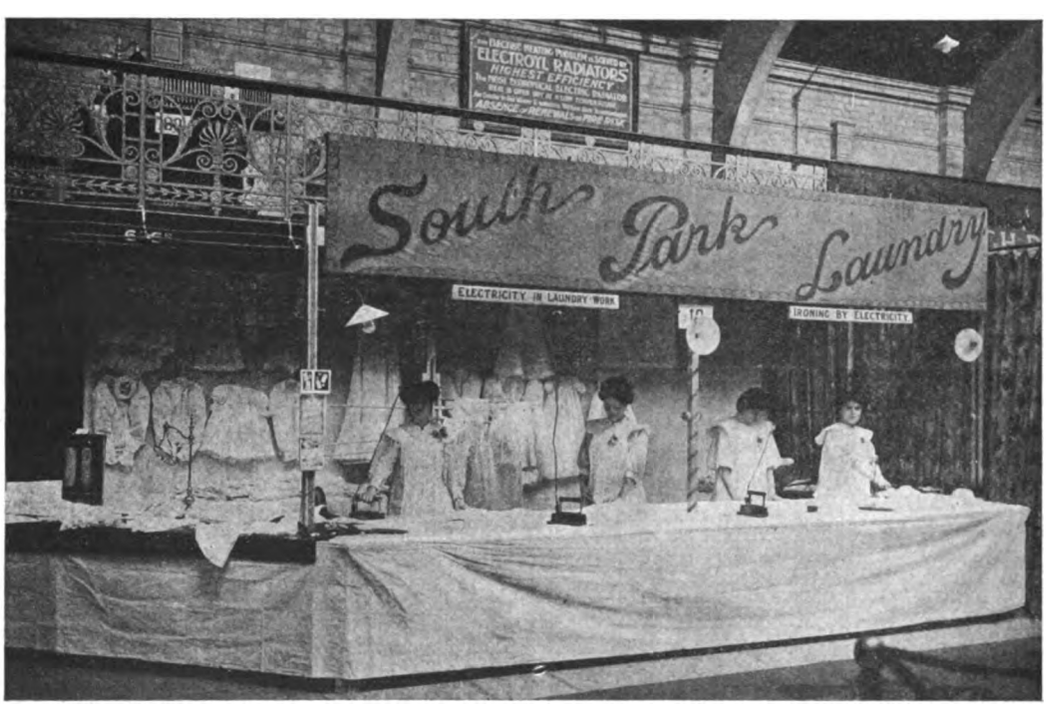
An amusing instance of the wrongful attribution of an outbreak of fire to electricity is brought to our notice by Messrs. Cox-Walker, Ltd., of Darlington. We print the letter which they addressed to a local paper on the occasion:—"Rockcliffe Park Fire.—In your issue giving an account of above, it is stated that the cause of this fire was supposed to be a fusion of electric wires, and as it is becoming a too common practice to ascribe unknown causes of fires to electric wiring we should be glad if you will make it known that in this instance the fire has been clearly traced to a faulty chimney flue, and that so far from electric lighting being the cause of the fire, it was actually the means of giving the first intimation, through some lights going out, that something was wrong, and it was not until our men, who were engaged on other work in the building, went into the false roof to ascertain the cause, that the fire was discovered, which had already been smouldering for many hours, if not days. In the interests of electric lighting generally, we shall be glad if you will publish this letter."

DÜSSELDORF MINING CONGRESS.

The International Congress of Mining, Metallurgy, Applied Mechanics and Practical Geology, to be held at Düsseldorf during June next, will be an important affair. Section B will include sub-sections dealing with processes for the production of electro-steel; the driving of rolling mills considered technically (by steam, gas, and electricity); In Section E, on economics of the iron industry, patent rights are to be discussed. In Section III., on Applied Mechanics, there are sub-sections dealing with (1) central electric power stations (*a*, reciprocating engines, gas, and steam; *b*, turbo-engines); (2) winding engines (including electric winders); (3) rolling mills and accessories; and (4) conveyors for mining and smelting works (*a*, for materials in bulk, coal or coke; *b*, special cranes and ladle cars; *c*, loading and unloading apparatus). Under Practical Geology, the subject of the utilisation of natural sources of water power will be considered.

ROBERTSON & OSRAM FANCY DRESS BALL.

A very enjoyable evening was spent at the Brook Green Works, Hammersmith, London, on Saturday, the occasion being the first annual ball in connection with the Robertson and Osram Electric Lamp Social and Athletic Club. Varihued Osram lamps, artistically arranged, with flags and banners and floral decorations, gave the hall a charming appearance and with dancing in full swing the effect was extremely pretty. Upwards of 400 members and friends accepted invitations, a large proportion attending in fancy dress. There was a capital dance list, the duties of M.C.'s being in the able hands of Messrs. F. Pluck and F. Coleman. Among others present were Mr. and Mrs. C. Wilson, Mr. E. G. Shepherd and Mr. C. Beaven. Some handsome prizes were offered for the best fancy costumes, the principal winners being Miss Simmonds, Miss Kimpton and Miss A. Williams, Messrs. J. Minson, Harris, and Courtice. Praise is due to Mr. G. H. Freeman for the excellent secretarial arrangements.



IRONING BY ELECTRICITY.

Electricity is making steady headway as a recognised useful servant in laundry work, both as regards the large trading steam machinery establishments and in domestic circles. For trading laundries, electricity is used not only as an illuminant and heating agent, but as motive power sometimes for driving washing and ironing machines, though more generally at present for hydro-extractors and ventilating fans. For heating purposes electricity is fast becoming the favourite agent for machine and hand irons. A good instance of the latter application is afforded by the up-to-date equipment of Messrs. Loud & Western's numerous London laundries. At the recent Wimbledon Municipal Electrical Exhibition, Messrs. Loud & Western made a most attractive display of their South Park Laundry ironing equipment, a photograph of which we reproduce. We understand that this proved not only a capital advertisement for the laundry, but induced many local householders to go to local shopkeepers and either buy or hire electric irons, to the benefit of the Electricity Department, whose profitable load was increased thereby.

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INTERNATIONAL CONFERENCE ON ELECTRICAL UNITS AND STANDARDS, 1908.

An appendix to the Report recently issued contains notes to the specifications as to the methods adopted in various standardizing laboratories to realise the international ohm and the international ampere, and to prepare the Weston normal cell. It is pointed out that when international co-operation in standardizing work has been further developed, mutual agreement on methods of procedure will no doubt be secured with a corresponding increase in accuracy. At the present time the international comparisons which have been made indicate that the various methods of procedure give very nearly identical results.

Specification Relating to Mercury Standards of Resistance.

Glass.—The glass hitherto used has been Jena 16^{111}, Jena 59^{111}, and "verre dur."

End Vessels, Cross Section of Tube, and Nominal Resistance of Standard.—The spherical terminals employed to connect the mercury column to the resistance measuring circuit necessitates the application of a correction, the value of which has been obtained to a close approximation by Lord Rayleigh.

The resistance of a tube filled with mercury, apart from the correction due to the ends, may be calculated from the formula :—

$$R = C\frac{L^2}{G}\frac{14{\cdot}4521}{1063^2} - 0{\cdot}00001278982\ C\frac{L^2}{G}\text{Ohm.}$$

where L denotes the length in millimetres, G the mass of mercury in grammes, and C the calibration factor of the tube.

Filling the Tube.—The mass of mercury contained by a tube depends, to a small extent, on the applied pressure. A film of air and moisture separates the mercury and glass, and this film diminishes in thickness when the tube is practically exhausted of air. Experiments in France and in Great Britain show, however, that the same mass of mercury is contained by the tube, provided it is always filled under the same conditions.

Descriptions of the methods adopted by the National Physical Laboratories of the various countries for the manufacture of the Weston Standard cell are given. The communications are from the National Bureau of Standards, U.S.A.; Laboratoire Central d'Electricité de Paris; Physikalisch-Technische Reichsanstalt, Germany.

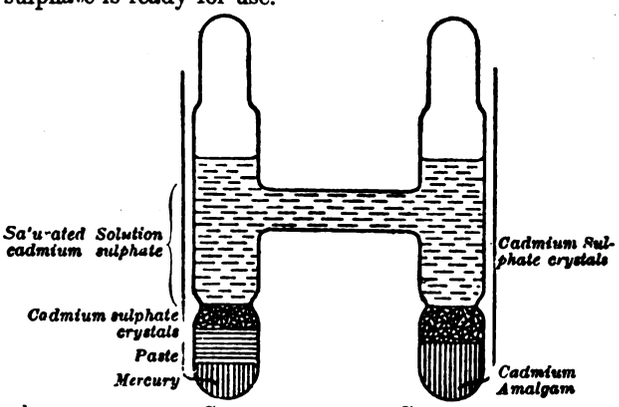
Below is a description of the method practised at Kew :

(*a*) *Mercury.*—Commercially pure mercury is squeezed through wash-leather and passed, in the finely divided condition in which it emerges, through dilute nitric acid (one part of acid to six parts of water) and mercurous nitrate solution, and afterwards through distilled water. The mercury is then distilled twice in vacuo.

(*b*) *Cadmium Amalgam.*—Two methods have been used : (1) A current is passed from a thick rod of commercially pure cadmium to distilled mercury, the electrolyte being cadmium sulphate solution rendered slightly acid by the addition of a small quantity of sulphuric acid. The cathode is weighed before and after electrolysis, and the percentage of cadmium calculated from the two weights. More than the requisite quantity of cadmium is deposited, and the percentage reduced to 12½ by the addition of mercury. The anode is conveniently contained in a filter-paper cup. The amalgam, with dilute sulphuric acid flooding its surface, is melted over a water bath and stirred to ensure homogeneity. It is then ready for use. (2) Commercially pure cadmium is added to mercury in the proportion of one to seven by weight and the mixture fused. It is freed from oxide by flooding its surface with dilute sulphuric acid.

(*c*) *Cadmium Sulphate.*—Commercially pure cadmium sulphate is dissolved in water, and re-crystallised by evaporation at a temperature not exceeding 50° C. The re-crystallised salt is washed with successive small quantities of distilled water, and part of it is dissolved to form a saturated solution. If the solution is not neutral to congo red, the procedure is repeated until it is so.

(*d*) *Mercurous Sulphate.*—Fifteen cubic centimetres of pure strong nitric acid are added to 100 grams of mercury, and the mixture placed on one side until the chemical action is practically over. The mercurous nitrate thus formed, together with the excess of mercury, is transferred to a beaker containing about 200 cc. of dilute nitric acid (1 part of acid to 40 parts of water). A clear solution results. About 1 litre of dilute sulphuric acid (1 part of acid to 3 of water) is prepared, and while the mixture is hot the acid mercurous nitrate solution is added to it as a very fine stream from the narrow orifice of a pipette, the mixture being violently agitated during the mixing. Mercurous sulphate is precipitated. The hot clear liquid is decanted, and the precipitate washed twice by decantation with dilute sulphuric acid (1 part of acid to 6 parts of water). The precipitate is then filtered, washed three times with dilute sulphuric acid (1 to 6 of water), and afterwards six or seven times with neutral saturated cadmium sulphate solution to remove the acid. When these operations are complete, the mercurous sulphate is flooded with saturated cadmium sulphate solution and left for one hour; the solution is then tested with congo red paper. In general, no acid is detected, and the mercurous sulphate is ready for use.



Setting up the Cell.

The following electrolytic method is also sometimes employed, the preparation being conducted in a darkened room. Mercury forms the anode, and platinum foil the cathode, the electrolyte being dilute sulphuric acid (1 of acid to 5 of water, by volume). The mercury is placed in the bottom of a large flat-based beaker, and about 20 times its volume of the dilute acid is added. Contact with the mercury is made by a platinum wire passing through a glass tube, and the cathode is suspended in the upper portion of the liquid. A current density of 0·01 ampere per square centimetre of anode surface is generally used, and the electrolyte is continually stirred during electrolysis. The mercurous sulphate so prepared is filtered, and the greater part of the mercury is removed; it is then washed with dilute sulphuric acid and saturated cadmium sulphate solution in a manner already described for the previous preparation.

(*e*) *The Paste.*—The mercurous sulphate is mixed with about one-fourth its volume of powdered cadmium sulphate and about one-tenth its volume of mercury. To the mixture sufficient saturated cadmium sulphate solution is added, so that when well mixed the whole forms a thin paste.

The figure shows the form of cell used. It is of the H form, and the lower end of each limb is slightly constricted. The platinum wires inside the vessel are amalgamated by passing an electric current from a platinum anode through an acid solution of mercurous nitrate to each of the wires in turn as cathode. The vessel is washed out twice with dilute nitric acid and several times with distilled water; it is dried in an oven. The amalgam is fused and its surface flooded with dilute sulphuric acid; sufficient of it to cover the amalgamated platinum wire completely is then introduced by means of a pipette into one of the limbs of the H vessel. To free from acid the amalgam is re-melted and washed with distilled water. Into the other limb of the vessel sufficient mercury is introduced to cover the amalgamated platinum wire completely. Then the paste, finely powdered crystals of cadmium sulphate, and saturated cadmium sulphate solution are added in the order named. The upper surfaces of the layers of cadmium sulphate crystals are on a level with the constrictions in the tubes. The cell is left in a warm room for about three weeks, and is then hermetically sealed. It is portable, and may be sent through the post.

The Blue Book closes with a bibliography of international literature on Mercury Standards of Resistance, on the Silver Voltameter, and the Weston Cell.

COOLING MEDIA TEMPERATURE IN SOFT IRON STAMPINGS.*

By R. D. GIFFORD, M.Sc., Student.

The temperature rise of electrical machinery is one of the most important of the many considerations to which the designer has to pay attention, since the resistance of the copper conductors increases as their temperature rises, thereby affecting the regulation of the machine, and also because of the danger of damaging the insulation if the temperature rises above certain limits.

The heating of the iron stampings of transformers subjected to an alternating flux, is due to the hysteresis and eddy-current losses. The latter may be greatly diminished by various methods.

As this loss is proportional to the square of the frequency, induction, and thickness of the iron plates, a reduction of any or all of these reduces the eddy-current loss very considerably.

It may also be reduced by insulating the stampings by inserting sheets of thin paper between each, or by other non-conducting coatings on their surfaces.

The hysteresis loss is dependent upon the frequency, induction and magnetic properties of the iron. This source of heating may be reduced by a suitable choice of the first two, or by using iron of high permeability, such as "Stalloy" iron, in which the carbon is to a great extent replaced by silicon.

But apart from the choice of iron used, thickness of plates, induction, etc., the temperature rise is obviously greatly affected by the external conditions, such as the amount of exposed surface of iron and the medium in contact with the surface.

The heat must escape from the iron by radiation, conduction, and convection. This implies a flow of heat from the iron surface into the surrounding medium, and the fact that a hot body takes a certain time to cool down further implies that there must be a resistance to the flow of heat, otherwise the heat would escape and the body would instantly assume the temperature of its surroundings.

The flow of heat will therefore depend upon the resistance offered to it, and also upon the temperature difference existing between the iron and the substance in contact with it. In fact, we may treat the flow of heat from a body in the same way as an electric current, heat flow per sq. cm. of surface in thermal units taking the place of current and temperature difference that of potential difference. We have, therefore—

$$\text{Heat flow per sq. cm.} = \frac{\text{temperature difference}}{\text{resistance}}.$$

In the case of heat, however, the resistance or its reciprocal, the conductivity, is made up of three distinct factors, viz., conduction, convection, and radiation, and the last two are not constant quantities, but depend upon the nature of the substance, as in the case of electrical resistances. The radiation depends upon the temperature difference, the nature of the surface, whether smooth or rough, dark or bright in colour.

The convection will depend upon the temperature rise of the medium, its co-efficient of expansion, its viscosity, the roughness of the surface, and the path of the convection currents. Therefore the law relating to the flow of heat, although it can be put in the form of Ohm's law, is in reality much more complicated than this, but if the law governing the variation of resistance under various practical conditions can be determined, then the temperature rise of the apparatus is found if we also know the heat flow—that is, the energy dissipated as heat.

The object of the research, then, was to determine the conductivity to heat flow existing between the surface of a cylinder made up of soft iron stampings and such cooling media as air and oil under the following conditions:—

1. Air, when the iron was (*a*) free in air, (*b*) enclosed in an iron case.
2. In a case, with draught of air flowing over the surface of the iron.
3. With iron surrounded by oil.
4. Iron in oil, and with cold water circulating through a cooling worm immersed in the oil.

* Abstract of Paper read before the Birmingham Local Section of the Institution of Electrical Engineers, January 5.

Description of Apparatus (see Figs. 1 and 2).—The apparatus consisted of about 300 soft iron discs, each 0·51 mm. thick, 16·8 cms. in diameter, and having 32 holes, each 0·5 cm. diameter, punched near the circumference, and a central hole 4·4 cms. diameter. These discs were clamped tightly together by means of four temporary bolts passing through the small holes, so forming a cylinedr 16 cms.

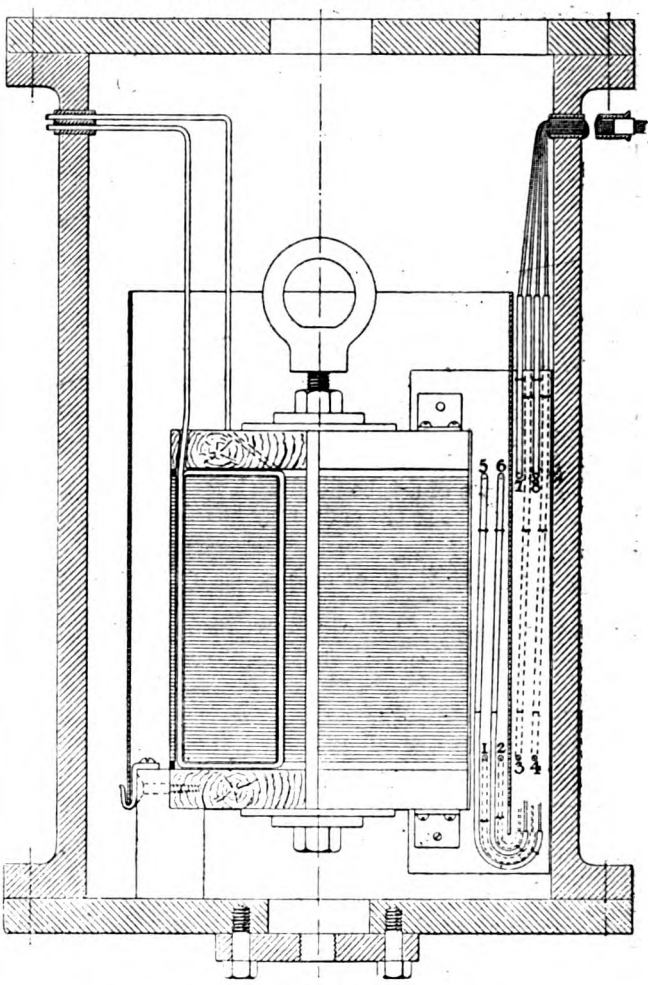


FIG. 1.

in height. The whole was then wound in gramme-ring fashion; that is to say, up an outer hole and down the centre, the bolts being removed as occasion demanded until all the holes were wound, double cotton-covered copper wire, 1·41 mm. diameter, being used. At the

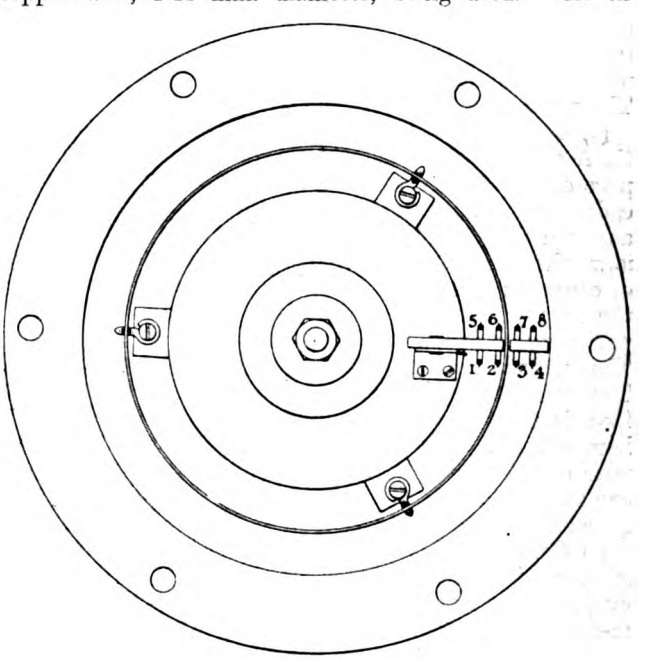


FIG. 2.

top and bottom of the cylinder, on the circumference, fibre washers were placed, to insulate as far as possible the flow of heat longitudinally, and also to protect the winding from damage by the wooden end discs. The two free ends of

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the winding were brought out at the top through the disc, and the whole bolted firmly together by means of a ½-in. bolt. The case, in which the tests with air blast and oil cooling were conducted, was made of cast iron of circular section, having top and bottom plates bolted to the flanges.

Measurement of the Energy absorbed in Hysteresis and Eddy Currents.—The energy absorbed by hysteresis and eddy-current losses in the iron was measured by the three-voltmeter method. Only one instrument was used for measuring the three voltages and the current. This was a Duddell thermo-ammeter supplied by the Cambridge Scientific Instrument Co., and consists essentially of a small heater in the form of a lamina of platinum deposited upon a sheet of mica 0·75 cm. long and 0·5 cm. in width. The platinum is scraped away in places so as to form a grid. Suspended over this heater, and in close proximity to it, is one end of a thermo-junction, whose wires are connected to a copper coil suspended in a strong magnetic field.

On the passage of a current through the heater, whose resistance was 160 ohms, the thermo-junction becomes heated, thereby developing a current in the coil and producing a deflection of the pointer. The maximum scale reading of the instrument was 10 milliamperes.

Fig. 3 shows a diagram of the connections of the instrument and of the supply circuit. The power was obtained from a 6 kw. Westinghouse rotary converter, having six slip-rings connected to tapping-points on the armature, so that various voltages could be obtained at 50 frequency.

From the converter, leads were taken to a Burnand transformer T, having a split secondary winding, giving a step-up transformation of two or four times the primary voltage.

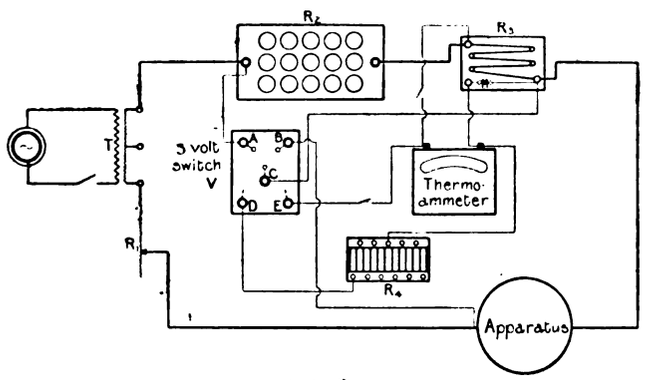

FIG. 3.

In series with the secondary winding were placed a main current regulator R_1, a non-inductive resistance R_2, which consisted of 15 110-volt lamps in parallel, a manganin resistance R_3, shunted by the thermo-ammeter, for the purpose of obtaining the current in the circuit, and the apparatus.

The resistance R_3, of which two were made, giving maximum scale deflections on thermo-ammeter with 3·5 and 1·75 amperes respectively, consisted of strip manganin mounted between terminals on a hard wooden base. These terminals were connected to the thermo-ammeter through a tapping key and mercury cups M, a small copper fork being used to connect the cups.

To read the voltages, the volt switch V was used. This consisted of three terminals, A, B, C, which were connected to mercury cups at the apices of an equilateral triangle, and mounted on a paraffin wax block. The terminals A B were connected across the supply, B C across the apparatus, and A C across the non-inductive resistance.

The voltage across any two terminals could be taken to the terminals D E, and so to the thermo-ammeter, through the series resistance R_4, by means of two copper legs insulated from each other by being mounted on ebonite, and so spaced that they dipped into the mercury cups. The series resistance R_4 consisted of 10 coils of No. 40 double silk-covered resistance wire, non-inductively wound on rectangular sheets of micanite. Each resistance was approximately 1,000 ohms. These were all connected in series and mounted in an ebonite frame-work, a terminal being placed at each junction, so that any resistance from 1,000 to 10,000 ohms could be used.

The advantages of the thermo-ammeter are :—

1. The heater has practically no self-induction or capacity, so that the instrument can be calibrated by direct-current instruments, and used on alternating-current circuits.
2. Practically no power is taken by the instrument, the maximum scale deflection being produced with a consumption of only 0·015 watts.
3. As the power it would be necessary to supply to the apparatus to produce a satisfactory rise in temperature under the different conditions of cooling was unknown, such an instrument was very valuable, as additional shunt and series resistances could be made if necessary.

Its disadvantages, so far as its present purpose is concerned, are that—

1. As in all hot-wire instruments, its action is sluggish, so that when four readings are to be taken to obtain the power supplied to the apparatus a liability to error occurs, due to slight changes in the supply volts during the interval occupied in taking the readings.
2. The deflection is approximately proportional to the square of the current, and therefore gives a very close scale at the zero end, necessitating a certain amount of manipulation of the series resistances to give a deflection well towards the open end of scale with each of the three voltages to be measured.

The instrument with its shunt and series resistances was carefully calibrated by standard direct-current instruments.

To obtain the watts supplied to the apparatus we have—

$$W = \frac{(E^2 - E_a^2 - E_l^2)\, I}{2\, E_a},$$

where—

I = current in amperes.
E = total volts across apparatus and lamps.
E_a = volts across lamps.
E_l = volts across the apparatus.

The Measurement of the Temperature Rise of the Iron and Cooling Medium.—This was effected by means of thermo-couples. As the drop in temperature, down the air or oil separating the iron of the apparatus from the outside case, was not expected to be very considerable, it was necessary to use a combination of metals giving a sensitive thermo-couple.

With the object of finding such a couple experiments were made with combinations of well-known alloys and copper in the form of double silk-covered wires. The thermo-couples to be tested were placed in glass tubes with the junctions projecting beyond the end of the tubes, which were immersed in oil contained in a copper vessel. A delicate thermometer reading to 0·1° C. was also placed in the oil close to the junctions. The oil tank was wound on the outside with resistance wire and heated by the passage of a current.

Fig. 4 shows the apparatus used for determining the electromotive force generated by any particular couple. It consists of a paraffin wax block arranged to accommodate 15 thermo-couples and a galvanometer damper. The eight mercury cups in the central row are connected to the terminal T_1, and thence to the reflecting galvanometer G, the low resistance R, and to terminal T_2. All the alloyes wires of the thermo-couples were connected to T_2, and the copper wires to the other mercury cups in the block, being kept in position by passing through narrow glass tubes embedded in the wax. A copper fork mounted in an ebonite handle, as shown in Fig. 4, connected any couple to the galvanometer circuit by placing it in the mercury cups such as x y.

The deflection of the spot of light on the scale was brought back to zero by sending a current from the four-volt accumulator B through the known resistance R. The current was read by a Siemens and Halske standard ammeter A, and adjusted to the necessary strength by the rheostats R_1 and R_2.

This "null" method of determining the electromotive force of a couple is extremely convenient and accurate, as only a short scale is required, and it eliminates the results of the "Peltier effect" and the "drop" in the thermo-

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couple wires and galvanometer. That these effects were very appreciable in the case of a copper-eureka couple used in the subsequent tests was shown by finding the separate deflections of the spot of light, due to the couple alone, and the E.M.F. down R alone, after bringing the spot of light to zero. Several such readings were taken, the following being an example :—

Deflection due to current in R alone = 238 divisions to the right.

Deflection due to thermo-couple alone = 195 divisions to left.

Deflection due to both together = zero.

Hence the combined "Peltier" and "drop" effects are very considerable, and are eliminated by the zero method.

The temperature of the oil at the junctions and of the air at the paraffin wax block switch being known, and the E.M.F. of the couple for these temperatures determined, we find the micro-volts per degree difference between the hot and cold junctions.

The alloys used were manganin, german silver, constantan, platinoid, and eureka with copper. All the alloys were electro-negative with respect to copper, and gave practically constant values of micro-volts per degree within the limits of the temperatures used, viz., 15° C. to 80° C.

The values found for the different couples were :—

Copper-Manganin ..	1·810	micro-volts per 1° C.
„ German silver	13·160	„ „
„ Constantan ..	17·700	„ „
„ Platinoid ..	24·000	„ „
„ Eureka ..	44·415	„ „

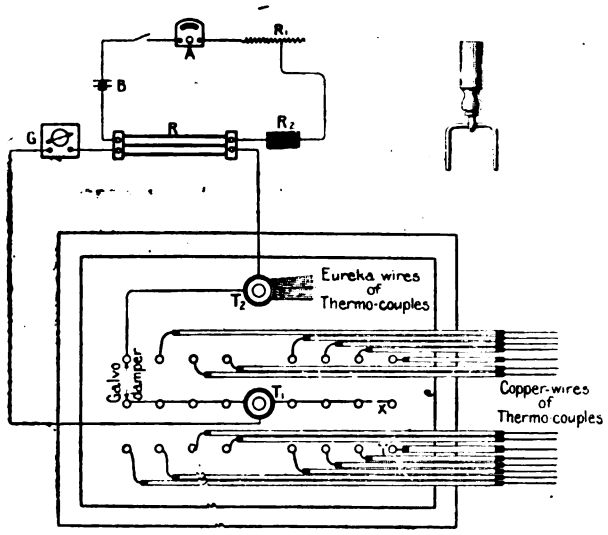

FIG. 4.

The copper-eureka couple was therefore chosen for use in measuring the various temperatures required. The value of the manganin resistance R (Fig. 4) was 444·7 microhms, hence the current I required to bring the spot of light to zero for a temperature difference t° C. is—

$$I = \frac{44{\cdot}415 \times t}{444{\cdot}7} = \frac{t}{10{\cdot}01},$$

or very approximately the temperature difference is given by multiplying the reading of the ammeter by 10.

Approximate Calculation of the Conductivity to Heat Flow from Iron to Air.

Heat Carried Away by Conduction and Convection.—When a heated surface is exposed freely to air, the air in the immediate vicinity becomes heated, and therefore rises, carrying away heat. It may be assumed that this action is confined to a comparatively thin layer of thickness δ cms. Let the surface be S sq. cms, at T° C. above air, temperature. If C be the conduction co-efficient of air then the heat dissipated by conduction in the length δ is—

$$P_1 = C\frac{S}{\delta}T.$$

The value of C in C.G.S. units is 0·00005551 (Landholt-Börnstein, Physikalisch-Chemische Tabellen), or in electrical units is $2{\cdot}32 \times 10^{-4}$;

$$\therefore P_1 = 2{\cdot}32 \times 10^{-4}\frac{S}{\delta}T \text{ watts.}$$

This loss per second by conduction alone in still air has been found to be $4{\cdot}65 \times 10^{-4}$ watts per sq. cm. of surface per 1°C. difference in temperature of surface and air (Hütte). Hence—

$$P_1 = 2{\cdot}32 \times 10^{-4}\frac{S}{\delta}T = 4{\cdot}65 \times 10^{-4}\,S\,T \text{ watts.}$$

$$\therefore \delta = 0{\cdot}5 \text{ cms.}$$

Convection.—Let v cms. sec. be the mean velocity of the air travelling up the surface of height h cms. The time taken to move up the surface = $\frac{v}{h}$ seconds. The volume of heated air is $S\delta$, and if we assume a uniform temperature gradient from the iron to the air, the mean temperature of this volume is $\frac{T}{2}$ above the surrounding air. The specific heat of air is 0·238 cals. per 1 gramme per 1° C. and 1 cubic metre of air at 15° C. and 760 mm. weighs 1·188 kgs., hence, approximately, for heated air we may say 1 cubic metre weighs 1 kg.; therefore the specific heat in electrical units per cub. cm. is 10^{-3} watt-secs. Therefore the rate of dissipation of heat by convection is—

$$P_2 = 10^{-3}\,S\delta\frac{T}{2}\frac{h}{v} \text{ watts.}$$

Radiation.—The law governing the radiation of heat is that of Stefan-Boltzmann :—

$$H = KSt\left\{\left(\frac{T_1}{100}\right)^4 - \left(\frac{T_0}{100}\right)^4\right\}$$

where—

H = large calories.
T_1 = absolute temperature of radiating body.
T° = absolute temperature surrounding medium.
S = radiating surface in square metres.
t = time in hours.
k = constant depending upon the nature of the surface.

For ordinary dark metal surfaces $k = 4$ (Hütte). Reducing to electrical units and taking S in sq. cms, we have rate of dissipation of heat by radiation—

$$P_3 = 4{\cdot}6\left\{\left(\frac{T_1}{100}\right)^4 - \left(\frac{T_0}{100}\right)^4\right\}10^{-4}\,S \text{ watts.}$$

This formula may be simplified and put in the form $P_3 = C\,T\,S$, where T is the temperature difference, S the radiating surface in sq. cms, c the co-efficient of conductivity of radiation.

The values of c are found from the Stefan law by assuming various values of T_1 and calculating P_3. The temperature of the air in the room is assumed to be 14·5°C., this being the value in Test I., Table I. If we allow a temperature rise of 50°C., the value of c is $5{\cdot}625 \times 10^{-4}$.

$$\therefore P_3 = 5{\cdot}625 \times 10^{-4}\,S\,T \text{ watts.}$$

The total dissipation of heat by conduction, convection, and radiation is therefore—

$$P = P_1 + P_2 + P_3 = \frac{2{\cdot}32}{\delta} \times 10^{-4}\,S\,T + 10^{-3}\,S\delta\frac{T}{2}\frac{v}{h} + 5{\cdot}625 \times 10^{-4}\,S\,T;$$

putting—

$$\delta = 0{\cdot}5$$

$$P = 10{\cdot}275 \times 10^{-4}\left(1 + \frac{0{\cdot}24\,v}{h}\right) S\,T,$$

or the total co-efficient of conductivity is—

$$C = 10{\cdot}275 \times 10^{-4}\left(1 + \frac{0{\cdot}24\,v}{h}\right)$$

Test I.

The Temperature Rise of Iron Stampings Free in Air.—Three thermo-couples were placed in the iron between the stampings, and about $\frac{1}{8}$ inch from the outside surface. The first was placed 2 cms. from the bottom, the second halfway up, and the third 2 cms. from the top of the stampings.

TABLE I.
Iron Free in Air.

Room Temperature °C.	Final Temperature Rise of Iron at—			Mean Temperature Rise. ° C.	Watts Dissipated.
	Top.	Middle.	Bottom. °C		
14·4	61·5	62·5	59·0	61·0	103·5
11·6	48·9	49·5	47·1	48·5	70·0
14·3	41·1	42·2	39·7	41·1	53·0
14·4	35·2	36 3	34·1	35·2	43·0
14·8	27·8	28·8	27·1	27·9	33·0
14·5	22·0	22·9	21·4	22·1	24·0

The iron was heated up quickly by cutting out the main regulator, and when a suitable temperature was reached the watts were adjusted to about the right value to maintain this temperature, and then kept constant, readings being taken at intervals of half-an-hour until the temperature assumed a final value.

The results obtained are given in Table I.

It will be seen that the middle of the iron always had a higher final temperature than the top or bottom, and that the temperature at the top is higher than at the bottom of the iron.

This is due to the fact that the energy lost in the upper half of the iron is equal to that in the lower half, but the temperature of the air surrounding the upper half is higher than that below, for the air rises in temperature as it travels up the hot surface. Consequently, if equal energy is dissituated, the temperature at the top must exceed that at the bottom. This is much more evident in the case of oil cooling, as will be seen by reference to Test IV. The conductivity to heat flow at various temperatures can be obtained from this curve. Let W watts be the total energy

TABLE II.
Iron Free in Air.

Total Watts Dissipated.	Mean Temperature Rise of Iron. °C.	Coefficient of Conductivity C.	Resistance to Heat Flow $R=\frac{1}{C}$
100	60·0	1·975 × 10⁻³	506
90	56·6	1·882 × 10⁻³	531
80	53·0	1·790 × 10⁻³	559
70	48·7	1·703 × 10⁻³	587
60	44·0	1·615 × 10⁻³	620
50	39·0	1·520 × 10⁻³	657
40	33·2	1·428 × 10⁻³	700
30	26·0	1·367 × 10⁻³	732
20	18·6	1·272 × 10⁻³	785

dissipated as heat, T the rise in temperature of the iron over the surrounding air, and S the total exposed surface of the iron. Then the heat flow per sq. cm. is $\frac{W}{S}$, and as the heat flow per sq. cm. $= \frac{\text{temperature difference}}{\text{resistance}}$

$= \{\text{temperature difference} \times \text{conductivity C}\}$ we have $C = \frac{W}{ST}$

The exposed surface of iron of the apparatus is 845 sq. cms. (diameter, 16·8 cms.; height, 16 cms.).

From the calculated value of the conductivity—

$$C = 10{\cdot}275 \times \left(1 + \frac{0{\cdot}24\ v}{h}\right) 10^{-4}$$

it is evident that at temperature rise equal to zero, $v = 0$, and therefore $C = 10{\cdot}275 \times 10^{-4}$. Now, by producing the conductivity curve to cut the axis, the value of C at $T = 0$ is $10{\cdot}75 \times 10^{-4}$, which agrees almost identically with the calculated value.

The total iron losses in Table II. may be separated into the three components: conduction, convection, and radiation.

The loss by conduction alone is found from—

$$P_1 = 4{\cdot}65\ S\ T \times 10^{-4} \text{ watts},$$

and that of radiation from—

$$P_2 = C\ T\ S,$$

the values of C being taken from a plotted curve, and T from Table II.

It is interesting to notice how quickly the quantity of heat carried away by the convection currents rises in comparison with radiation or conduction.

The equation connecting the co-efficient of conductivity and temperature rise is very nearly—

$$C = 10{\cdot}75 \times 10^{-4} + 0{\cdot}0725 \times 10^{-4}\ T^{1{\cdot}14}$$
$$= 10{\cdot}75 \times 10^{-4}\ (1 + 0{\cdot}00675\ T^{1{\cdot}14}).$$

Let σ be the watts dissipated per sq. cm. of iron surface. Then—

$$\sigma = 10{\cdot}75 \times 10^{-4}\ (T + 0{\cdot}00675\ T^{2{\cdot}1}),$$

from which—

$$T = 65\ \{\sqrt{1 + 25\ \sigma} - 1\} \text{ nearly.}$$

This formula, therefore, gives approximately the temperature rise of iron stampings, exposed freely to air, in terms of the watts dissipated and the exposed surface. To test the formula, the temperature rise has been calculated at various points and compared with the value obtained in the test.

Watts Dissipated.	Calculated Value of Mean Temperature Rise. °C.	Experimental Value of Mean Temperature Rise ° C.
20	17·0	18·6
30	24·4	26·0
40	31·2	33·2
50	37·4	39·0
60	43·4	44·0
70	48·8	48·7
80	54·3	53·0
90	59·5	56·6
100	64·8	60·0

TEST II.

The Temperature Rise of Iron Stampings when Cooled by Air and Enclosed in an Iron Case.—The apparatus was now placed in the iron case as shown in Figs. 1 and 2. The holes in the top cover were closed. The temperature of the iron was measured by the same thermo-couples as in Test I. The temperature of the air at the top and bottom of the iron was measured by eight thermo-couples, four at the top and four at the bottom. These were equally spaced between the iron and case, the distance between each being 1 cm. The couples were passed through glass tubes and supported in position by means of a brass plate screwed to the end discs of the apparatus. This plate was cut nearly to the bottom, midway between the apparatus and case to allow of the insertion of a brass separating sheet surrounding the apparatus. All the couples between this sheet and the apparatus were taken to the bottom and brought up on the outside, thus avoiding the necessity of disconnecting any couple wires when placing the separating sheet in position or removing it. All the couple wires were taken through a large glass tube at the top of the case and connected to the block switch as indicated in Fig. 4. The results obtained in this test are tabulated below.

The temperature rise in this case shows a large increase over that for Test I. for the same watts dissipated, due, of course, to the fact that there is not a fresh supply of cold air constantly coming in contact with the iron. Also, the difference in temperature between the top and bottom of the iron is very much more marked than in Test I., as the hot air now collects in the upper part of the case.

TABLE III.
Iron enclosed in Case—Air Cooling.

Room Temperature. ° C.	Final Temperature Rise of Iron.			Mean Temperature Rises. ° C.	Watts Dissipated.
	Top.	Middle.	Bottom.		
14·3	69·00	70·5	59·85	66·45	79·0
15·2	58·00	59·0	51·00	56·00	63·5
14·8	55·00	56·0	47·50	52·80	57·5
14·9	42·25	43·0	35 50	40·25	40·7
15·1	36·00	35·5	30·00	33·80	35·0

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From the above values, the curve of watts against mean temperature rise is obtained, and from this curve the co-efficient of conductivity from iron to air enclosed in a case is found, as in Test I., and tabulated in Table IV.

TABLE IV.

Iron in Case—Air Cooling.

Total Watts Dissipated.	Mean Temperature Rise of Iron °C.	Coefficient of Conductivity C.	Resistance to Heat Flow $R = \frac{1}{C}$
19·0	20	$1·125 \times 10^{-3}$	890
30·0	30	$1·184 \times 10^{-3}$	845
41·6	40	$1·232 \times 10^{-3}$	812
54·5	50	$1·291 \times 10^{-3}$	775
68·3	60	$1·348 \times 10^{-3}$	742
79·5	67	$1·405 \times 10^{-3}$	712

The conductivity co-efficient being plotted against the mean temperature rise of the iron, a practically straight line is obtained, so that the conductivity is a linear function of the final temperature rise, and therefore the watt-temperature curve is parabolic. As in the case of iron exposed freely to the air (Test I.), by producing this curve to cut the axis at T = 0, we have $C = 10·1 \times 10^{-4}$, being practically the same as for T = 0 in Test I.—viz., $10·75 \times 10^{-4}$—and as the calculated value $10·275 \times 10^{-4}$. The equation connecting C and T was thus—

$$C = 10·1 \times 10^{-4} + 0·05\ 10^{-4}\ T$$
$$= 10^{-3}(1 + 0·005\ T) \text{ nearly.}$$

Let σ be the watts dissipated per sq. cm. of iron surface, then $\sigma = 10^{-3}(T + 0·005\ T^2)$, from which $T = 100\{\sqrt{1 + 20\sigma} - 1.\}$

This formula therefore gives the rise in temperature of the iron in terms of the total watts dissipated, and the total surface, for iron enclosed in the case.

To test the formula, the temperature rise has been calculated and compared with the test values.

Rise in Temperature of the Air Flowing up the Iron Surface.—The arrangement for measuring the air temperatures has already been described, the eight thermo-couples shown in Figs. 1 and 2 being used for the purpose.

TEST III.

Iron Cooled by Air Blasts.—In this test, blasts of air of different intensities were blown through the case. The central plate at the bottom of the case was removed, and the whole placed upon a box-like structure having a small electric fan in front. The fan was provided with a series resistance giving three speeds. The supply of air was measured by an anemometer placed over the hole at the top of case, and the rise in temperature of the blast was measured by thermometers placed at the entrance and exit. Some difficulty was experienced in keeping the air blast constant, as the fan supply volts varied slightly. The watts carried away by the air has been calculated from the anemometer readings, taking the specific heat of air as 0·238 calories per gramme-degree, and weight of air at 15° C. as 1·188 grammes per litre. In all cases this calculated value agrees fairly well with the watts input to apparatus, showing that the anemometer was tolerably accurate.

The results of the tests are given below :—

TABLE VI.

Lowest Speed of Fan.

Room Temperature. °C.	Mean Final Rise of Iron	Cubic Feet of Air per Hour.	Te'perature of Air at Exit.	Rise of Air Temperature.	Watts Carried Away by Air.	Watts, Input.
15·3	53·7	950	25·2	9·9	86·0	90·0
14·7	43·8	1,000	22·0	7·3	66·5	70·0
15·2	32·6	980	20·3	5·1	45·4	50·5
15·0	20·5	980	18·0	3·0	27·0	30·1
Intermediate Speed of Fan.						
15·2	54·7	1,500	23·3	8·1	110·0	105·0
14·9	44·5	1,450	21·2	6·3	83·0	80·0
14·9	35·4	1,435	20·0	5·1	66·5	62·5
14·7	25·1	1,385	18·2	3·5	43·0	44·5
Highest Speed of Fan.						
14·8	47·3	1,700	20·5	5·7	91·0	95·0
15·0	39·0	1,680	20·1	5·1	79·5	82·5
13·2	31·9	1,800	16·7	3·5	59·0	65·0
14·3	21·7	1,650	16·9	2·6	40·0	43·0

The watt-temperature curves for the three tests might almost be taken as straight lines. The value of the conductivity co-efficient C will therefore be constant. These are, however, found to be—

C.	$R = \frac{1}{C}$.
$1·90 \times 10^{-3}$	525 for lowest blast.
$2·14 \times 10^{-3}$	470 for intermediate blast.
$2·42 \times 10^{-3}$	415 for highest blast.

The temperature attained by the iron when cooled by an air blast will depend upon four main factors :—

1. The volume of the blast per unit of time.
2. The velocity of the air.

This will depend upon the volume of blast and upon the sectional area of its path, *i.e.*, the dimensions of the apparatus and case. If the area is large and the volume of blast of medium value, then the velocity may be reduced to the order of that of convection currents, in which case the cooling will be similar to that of Test I., where the iron was exposed freely to the air.

3. The temperature of the ingoing blast.
4. The direction of the air blast with respect to the surface of the iron.

The iron will be cooled more effectively if the cold air impinges normally upon its surface than if it flows parallel to the surface, for not only will the contact between the air and iron be better in the former case, but the agitation of the air will be much greater, thus bringing a constant stream of cold air against the iron. For these reasons it is impossible to generalise to any extent upon the results of this test.

The Oil Cooling of Iron Stampings.—Owing to the high value of the co-efficient of heat conduction of oil in comparison with that of air an oil-cooled transformer has a much larger output than that of an air-cooled transformer. Oil cooling is therefore more economical than air cooling, since the amount of material in the transformer is less for the same output. Another advantage attending the use of oil is due to its high specific heat. The energy loss in the tranformer is absorbed by the oil, whose temperature rises slowly. Hence when working intermittently, for instance, during the day only, the transformer may never reach its steady final temperature corresponding to the watts lost. The high specific heat of the oil also allows of the transformer being worked at a high overload for a considerable time without overheating. Other advantages of oil over air are :—

1. The high insulating properties of oil.
2. Its high dielectric strength, this being about five times that of air.
3. The prevention of particles of dirt and moisture getting into the windings. These have a very detrimental effect upon the insulation of the transformer, especially if working on high-tension circuits.

Tests similar to those already described were now made, using oil as the cooling medium.

The oil was best transformer oil supplied by the Vacuum Oil Co. Its specific gravity was 0·84, and its specific heat as determined by the method of mixtures was about 0·5 calories gramme,° this being taken from two results —viz., 0·51 and 0·518.

TEST IV.

The case was filled to a height of 11 cms. above the upper wooden disc of the apparatus, Fig. 1, about 3½ gallons of oil being used. As in the preceding tests, the initial heating was performed with a large current by cutting out the main current regulator. When a satisfactory temperature had been reached the watts were reduced to approximately the correct value, and readings taken until the temperatures became constant. Even then several hours were usually taken before the final temperatures were reached.

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The temperatures assumed by the oil are interesting. As with air cooling there is a large temperature drop between the iron and the oil at the surface, although not so marked as in air cooling. This point will be further dealt with shortly. The drop in temperature down the oil at the top of the iron is very slight. This is not only due to the good conduction co-efficient of the oil, but also to the fact that the hotter oil near the iron is in motion and mixes with the cooler oil at the case, so giving an almost uniform temperature horizontally. At the bottom of the iron the oil temperature at the two couples nearest the case is slightly higher than at those nearest the iron. This is due to convection, some of the hot oil at the top sinking as it is cooled by the case and displacing cold oil from the bottom which flows past couples 1 and 2. Between the oil and case there is always a large temperature drop similar to that between the iron and oil. The final mean temperature of the case is proportional to that of the iron, the temperature rise of the iron being roughly 2½ times that of the case.

The temperature rises of the oil nearest the iron—viz., at couples 1 and 5 are plotted against the temperature rise of the iron at the bottom and top respectively. These points may be taken to lie upon straight lines. The ratio of the iron temperature at the top to that of the oil in contact with it is about 1·6, and at the bottom is 1·7, or we may say that the ratio of the mean temperature rise of the iron to that of the oil is 1·65. If T_i represent the mean temperature rise of the iron, and T_o that of the oil, then $T_i = 1{\cdot}65\ T_o$. If S be the area of the iron exposed to the oil, and W the total waits passing as heat to the oil, then $_iC_o = \frac{W}{S\,(T_i - T_o)}$ from iron to oil.

$$\therefore\ {}_iC_o = \frac{2{\cdot}5\ W}{S\ T_i} = 2{\cdot}5 \times 3{\cdot}75.\ 10^{-3} = 9.4 \times 10^{-3}.$$

In the same way we have $_oC_c$, the conductivity from the oil to case is—

$$_oC_c = \frac{W}{S\,(T_o - T_c)}$$

where T_c is the temperature rise of case, and S is the area of the case in contact with the oil. As it is very probable that the oil underneath the apparatus remained practically at atmospheric temperature throughout the test, the area af the bottom of the case may be neglected.

Taking only the vertical sides of the case in contact with the oil we have S = 3,000 sq. cms. From the given values of the temperature of the oil at the case we obtain

$$\frac{T_o}{T_c} = 1{\cdot}53, \text{ and putting } \frac{T_i}{T_o} = 1{\cdot}65—$$

$$_oC_c = 5 \times 10^{-3}.$$

Lastly, if S_c be the surface of the case, and T_c its temperature rise, then the conductivity co-efficient from case to air is—

$$_cC_a = \frac{W}{S_c\,T_c}.$$

TEST IVA.

This test is a repetition of Test IV., but with the separating sheet put in as in Test IIA. The results of Test IIA. showed that this sheet was a distinct failure as an agent in cooling the iron in air.

Below a temperature of 25°C., the effect of the sheet is to increase the temperature rise of the iron. This is probably due to the shielding effect of the sheet noticed in Test IIA. Above 25° the sheet exerts a cooling effect upon the iron. This is the result of the additional circulation of the oil, which takes place with the sheet dividing the oil into two separate portions. Hence at 25° rise the tendency of the sheet to stop the flow of heat through the oil, and the reflection of the radiant heat is counterblanced by the increase in the circulation. Above that temperature the circulation predominates, and below it the screening effect predominates.

TEST IVB.

As the result of Test IV. values were given to the conductivity co-efficients between the various surfaces obstructing the heat flow from the iron stampings to the external air.

It is unnecessary to say that these are not absolutely definite values under all circumstances, but must alter slightly with varying conditions. One such variable is the quantity of oil in the case.

The conductivity co-efficient from the oil to the case has been given as—

$$_oC_c = \frac{W}{S\,(T_o - T_c)},$$

where—

W = total watts dissipated as heat.
S = surface of case in contact with oil.
T_o and T_c = temperature rises of oil and case respectively.

Now if S be decreased, by reducing the quantity of oil, the watts remaining constant, and we suppose the value of $_oC_c$ to remain approximately constant, then the temperature difference $(T_o - T_c)$ increases. Now T_c must be constant, since the case is dissipating the same watts as before, hence T_o, the temperature rise of the oil, increases, and so $\frac{T_o}{T_c}$ increases. At the surface of the iron we have—

$$(T_i - T_o) = \frac{W}{{}_iC_o S}.$$

The exposed surface S of the iron is unaltered, hence $(T_i - T_o)$ is constant for a constant loss W. But as T_o has increased, T_i, the temperature rise of the iron, increases, and $\frac{T_i}{T_o}$ decreases.

To find if this actually occurred, the level of the oil was reduced almost to the top of the iron.

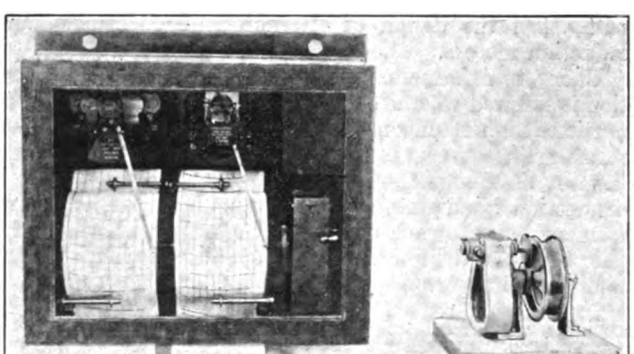
From these figures curves may be plotted of the temperatures of the iron and adjacent oil from which is found $\frac{T_i}{T_o}$ at top of iron = 1·65 and at bottom = 1·37, or mean value of $\frac{T_i}{T_o} = 1{\cdot}5$.

(To be continued).

SPEED INDICATOR FOR ENGINE ROOM AND SHIP USE.

We illustrate a capital type of instrument intended for use in such installations as may necessitate the indication of speed at a distance from the machine itself. For this purpose a small magneto generator is driven either by a belt or direct coupling from the shaft whose speed is to be measured; all that is then needed is to lead two small wires from the generator to the indicator, which can be fixed in any convenient position. The scale of the instrument is divided perfectly evenly, and can be given any required form, a very convenient one being a sector pattern instrument with an illuminated dial, or, where space is of importance, an edgewise instrument.

The indicator is dead beat, and it will be evident that there can be no hunting in the transmitter, so that the speed is instantaneously taken.



For ship equipment it is now often the practice to have several indicators fitted at different points, one being, as a rule, fitted on the bridge, and for such purposes the instruments can be rendered water-tight.

When it is wished to record the speed on a paper chart, a recorder of the ordinary pattern with either 24-hour or weekly charts is provided. Our illustration shows the instrument above described arranged to record simultaneously power and speed. It is designed and manufactured by Messrs. Everett, Edgcumbe & Co., Ltd.

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REVIEWS.

"Elementary Electrical Calculations." By T. O'Conor Sloane. Published by D. van Nostrana Co., New York, and by Crosby, Lockwood & Son, London. Price 9s.

A large proportion of the 300 pages of this book is taken up with worked-out calculations, the mathematics used being mostly arithmetic and elementary Algebra. Some of the questions are rather quaint, thus: "A car goes at 30 miles an hour on a 4 ft. 8½ in. track; if the vertical component of the earth's magnetic field is 0.438 lbs. of force, what E.M.F. will be developed in the axle?" Now, there are numberless questions one can ask about a tram-car without worrying about the earth's vertical component. Here and there the book goes beyond elementary work; capacity, inductance, and calculations of networks are fairly well done, and the last chapter demonstrates the convenience of the calculus. Under mechanics and physics the word *entropy* is defined as available energy, and the available energy of the universe is constantly diminishing coal, and oxygen existing separately represent high grade energy. After burning the two, the grade of the unutilised energy is so low, that it cannot be used, and *entropy* has been lost.—E. K. S.

"Elements of the Differential and Integral Calculus." By A. E. H. Love, M.A., D.Sc., F.R.S. (University Press, Cambridge, 1909).

This excellent work is another example of the radical transformation which the teaching of all branches of mathematics has undergone of late years. The old cast iron methods have given place to others more flexible and better adapted to meet the requirements of the case. The treatment of the calculus in the work under notice is new, especially in the earlier chapters of each of the two sections, and, in our opinion, a great improvement on any that we have seen before. The numerous examples are well chosen and well adapted to enable the student to test his own progress.

"Alternating Current Machines": Being the 2nd Volume of Dynamo Electric Machinery. By S. Sheldon, D.Sc., H. Mason, B.S., and E. Hausman, B.S. (D. van Nostrana Co., New York, and Crosby, Lockwood & Son, London).

The fact that this book is the eighth edition, and has been completely re-written, shows how changeable is electrical science. The book is written primarily for students well grounded in mathematics, some of the pages being covered with formulæ. The subject matter is divided up into paragraphs, each under a main head, so as to be easily found; a number of questions are given at the end of each chapter.

The general theory of alternating currents is first dealt with, then the design of alternators, transformers, and induction motors.

Under transformers, the "delta" and "star" connection is referred to, and it is stated that with "delta" connection it is not uncommon to supply motors from three-phase mains by two somewhat larger transformers, rather than by three smaller ones. On the other hand, the "star" connection is advantageous for extra high tension transformers, because each transformer can then be wound for only 57·7% of the line voltage, and, consequently, they are safer and cheaper.

In order to reduce the starting current, the General Electric Co. makes small squirrel-cage motors with centrifugal friction clutch pulleys, so that, although a load may be belted to the motor, it is not applied to the rotor until the latter has reached a certain speed. The starting current is, therefore, a no-load starting current.

The various dodges which have been invented to make the single-phase traction motor a workable piece of apparatus are fully described. One cannot help thinking that it is a pity the brain effort these dodges represent could not have been directed into a more promising field.

Mark Twain is said to have invented the word "boost," and electrical engineers have brought it into common use. A machine to give the opposite effect can, of course, be made, and it appears our American friends have christened it a *crusher*. One is thus described in the book. The primary windings are placed in slots in the interior of a laminated iron frame like a stator. The secondary winding is placed in what corresponds to the slots of a rotor, and the rotor can be moved through an angle by a small direct current motor. If the secondary core is rotated by an angle corresponding to the distance between two successive poles, the action of the regulator will change from that of *booster* to that of *crusher*.

The last chapter deals with power transmission, and the well-known Kelvin law for conduits is given a new name: "Economic Drop." A transmission of 5,000 kw. three-phase, over 100 miles, using aluminium conductors at 66,000 volts 25 volts, is worked out in detail, and the ten pages thus occupied in the book seem to the writer to be about the best.—E. K. S.

The Deinhardt-Schlomann Series or Technical Dictionaries, in six languages; "Vol. V.: Railway Construction and Operation," compiled by Dipl.-Ing. August Boshart. With about 1,900 illustrations and numerous formulæ. (London: Archibald Constable and Co., Ltd., 1909. Price 25s.)

This is the fifth volume of the series, but at the same time the first to show the serious drawbacks of the system adopted for these dictionaries. The volume is supposed to deal with Railway Construction and Operation, yet about one-fourth of the matter has nothing to do whatever with either subject. Again, the majority of the sketches convey no meaning to the reader; in many cases an explanation would be required to make the sketches intelligible. I refer more especially to the illustrations in the chapter on "Signalling and Safety Appliances," where nine out of ten drawings seem more or less useless. Judging in particular from the chapters on electric railways, the translations, which seemed to have been fairly correct in the previous volumes, are very frequently carelessly done. Also, there are many terms which are quite out of place here. Why, for instance, give the term "riveted bolt"? (p. 387). Surely it has nothing to do with Electric Railways in particular. Or again (on p. 504): "insulation testing apparatus." This is a general electrical term. But why place it in the chapter on electric railways? Its place is in Vol. II. (Electrical Engineering), where, of course, it can be found. Such terms seem merely to be inserted to increase the bulk of the matter; and unfortunately, there are very many of them. As for translations, I find amongst them a great number of odd renderings like, for instance, the following: Betriebsfuehrung—Management. Surely such a mis-translation ought not to be made. There is also a curious point: The volume is entitled, "Railway Operation"; yet we look in vain for a translation of this very expression in the book—it is not to be found there. An omission like this certainly does not speak highly for the compilation.—C. K.

"Deutscher Kalender Fuer Elektrotechniker." Begruendet von Uppenborn. Siebenundzwanzigster Jahrgang, 1910 herausgegeben von G. Dettmar. Munich and Berlin: Druck und Verlag von R. Oldenbourg. 2 Parts. Price 5 marks.

This, the 27th edition of the well-known "Uppenborn-Kalender," hardly needs recommendation. The fact that it is so extensively used by English Electrical Engineers speaks for itself. Mr. Dettmar, who since the death of Mr. Uppenborn has become the editor of this work, has added materially to its usefulness. We note with great satisfaction that practically all chapters are brought quite up-to-date, a thing that can hardly be said of some of the corresponding English pocket-books. If there is one thing that could be improved upon, it is the somewhat insufficient treatment of purely practical matters. Thus, for instance, while there are about 60 pages on the theory and design of electrical machines, there is only one page dealing with the maintenance of machines, and no mention of troubles in working, or their remedy. Yet it is just these points we would look for in a pocket-book. Or, again, there is nothing said about the maintenance of alternating current machines. Probably the editor might add a few pages on these matters to the next edition.—C. K.

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THE

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ELECTRICITY IN FRANCE.

With a daring that is characteristic of French engineers, our brother electricians on the other side of the Channel have been putting forward rather startling projects for the complete electrification of their country. The Tavernier scheme contemplates some form of combination whereby the whole available water power in France, and as we recently showed (ELECTRICAL ENGINEER, Vol. XLIV., p. 776) this is estimated to amount to 5,857,000 H.P., could be utilised for the generating of electricity at a comparatively few central stations, for distribution to sub-stations all over the country. It is a grandiose idea, and we find some minor attempts to pave the way to such an end, as we see in the earliest of these undertakings, the Jonage station on the Rhone (20,000 H.P. hydro-electric, supplemented by 6,000 H.P. auxiliary steam generated), the Tuillére station on the Dordogne (16,000 H.P. hydro-electric, 6,000 H.P. auxiliary steam generated), others in the South of France, and the new Harlé-Blondel proposal to establish a huge hydro-electric station on the Rhone for the supply of electricity by means of the Thury high pressure system to Paris (ELECTRICAL ENGINEER, Vol. XLIV., p. 377). While admiring these projects for the future, it is well to consider the actual condition of affairs and the difficulties in the way not of a Garnier, but even of a Harlé-Blondel scheme. This has been done for us by M. Albert Marnier in the columns of the *Revue Industrialle*. He is not inclined to assign the primary place to hydraulic power in the big schemes for electrification. He foresees too many drawbacks. To begin with, as he points out, the capital outlay in most hydro-electric schemes (certainly in those on a large scale other than where waterfalls are available) is considerably heavier than that for steam turbine stations of equal capacity. There is, no doubt, an economy of upkeep in favour of water power, but this, M. Marnier holds, is being reduced, thanks to the enormous progress made in steam generation. The staff required for the latter type of station is gradually being brought on the same

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level as that for a hyrdo-electric station. Apparently what is regarded as the most serious drawback is that of the seasonal change. M. Marnier declares that the period of minimum available power is the same for the whole of France. This, however, seems scarcely to be borne out by the rainfall and river flow statistics. Another difficulty that has to be faced in hydro-electrics is that of flooding, but this would tend to be regulated if systematic exploiting took place. M. Marnier recognises that as the difficulty and cost of winning coal increases, the disparity in the cost of generating electricity by the two methods will be levelled. The critic looks for immediate advance along the line of concentration. A good deal is already being done in this direction, and it is possible that in the near future the general type of exploitation will be one or two large central generating stations, with a number of sub-stations, the existing smaller undertakings being merged in the larger, and falling into the category of sub-stations. Something of this kind is taking place in Paris and its neighbourhood. Recent legislation has hastened the unification of methods and of undertakings. Fewer generating stations will be the rule, serving sub-stations, while the high tension currents will be transformed for general service. The actual position seems to be this: There is the three-phase generating station at Asniére-sur-Seine, with a capacity of 12,400 KW., capable of being increased to 24,000 KW., which supplies current for lighting and power to 19 urban or rural districts, including the place Clichy district, the suburban district served by the Paris-Nord-Lumiére, and Montmorency. The generating station of Puteaux-Ouest-Lumiére, with a present capacity of 15,400 KW., which serves an outlying district touching that of the Nord-Lumiére, and extending as far as Versailles. The generating station of the Compagnie Generale de la distribution d'Energie Electrique at Vitry, which is affiliated with the French Thomson-Houston Co., with an outfit of three alternating turbo-generators, one of 9,000 KW., and two of 6,000 KW. each. This station supplies electricity to Est-Lumiére, serving the south-east of Paris. The generating station of Alfortville, belonging to the Est-Lumiére Co., and having a capacity of 10,600 KW.; and enjoying the privilege of buying bulk-current from the Vitry station; it serves the south and east of Paris. The Saint Denis generating station of the Société d'Electricité de Paris, with a capacity of 85,000 KW. It is equipped with both Parsons and Brown-Boveri alternating turbo-generators; there are 10 groups at present, and room for two more. It supplies current to the Metropolitan Railway (33,000,000 KW.-H. in 1908), to several tramway companies, to the city of Paris, and will also serve, in conjunction with the Vitry station, the Nord-Sud Paris Railway. There are over and above these a number of smaller stations, installed either by railway or tramway companies, or for the service of different districts of the capital. The chief of these are the generating stations of Moulineaux, equipped with nine generating groups of a capacity of 800 KW. each (Westinghouse system), serving the Western Railway, tramways; the Station of Bercy, with eight generating groups of a capacity of 1,500 KW. each, serving the Metropolitan Railway, and the Compagnie Parisienne de Distribution, with a capacity of 75,000 KW. These eight large stations, then, have a total capacity of 250,200 KW., but M. Marnier estimates the yearly consumption of electricity in Paris and its suburbs at 190,000,000 KW.-H. If this is accurate, it will be seen that the minor stations must be credited with a large annual output. Nevertheless it is deemed that they are destined soon to become merely sub-stations of the eight undertakings enumerated. Our French *confrere* sees nothing but profit in this, as tending to bring about better and cheaper service, so that even manufacturers will find it more economical to scrap their plant and take electricity from the large companies. It is noteworthy, as we have pointed out from time to time, this concentration and co-operation is going on extensively in the North of France, where hydro-electric generation is rare, but where the central stations can be installed practically at the coal pit mouths.

CORRESPONDENCE.

TO CORRESPONDENTS.

All communications intended for the Editor should be addressed "The Editor, 149, Fleet Street, London, E.C." Anonymous communications will not be noticed. Letters should reach the Editor not later than Tuesday afternoon to be included in that week's issue of the Journal.

The Editor is not responsible for, nor does he necessarily endorse opinions advanced by correspondents.

ELECTRICAL PROPULSION OF INTERNAL COMBUSTION ENGINED SHIPS.

There appears an acknowledging letter in your issue of 31st ult. on the above subject, which was induced by mine of the 24th ult., intimating the availableness of a marine bituminous gas producer capable of taking its place as part of the power system which is being so ably championed through your journal by Mr. W. P. Durtnall, M.I.M.E., the author of the letter referred to, and others of good company. Mr. Durtnall acknowledges the many attempts made in the past to bring this intricate matter to a successful issue, and inferentially admits that the path is strewn with failures. I candidly confess that my own prolonged studies in this department have had a sobering effect, and have driven home the truth that the subject may not be dealt with in a flippant spirit. But, sir, a close study of even failures may be as a sign-post by the wayside to such as seek direction in the right path, even in matters of engineering.

Having digested the truism that success is built on past failures, I have profited thereby. Hence it was with due sense of responsibility that I ventured to request the courtesy of your admitting me to your correspondence column. Mr. Durtnall's letter practically solicits assurance on the main point of space occupied, seemingly having in mind that on land the bituminous gas producer has usually become associated with bye product plant, or elaborate and space occupying scrubbing and cleaning plant, altogether unsuitable for aboard ship.

Now, it is well-known that tar is the bugbear of the land gas producer which uses bituminous fuel, and this will-o'-the-wisp has succeeded in evading its would-be captors. It is clear that no producer plant is acceptable in the marine world which involves elaborate cleaning apparatus, space being more precious on board ship than on land. As Wyer puts it: "It is self-evident that the prevention of a trouble is always very much better than after-attempts to rectify it; therefore, the prevention of the formation of tar in the gas is preferable to any after-attempt at tar removal."

I will add to that axiom another, viz., that no gas producer can become applicable for marine service which does not completely and satisfactorily meet and embody that principle.

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Hence, having a clear conception of these central truths, Mr. Durtnall will understand that when I pronounce on this matter my statement is one of fact, and since he has welcomed the intimation, I will undertake to suitably place the matter before him, so that he may judge the scheme as a sound marine proposition.

Yours etc.,
JOHN STEWART.
(Stewarts' Gas Producers Co.)

141, Bath-street, Glasgow,
January 6, 1910.

RADIO-TELEGRAPHIC MEASUREMENTS.

Sir,—As Dr. Fleming's statements in reply to Mr. Taylor and myself in the discussion on his paper on "Radio-telegraphic Measurements" are somewhat inconclusive, may I take this opportunity to state more clearly the points of difference?

1. The correctness of the general principle of balancing two thermo-ammeters against one another is quite obvious, and was not questioned by anyone; but Dr. Fleming's use of a spark gap in the high frequency circuit is wrong, because the charging current, which is of *low* frequency, passes through the wire under test and contributes to the heating effect measured.

2. Dr. Fleming asserts that Dr. Barton's formula for damped current resistance has nothing to do with the question. In this he is also incorrect, since, in his paper, he compares experimental results obtained with a damped current, with calculated figures got from the formulæ of Kelvin and Rayleigh for undamped current. He should have calculated these figures from Barton's formula after measurement of the damping of the circuit.

Thus, though Dr. Fleming's experimental measurements may be approximately correct for the particular apparatus with which he was working, he has not measured the "high frequency resistance" of the wires, and has, therefore, not given a result of general utility.

3. I do not understand what Dr. Fleming means by the statement: "I totally disagree with Dr. Murray's explanation of short spark phenomena." Possibly he refers to a question which I put to him in regard to the trains of sparks obtainable with a hammer break, and which he has not otherwise answered. Perhaps he will explain.

4. As regards the photographs of groups of sparks obtained with an A.C. supply, I need only refer those interested to pp. 112–115 of Ruhmer's "Wireless Telephony," and leave them to judge for themselves whether the records are, or are not, as good as those of similar phenomena shown by Dr. Fleming.—Yours, etc.,

J. ERSKINE-MURRAY, D.Sc., M.I.E.E.,
Consulting Engineer and Wireless Telegraphist.

Oswaldestre House, 34, Norfolk-street, London, W.C.,
January 11, 1910.

WARMING UP MOTORS.

The warming up of electric motors which have to work in damp situations, as for example, in ship yards, docks, and in underground chambers for pumping, etc., is quite an important matter. With shunt-wound motors for ship-yard work we have heard of it being done by the electrical engineer switching on the shunt coils about half-an-hour before the workmen arrived in the early morning. Even where a motor is entirely enclosed this is a useful precaution to take because such motors are liable to sweat. Having a quantity of calcium chloride inside the casing helps matters, but there is a chance of its renewal being overlooked. On the other hand all the shunts of all the motors can be so connected that they receive current directly the main supply goes on. Messrs. Cox-Walkers, of Darlington, have recently laid down an automatic electric pumping plant for the water supply of Darlington and it is interesting to note that they provide against damp on the motor and switchboard by means of heating units consuming about 50 watts each. Here then is a new opening for electric heaters for which electric supply engineers should keep their weather eye lifted.—E.K.S.

A NEW METHOD OF MEASURING LIGHT EFFICIENCY.

Mr. C. C. Hutchins has devoted a considerable amount of time and care to the measurement of light efficiency, which he thinks has been attended with unusual difficulties, considering that what is required is merely the ratio of two numbers representing respectively the values of the visible and total radiation of the source. These difficulties arise not merely from the necessity of comparing large things with small, but rather for the want of some method of properly separating the quantities to be compared, and so he set to work out a system which he has expounded in the *American Journal of Science*.

To obtain a complete energy curve, and to compare the integral of the visible portion with the total is an extremely tedious and somewhat uncertain procedure. Angström's method requires an elaborate apparatus and the application of several troublesome corrections.

It is believed that the following method will be found as accurate, and much more simple and direct than those hitherto in use.

Theoretical.—Let the figure represent the energy curve of the light source; the vertical line separating the visible (a), from the infra-red (b). If now we define efficiency as the ratio of the visible to the total radiation, we have:

$$\text{efficiency} = \frac{a}{a+b}.$$

Let a water cell a few millimetres thick be placed in the path of the light. Assuming for the moment that the water is perfectly transparent to light, $a + c$ becomes the transmitted energy, the curve coming down to zero at wave length $1{\cdot}8\mu$.

Further, let a cell identical with the water cell, but containing a water solution opaque to light but transmitting more or less infra-red, be interposed, and let the transmitted energy be d. The transmission curve d must lie within the same narrow limits with c and the two areas be strictly comparable under like conditions.

If now we can measure $a + b$, $a + c$, d, and the ratio of c to d we have all that is required. For let

$$a + b = n$$
$$a + c = m$$
$$\frac{c}{d} = r$$

then

$$\frac{a}{a+b} = \frac{m - dr}{n}$$

Apparatus and Methods.—A thermopile consisting of a single junction at the focus of a small concave mirror set in a proper tube with diaprhagms is pointed at the light and exposure made by moving a double wooden shutter. The deflection of the galvanometer is reduced by a known amount by putting resistance in the circuit. The deflection so obtained is proportional to n.

A water cell about five millimetres thick, having thin plate-glass walls, is then placed behind the shutter; the resistance is removed from the circuit, exposures made as before, and we obtain deflections proportional to m.

For obtaining d, a preliminary study of a large number of substances showed potassium permanganate to be quite suitable. It is very strong in colour in solution, may be made opaque to sunlight in a thin layer, while transmitting a considerable amount of infra-red. A duplicate of the water cell is filled with a solution of permanganate of such strength as to just show the light under investigation, when held between the light and the eye. This cell being substituted for the water cell, we obtain a deflection proportional to d.

To find the ratio r. A spectroscope was given the following additions. A long slit was put in the place of the ordinary short one. The eye-piece was removed and replaced by an ebonite screen having a rectangular opening. One edge of the opening was cut to fit the curve of the spectrum lines in the red. The spectrum of the light source is focussed upon the screen and the telescope adjusted so that the visible spectrum is just cut off by the curved edge. The infra-red alone now appears in the opening. In this position the telescope is firmly clamped.

Over the eye end of the telescope is now slipped a tube,

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having at its farther end a concave mirror and thermal junction. The mirror is large enough to receive the entire cone of rays coming through the screen, and condenses them upon the junction at its focus. This arrangement was used because it was at hand; a thermopile or bolometer, having a suitable receiving surface, placed immediately behind the screen, would be simpler. An image of the light source being thrown upon the slit of the spectroscope, the water and permanganate cells are placed alternately against the objective of the collimator; a shutter is moved as before, and the attached galvanometer gives deflections proportional to c and d respectively.

Remarks Upon Setting the Screen.—It has been customary in determinations of light efficiency to assume some definite limit to the visible spectrum, as $0{\cdot}76\mu$. Such a limit is quite useful for purposes of uniformity, that one man's work may be compared with another's, but only roughly corresponds to fact except in the case of sunlight. The limit of the spectrum is not the same for all lights or all eyes. It would therefore seem more logical to set the screen upon or near the limit of the red of the light under examination, although this will commonly give a smaller value for the efficiency than that obtained from $0{\cdot}76\mu$ as a limit. This procedure seems further justified when we observe how steeply the energy curve rises at the limit of the red; so that a very slight movement of the screen upwards in the spectrum diminishes the apparent efficiency largely, while the actual light is diminished by an inappreciable amount. The smaller values therefore more nearly represent practical efficiencies.

Example of the Method.—The following measurements were made upon a portable acetylene lamp in which the gas was generated by automatically feeding granular carbide into water contained in the base of the lamp. The feed being intermittent, the light varied considerably but a fair average could be obtained by distributing the readings over a considerable time.

The resistance of the galvanometer and circuit was 2·203 ohms.

Through water the mean of five deflections was 202·2 millimetre divisions; through permanganate, 45·0 divisions. Ten ohms were added to the circuit, and the lamp direct gave 230·6 divisions, which when reduced to the scale of the others becomes 2531.

With the prismatic apparatus the mean of twenty readings through water with four ohms in circuit was 293·7. The resistance of the circuit was 2·203, and the deflection without added resistance reduced to 827·0.

The mean deflection through the permanganate cell was 205·8.

From these readings we have

$$m = 202{\cdot}2 \qquad dr = 180{\cdot}9$$
$$n = 2531 \qquad m - dr = 39{\cdot}3$$
$$d = 45{\cdot}00 \qquad m - dr$$
$$r = 4{\cdot}028 \qquad \frac{m - dr}{n} = {\cdot}0263$$

This result is subject to a plus correction of 13% because of the loss of light to that amount in passing through the water cell. Applying this correction, we get ·0296 for the light efficiency.

A second determination made after resetting the screen and changing the sensibility of the galvanometer gave ·0323. The mean of the two is ·0309 and the departure from the mean 6%. The result may be considered very satisfactory considering the large change in apparent efficiency produced by a small displacement of the screen.

CANADIAN "WIRELESS" PROJECT.

It appears that the Northern Navigation Co., who operate a line of steamers on the Athabasca, are contemplating installing a system of wireless telegraphy at points in the north country. The *Standard of Empire* announces that Mr. J. K. Cornwall, M.P.P., and Captain Barber leave in a few days for Germany to study the methods of river navigation employed in that country, and also wireless systems. Should a system be installed, the river steamers would be equipped with apparatus, and stations erected on the Peace, the lower Athabasca, and at Lesser Slave Lake. This would greatly facilitate trading operations both in and into the country.

RATING APPEAL.

ENORMOUS REDUCTION ALLOWED.

At the Surrey Quarter Sessions among the appeals was one by the Richmond Electric Light and Power Co. against the poor rate of Richmond, and Mr. Bucknill appeared for the appellant company, and Mr. C. Whiteley for the Richmond Vestry. Mr. Bucknill explained that the assessment of the company made by the Vestry for 1908 was £3,893, and it had since been agreed between the appellant and the respondent that that sum was grossly excessive. The Chairman: You can hardly say that. Mr. Bucknill said that it was so in fact, for the agreement arranged for its reduction from £3,893 to £1,633, and the first part of his motion was that the rate book should be altered and the figures agreed to substituted. The Chairman: That is assented to? Mr. C. Whiteley: That is so. Mr. Bucknill said there was another point. The appellants had to pay in 1908 rates on the higher figure when they should have paid on £1,633, and that meant that the company had incurred a loss of £700. If it was possible, he asked for that amount of £700 to be taken into account in the assessment for that year—it might be asking a great deal, but at the same time, if there was anything in equity, he was sure the chairman would appreciate that it was very hard that his clients should be mulcted of that sum by the Vestry, which they now admitted they had no right to take. The Chairman: Do you suggest we can do anything? Mr. Bucknill: I am not in a position to say whether you can or not, but I submit——. The Chairman: You might have appealed last year and had your remedy. Mr. Bucknill said that there was an agreement reached last year, in order to save expense, that there should be no appeal in that year, but that it should be opened up this year, and that some credit should be given for any amount paid during that year. Mr. Whiteley said that the appellants were bound by the notice of appeal, which only referred to the rate of 1909. It was agreed that the matter should be opened up, and it had now been brought before the Sessions. The Chairman: The appeal is allowed. We cannot do more. Mr. Whiteley in answer to a question, said each party had agreed to pay its own costs.

DIARY.

TUESDAY, JANUARY 18.

INSTITUTION OF ELECTRICAL ENGINEERS (Manchester Local Section, Students' Section).—At 7.30 p.m., at the Municipal School of Technology, "The High Tension Spark Discharge in Air," by P. Kemp, M.Sc.Tech., and W. A. Stephens, M.Sc. Tech.

WEDNESDAY, JANUARY 19.

ROYAL SOCIETY OF ARTS.—At 8 p.m., "The Japan-British Exhibition, 1910," by Count Hirokichi Mutsu, C.V.O.

INSTITUTION OF ELECTRICAL ENGINEERS (Students' Section).—Meeting at 92, Victoria-street, S.W., at 7.45 p.m. Paper by P. J. Cottle and J. A. Rutherford: "Collection of Current at High Peripheral Speeds."

FRIDAY, JANUARY 21.

NORTHAMPTON INSTITUTE ENGINEERING SOCIETY.—Visit to the Board of Trade Laboratory, Whitehall.

NORTHAMPTON INSTITUTE ENGINEERING SOCIETY.—At 8 p.m., at the Institute: Lecture, "The Choice of Prime Movers for Power Stations," by Mr. E. T. Driver.

INSTITUTION OF MECHANICAL ENGINEERS.—At the Institution House, Storey's Gate, St. James's, at 8.p.m: "The Ninth Report to the Alloys Research Committee: On the Properties of Some Alloys of Copper, Aluminium and Manganese"; (With an Appendix on the Corrosion of Alloys of Copper and Aluminium when exposed to the Sea). By Dr. W. Rosenhain and Mr. F. C. A. H. Lantsberry, of the National Physical Laboratory, Teddington.

PHYSICAL SOCIETY OF LONDON.—At 5 p.m., at the Imperial College of Science, South Kensington: "The Polarization of Dielectrics in a Steady Field of Force," by Prof. W. M. Thornton, D.Sc., D.Eng., and "On the Use of Mutual Inductometers," by Mr. A. Campbell, B.A.

ROYAL INSTITUTION OF GREAT BRITAIN.—At 9 p.m., at the Institute: Discourse on "Light Reactions at Low Temperatures," by Prof. Sir James Dewar, D.Sc., F.R.S.

SATURDAY, JANUARY 22.

ASSOCIATION OF ENGINEERS IN CHARGE.—At 8 p.m., at the St. Bride's Institute, London, E.C., Discussion on Mr. Aldwinkle's paper on "Heating and Ventilation."

JUNIOR INSTITUTION OF ENGINEERS.—At 3 p.m.: Visit to the New Generating Station of the Westminster Electric Supply Corporation, Horseferry-road, Westminster.

MONDAY, JANUARY 24.

INSTITUTION OF ELECTRICAL ENGINEERS (Leeds Local Section).—At Armstrong College, at 8 p.m., "On the Safety Devices in Coal Cutters," by Mr. H. J. Fisher.

TUESDAY, JANUARY 25.

INSTITUTION OF ELECTRICAL ENGINEERS (Manchester Section).—At the Physical Laboratory, University of Manchester: "The Generation and Electrical Transmission of Power for Main Marine Propulsion," by W. P. Durtnall, M.I.Mar.E.

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PUBLICITY.

In this Section of "The Electrical Engineer" we give Publicity to New Inventions and Specialities.

SOME SCIENTIFIC APPARATUS.

In our account of the recent Exhibition of the Physical Society, we mentioned some of the appliances shown by Mr. Leslie Miller. One of these was devised by Dr. Lewis Jones, of St. Bartholomew's Hospital, which we now have the pleasure of illustrating. It is for regularly varying small currents of a few milliamperes, such as those used for medical treatment by continuous or sinusoidal current. Both on animals and on the human subject such rythmic stimulation of weak nerves and muscles produces far better effects than if it were sustained without intervals. Full particulars of a series of remarkable experiments were published in the *Lancet* of November 13th, 1909. The desired variation in the applied current is obtained by interposing a water resistance in the circuit. This is formed of a high narrow glass vessel filled with tap water, with one contact at the bottom of thejar. The other contact is a piece of platinum wire, which is caused to traverse the column of water from the top to the bottom, about sixteen times a minute by means of a reciprocating motion imparted to it by a suitably geared electro motor. A greater range of change is obtained by causing the wire to dip down through an ordinary glass funnel with the large end resting on the bottom electrode. Clock work may be used for driving purposes instead of an electric motor. A current range of 1 : 10 is obtained.

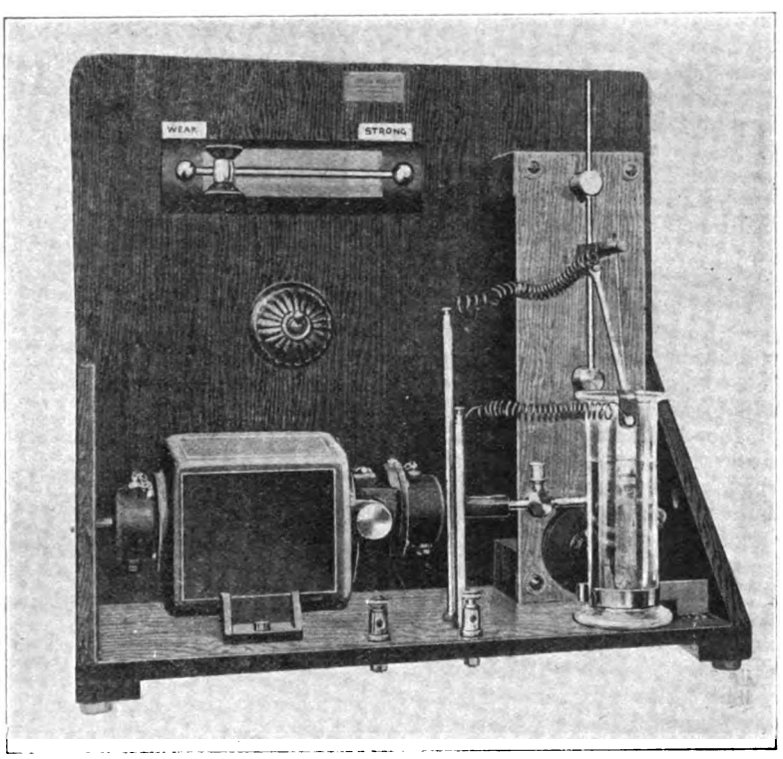


FIG. 1.—LEWIS JONES RYTHMIC INTERRUPTER.

Mr. Miller also showed one of his large patent induction coils, worked from the 110-volt circuit, through a series resistance, and one of his new mercury breaks fitted with a mechanical rectifying device driven in synchronism with the break. The special winding of his coils is now fairly well known, but as it is applicable to all kinds of high-tension winding, we give a diagram to illustrate it. It is carried out by means of a special winding machine, which winds the wire without any joints, as shown in the diagram, from the inside to the outside, and back again from the outside to the inside till the wire comes to an end. It is in the matter of joints that it differs from all other windings carried out in England, and the gain in

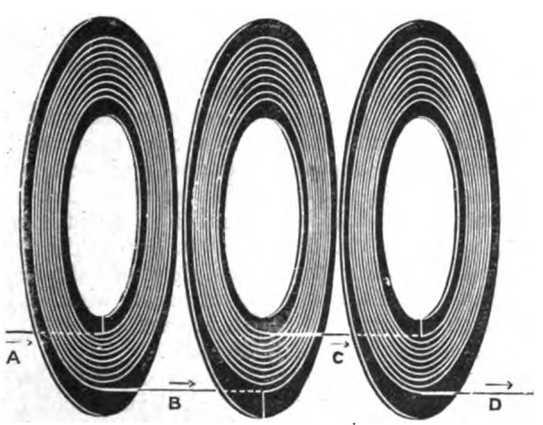
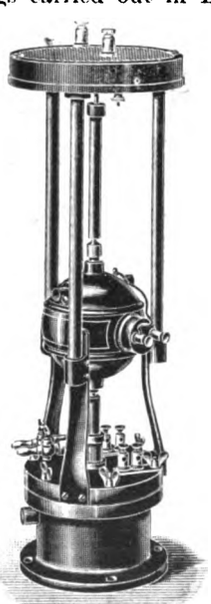


FIG. 2.—WINDING OF THREE SECTIONS.

DIAGRAM OF MILLER'S PATENT JOINTLESS, SINGLE WIRE SECTION WINDING. THE PAPER DISCS ON WHICH THE WIRE IS WOUND ARE SHOWN OPENED OUT FOR THE SAKE OF CLEARNESS AND THEY ARE ACTUALLY STRONGLY COMPRESSED TOGETHER.



MICA-DISC VALVE

ELECTRO-MOTOR

MERCURY-JET INTERRUPTER

FIG. 3.—MERCURY INTERRUPTER FITTED WITH RECTIFYING VALVE.

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insulation by not bringing a wire down over the winding from the outside edge, so as to start again from the inside is evident. It has proved in seven years' practice to give complete immunity of coils and high-tension transformers from internal short circuits.

The interrupter for the induction coil is of the ordinary mercury-jet type, working in an atmosphere of coal gas. It is driven by a small motor fixed overhead, which revolves on the same shaft a mica disc. This has holes in it arranged to let through at the right moment, the

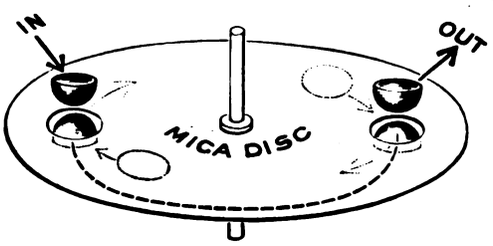

FIG. 4.—MICA DISC VALVE.

useful "break" secondary current, and stop the inverse "make" current. Such a coil and break will give 18-20 milliamperes of unidirectional current across a 20 cm. air gap, when worked on a 200 volt circuit with about 5 amperes mean current. The current across a definite gap will probably convey the best idea of the useful output of any induction coil, but the current must be "break" only, as the inverse current abnormally lowers the air resistance and gives high figures which are quite misleading.

"ADNIL" SPECIALITIES.

In these days when station engineers are so anxious to encourage the use of heating appliances and all varieties of small domestic motors, anything that conduces to this desirable end is sure of receiving attention. We have, therefore, no hesitation in calling special attention to the one-meter system for lighting and power circuits now being introduced by the Adnil Electric Co., Ltd. In this clever, and certainly timely, contrivance, the standard type Adnil lighting meter is fitted with a special power terminal, connected inside the meter to the main current coils in such a manner that the current taken by the heating or cooking apparatus does not flow through all the turns of the main current coils, but only through a portion of them, dependent on the ratio of the power tariff to the lighting tariff. The current taken by the lights flows through the meter in the ordinary manner. Thus the meter registers the total lighting units, and, in addition, that proportion of the power consumption which charged for at the lighting rate equals the total power consumption charged for at the power rate. So, to arrive at the total bill, the units registered by the meter are read in the ordinary manner, and are multiplied by the lighting rate. The method of connection is illustrated diagrammatically in Fig. 1, in

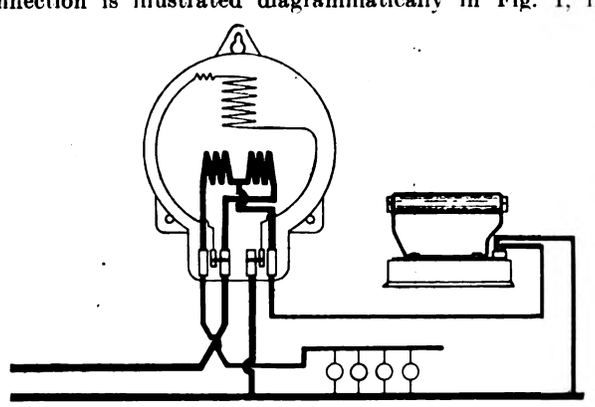

FIG. 1.

which the special power terminal is shown connected inside the meter to one-half of the series windings. In this case the ratio of the power and lighting rates is assumed to be 1 : 2—*e.g.*, threepence for power and sixpence for lighting; it will also be seen that it is only necessary to run one extra main back to the meter from the heating apparatus, etc., and connect it to the power terminal. The illustration given is that of an alternating current meter, but the system is equally applicable to the direct current meters. It may be pointed out that the cost of these double purpose meters is so slightly in excess of that of an ordinary meter, that supply station managers need not make any extra charge for rental, and this is a consideration for a large percentage of the newer patrons, people living in flats and quite moderately rated houses.

Another notable speciality of this firm is the automatic lift controllers (Fig. 2). These controllers are entirely self-contained, made of incombustible materials, and absolutely automatic. They contain two drums, the upper for gradually cutting resistance out in different steps; the lower, in controller form, for breaking the circuit and reversing the direction of rotation. The reversing drums have removable copper segments and suitable arc shields to prevent arcing over between adjacent contacts. This arrangement also has the advantage of reducing wear and tear and sparking. Another good idea is to place removable copper tips to the controller fingers, which reduces cost of renewals. The starting mechanism is quite simple, and so contrived as to prevent too rapid starting. If desired, an electrically-operated locking gear can be affixed, locking the controller when any of the lift gates is left open. It shows a high type of design and finish.

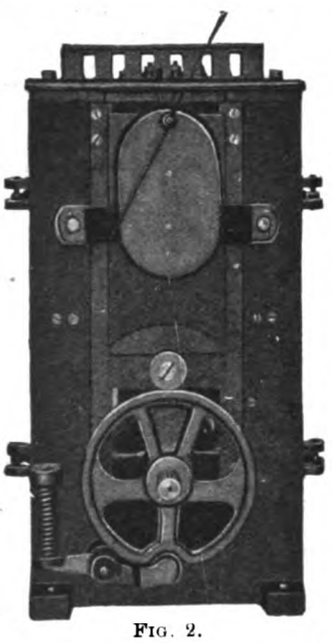

FIG. 2.

CANALS IN CANADA.

LIGHTED BY ELECTRICITY.

The report of the Department of Railways and Canals of Canada for the fiscal year ending March 31, 1909, contains statistics concerning the canal system of the Dominion which shows that the total traffic through the several canals during the season of 1908 amounted to 17,502,820 tons, a decrease of 3,040,819 tons compared with the previous year; 280,830 passengers were carried, an increase of 1,631.

Taking the St. Lawrence river canals, of which the Cornwall canal is a unit, in particular, the following facts are given: 2,009,102 tons of freight were moved, a decrease of 91,364 tons compared with 1907; 1,315,682 tons were through freight east-bound and 257,317 tons through freight west-bound; 867,037 tons were agricultural products, 826,177 tons merchandise, 430,004 tons coal, and 180,022 forest products. There were 111 cargoes of wheat and corn, aggregating 343,733 tons, taken direct to Montreal through the Welland and St. Lawrence canals, as against 116 cargoes and 168,796 tons in 1907. In 1900 there were only 15 cargoes, aggregating 7,924 tons.

By means of the enlarged Canadian canals system and the intermediate waterways, a minimum depth of 74 ft. of water from Lake Superior to the head of ocean navigation at Montreal is afforded. The smallest lock in this entire system is 270 ft. in length and 45 ft. in width, accommodating vessels 255 ft. long and 44 ft. beam. The through route from Port Arthur on the west shore of Lake Superior to Montreal comprises 73 miles of canal, with 48 locks, overcoming a difference of 600 ft. in level, and 1,167 miles of lake and river, a total of 1,230 miles.

The approaches to the canals and channels through the intermediate river reaches are well defined and lighted by gas buoys under control of the Department of Marine and Fisheries, making navigation in the hands of a competent pilot safe by day and night. Several of the canals—as, for instance, the Cornwall canal—are well lighted by electricity throughout their entire length. The Farran's Point canal, above Cornwall, is lighted by acetylene gas.

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ONTARIO'S HYDRO-ELECTRIC POWER.

We have from time to time given particulars of the Ontario Hydro-Electric Power Commission and its methods of working. This incursion of the Provincial Government into the electric supply organisation provoked a considerable amount of opposition, and strong threats were made to appeal to the Dominion Government to disallow the legislation whereby the Commission was brought into existence. These threats were not fulfilled, but the Government of Ontario has just issued a most interesting reply to its critics, this being in the form of a report from the Attorney General to the Lieutenant-Governor.

It states that: "In pursuance of a general policy the Government of the Province of Ontario brought forward and the Legislature passed an amendment to the Power Commission Amendment Act, such amending Act being known as The Power Commission Amendment Act, 1909, being 9 Edward VII., chapter 19—the Act in question. This Act deals with property and civil rights in the Province of Ontario, matters which are by the British North America Act, section 92, clause 13, given to the Legislature exclusively to make laws in relation thereto.

"The Act referred to does not, therefore, fall within the list of cases referred to by the then Minister of Justice in a despatch from Ottawa dated the 8th of June, 1868, and approved by His Excellency the Governor-General in Council on the following day in that it is not altogether illegal or unconstitutional, nor is it illegal or unconstitutional in part, being in fact both legal and constitutional; nor does it clash with the legislation of the Dominion Parliament; nor does it affect the interests of the Dominion generally."

After a long legal discussion and citation of authorities, the report goes on to say:

"One of the petitions refers to the use of the waters of the Niagara rivers being under the control of the Dominion Parliament, and, therefore, not subject to the control of the Provincial Legislature. By force of the British North America Act, section 109, the soil of the Niagara river to the International Boundary line belongs to the Province of Ontario, and the one chain reservation along the river bank is also the property of the Province of Ontario, and even if the river were considered a harbour, which, clearly at the points from which the water is taken by the Ontario Power Comment to the Act of 1907. Reading the two Acts together and applying the principle of construction applicable to Acts of Parliament, there is no doubt that the proper reading of the Power Commission Amendment Act, 1909, is that compensation must be given, and in fact there was no other intention on the part of the Hydro-Electric Power Commission, or the Legislature. If there is any doubt as to this it can be made clear by the Legislature at its next Session by a declaratory Act.

"A point attempted to be made in several of the petitions, and referred to in two letters transmitted to the Premier of Canada by Mr. W. M. German, of Welland, dated respectively 7th and 16th of September, 1909, is that under Clause 16 of the agreement between the Queen Victoria Niagara Falls Park Commissioners and William Mackenzie and others, dated the 29th day of January, 1903, the Commissioners and the Government as being represented by them had contracted and agreed not to transmit electric power, whereas the fact is that the Commissioners contracted merely that they would not 'themselves engage in making use of the water to generate electric, pneumatic or other power except for the purposes of the Park.' If the Commissioners had intended to agree not to transmit electric power, the agreement, which is full and explicit, would have clearly set this out. Moreover the action of the Hydro-Electric Commission is for the benefit of these Power Companies, because such action will give them many more consumers for their output."

Some extremely interesting particulars are then given of the Commission and its work. The report says that:

"While neither the facts relating to, nor the conditions causing, the situation with reference to which the legislation in question was enacted are germane to the question of disallowance, it may be well, having regard to the great volume of misrepresentation given to the public by those selfishly interesting themselves in the attack on the powers of the Provincial Legislature, to recite shortly some of the facts, as well as some of the occurrences leading up to the present situation.

"Previous to 1902 two franchises for the generation of electrical power had been granted to private corporations on the Canadian side of the Niagara River—the Canadian Niagara Power Company and the Ontario Power Company—and a little later one was granted to H. M. Pellatt, Frederic Nicholls and William Mackenzie—who subsequently transferred it to the Electrical Development Company. Indications were not wanting at this time that the public was intensely interested in the development of power at Niagara Falls. A committee had been appointed by the Toronto Board of Trade on the 25th of April, 1900, which committee duly reported, and on June 9th, 1902, a large gathering of manufacturers was held at Berlin to confer respecting the best method of securing electrical power for manufacturing purposes from Niagara Falls. A committee was appointed to prepare a practicable scheme. In July of the same year, at a meeting of municipal representatives at Berlin a committee was appointed to obtain information, and reported at a meeting on 17th February, 1903, in favour of obtaining from the Legislature powers enabling municipalities to purchase and sell power, develop, distribute, etc., etc. At this meeting a motion was adopted urging the Provincial Government to build and operate lines for the transmission of electric power from Niagara Falls, etc., etc. In January, 1903, the City of Toronto asked for legislation giving it the right to generate and transmit power from Niagara Falls. The application was refused by the Government then in office. On 27th February, 1903, the then Government promised a measure giving the Municipalities the right to transmit power from Niagara Falls, and to co-operate for that purpose. In furtherance of this promise, on 12th June, 1903, 'An Act to provide for the construction of Municipal Power Works, and the transmission distribution and supply of electrical and other power and energy' was passed. (3 Edward VII., cap. 25). Under this Act Commissioners were given very wide powers for the acquirement or construction of works for the generation, transmission and distribution of electrical and other power, and for the fixing of the rate or price which should be charged, and authority was granted for the issue of Bonds for the carrying out of the works. Under these powers the representatives of seven Municipalities met in August, 1903; a Commission of four prominent men, Mr. E. W. B. Snider, of Waterloo; Mr. Adam Beck, of London; Mr. W. F. Cockshutt, of Brantford, and Mr. P. W. Ellis, of Toronto, with Prof. Fessenden, an Electrical Engineer, and Messrs. Ross & Holgate, of Montreal, Hydraulic experts, was appointed. This Commission made a comprehensive report of seventy-six pages, published March 28th, 1906.

"In the meantime, the present Government came into power, and a Commission composed of Hon. Adam Beck, Mr. George Pattinson, M.P.P., and Mr. P. W. Ellis, of Toronto, was appointed. This Commission published five valuable reports, each relating to a distinct locality in the Province. The investigation of this Commission made it clear that power could be produced and sold at a much lower rate than was being charged by the Companies. Later on a deputation from cities and towns—the largest and most influential that ever waited upon any Government in the Province, comprising men of both political parties and representing about one million of people—urged their views upon the Government with the result that the Act 6 Edward VII., cap. 15 (1906), was passed, under which the Hydro-Electric Commission as at present constituted, viz.: Messrs. Hon. Adam Beck, Chairman; Hon. J. S. Hendrie, and W. K. McNaught, M.P.P., came into office. This Statute was repealed by 7 Edward VII., chap. 19, which dealt with the whole question and increased the scope of the Commission. It should be observed here that the Commission is not competing in any sense with the Companies. Under the provision of the Statutes it is acting merely as the agent of the Municipalities in procuring for them cheap power at Niagara Falls and transmitting it to them.

"In January, 1907, by-laws were submitted to the ratepayers by a large number of Municipalities in Western Ontario authorizing Councils to deal with the Commission,

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and these by-laws were carried in nearly all cases by a vote of 4 to 1, and no profit or advantage is, or is intended to be derived from the works by the Province at large.

"In order to carry out the powers given to it by the Statute, viz.: to procure and deliver power to the Municipalities desiring it, the Commission on July 17, 1906, asked the three Companies at Niagara Falls to tender for the supply of such power there, the Commission undertaking to transmit it to the Municipalities. After consi erable delay, some of which occurred at the request of the Electrical Development Company, tenders were received from all three of them, the result being that the tender of the Ontario Power Company was the lowest, the tender of the Electrical Development Company, dated 11th April, 1907, being higher. Ordinarily this would have settled the matter, but the Electrical Development Company being a Canadian Company, the Government was anxious to secure for it a portion at least of the contract, and, after earnest effort in that behalf, the Ontario Power Company was induced to agree to confine their tender to that part of the Province lying west of a line drawn from a point near Hamilton to Owen Sound, leaving all the territory East of that line to be given by the Commission to the Electrical Development Company, or any other Company, at the same rate. This was offered to the Electrical Development Company subject to certain provisions preventing the Company from underselling the Commission outside of Toronto and from competing in the territory West of said line, but the offer was not accepted and indeed the Electrical Development Company refused to entertain the proposition except on condition that it should be allowed to cross the line mentioned. No objection was at any time made by the said Electrical Development Company to the action of the Government until after the lower tender of the Ontario Power Company had been received and accepted.

"An Act was passed in the Session of 1908, 8 Edward VII., chap. 22, confirming certain by-laws and contracts, and on the passage of which, by unanimous vote of the House, it was made clear by questions and discussion on the third reading that the effect of it was that contracts passed by Municipal Councils in pursuance of the by-laws (which had been carried by votes of the ratepayers) need not be sent back to be again approved of by the ratepayers. Contracts were thereupon entered into and passed by the Councils of fifteen of the Municipalities, but the Mayor of the town of Galt, one of the fifteen, refused to sign the contract passed by the Galt Council. An action was brought to compel him to do so, in which it was determined that, after the adoption of such a contract by the Council, it must still go back for the approval of the ratepayers. The judgment was, in this respect, exactly the opposite of the expressed intention and desire of the Leglisature when it passed the Bill by unanimous vote. Actions were also brought by other persons opposed to the Power Scheme, one by a ratepayer of Toronto asking among other things that the Municipal Council of the City be restrained from entering into a contract with the Commission. Upon the above judgment being given twelve of the Municipalities—Toronto, London, Guelph, St. Thomas, Woodstock, Berlin, St. Mary's, Preston, New Hamburgh, Waterloo, Ingersoll, and Hespeler—sent to the Government a petition setting out that: 'Pursuant to the Power Commission Act, the Municipal Corporations of Toronto, Guelph, St. Thomas, Woodstock, Ingersoll, Berlin, Hespeler, St. Mary's, Preston, Waterloo, and New Hamburgh have signed contracts with the Hydro-Electric Power Commission for the supply of, in all, 24,033 h.p. from Niagara Falls. That other municipal corporations applied for power, but the arrangements therein to take such power have been delayed by special circumstances. Since the contract was submitted, other municipal corporations have applied to the Commission for a supply of power. That actions at law had been commenced against certain municipal corporations to set aside certain by-laws and contracts, and delay may be caused thereby. That the Commission have received tenders and entered into a contract for the construction of the said transmission lines, and have received tenders for the electrical equipment, and are about to enter into a contract therefor.' So the Councils urged that the Legislature of the Province of Ontario should pass an Act to validate all proceedings, by-laws and contracts between the Commission and the municipal corporations.

"In compliance with the above petition and to correct the defects pointed out therein by the said judgment the Act objected to was passed. The circumstances were exceptional, and any other course would have invited disaster. Such legislation is not unsual under like circumstances. No vested right, or right of, or to, property of any kind is in nay way affected by the Act in question. Assume the Toronto case, Beardmore *v.* Toronto, to have been carried to judgment, what would the plaintiff have gained? He would have simply prevented the City of Toronto for a time from entering into a contract with the Hydro-Electric Commission, and he would have received his costs, say $300. Delay would have occurred until the Legislature had an opportunity to deal with the question. This delay, and the costs, represent what the plaintiff would have succeeded in getting. And the delay would have been disastrous to the whole Power Scheme which had been endorsed by the Province. There was no substantial right at stake. Supposing the Legislature at any time to have passed an Act authorizing the Councils of Municipalities to enter into contracts with the Hydro-Electric Commission without the assent of the ratepayers, such legislation would not be open to question nor would it have caused surprise. The legislation which is attacked does not go so far as this, but makes valid contracts which have once been approved by the ratepayers without putting the Municipalities to the expense and trouble of a second assent being given. Careful consideration of the facts must result in the conclusion that the legislation in question was desirable and necessary in order to prevent great injury to the Power Scheme, in the success of which the people of Ontario are intensely interested, and that by it no vested right or right of property is attacked.

"It is worthy of notice that the Electrical Development Company has not applied or petitioned for the disallowance of this legislation.

"The Act was passed subsequent to and relying upon the dicta of the Minister of Justice in the case of the Florence Mining Co., which have been quoted; and also subsequent to the Ontario Provincial Election of June 10th, 1908, prior to which this case was freely discussed both on the public platform and in the Press, and the result indicated the approval of the electors of Ontario of the Government's position therein.

"Finally, the people of Ontario take their position on the positive and unshaken foundation formed by the British North America Act and the decisions which have been indicated and in agreement with the principle laid down by the present Minister of Justice in the Report and Speech hereinabove quoted, and respectfully submit that for upwards of 200 years the Lords and Commons of Great Britain have legislated without fear of the Royal veto, although its existence has been undoubted, and, therefore, in full accord with the spirit and genius of British Institutions, the people of the Province entitled to all rights of British subjects elsewhere, and as free, as has been practically pointed out by the Minister of Justice, to legislate within their jurisdiction as the Lords and Commons of Great Britain are free to legislate, cannot submit to any check upon the right of the Legislature to legislate with reference to subjects within its well-defined jurisdiction, although a technical right to dissallow may exist. Any other view would mean that there are different grades of British subjects in the Empire; that the people of the several provinces of the Dominion have not and are not entitled to the full and free enjoyment of those civil rights and liberties which are enjoyed by British subjects in the Mother Country, a condition of things which would be intolerable. Without, therefore, in any way suggesting the possibility of such interference, an appreciation of the very grave and serious consequences which must inevitably follow such an act fully justifies, in the opinion of the Attorney General, a respectful recital of the rights of the Province in this behalf, and a clear intimation of its attitude in respect thereto."

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ELECTRICAL PROGRESS AT HOME & ABROAD

FROM OUR SPECIAL CORRESPONDENTS.

TYNESIDE NOTES.

NEWCASTLE-ON-TYNE.

Electrical trade in the North-Eastern Counties has in recent times been subjected to such a variety of disturbing factors, that it is remarkable that any business is left. The latest trouble which has afflicted us is that the pitmen appear to show a very strong disposition to go back upon the decision of their chosen representatives with regard to the working of the Eight Hours' Act. A considerable number of mines are at present laid idle, particularly in Northumberland, and in view of the uncertainty, mine owners are not at present buying very largely in electrical supplies. The impression is that the trouble is only temporary, as if the men go back on their representatives, the solidarity of the trades unions will be broken up, and owners will be able to deal piecemeal with small groups of collieries. Although coal is expected to be dearer this month, it will not greatly affect the large supply authorities, who have for months been safeguarding themselves and their consumers by laying in large stocks of coal. An incidental advantage of taking power for manufacturing purposes by means of an electricity supply in bulk is thereby demonstrated.

Not an Electrical Fire.

The modern reporter appears to suffer from an overpowering tendency to put down the origin of any fire, whether mysterious or not, as due to the "fusing of an electric wire." An instance of this occurs in connection with a fire which unfortunately occurred on the premises in Gallowgate, Newcastle-on-Tyne, which are jointly occupied by a boot factory owned by Messrs. Dixon, and the local depôt of the General Electric Co., Ltd. The fire was, with one small exception, confined to the boot factory portion of the building, and caused a considerable amount of damage, both building and machinery, together with stock and raw material, being burnt. The disaster was reported by one London paper as being caused, "it is believed, by the fusing of an electric wire"; but as the result of enquiries I am satisfied that this is incorrect, as I understand that an authorised inspector discovered, after the fire, that the electric motor circuit was intact, and that the fuses had not even blown. The operations of the General Electric Co.'s (Ltd.) department are unaffected by the occurrence.

A Useful Cable Joint.

The proper jointing of large cables, particularly when these have an irregular cross-section, as in the "cloverleaf" three-conductor cable, has for a long time been a matter of difficulty. The squeezing of the cable into a circular section to fit a tube is inadvisable, and even if a specially shaped tube is used, it is not always certain that the two sections will meet accurately, due to the twist in the cable. Moreover, when a cable is sweated into a tube there is a risk of contact being only obtained on the sections of the strands touching the inner surface of the tube. In order to meet this, Mr. C. Vernier, A.M.I.E.E., of 32, Bath-terrace, Gosforth, who from his large experience in cable laying in this area is well qualified to deal with the problem, has invented and patented a system of jointing, which, using only the simplest materials, secures remarkably good contact and high mechanical strength. The process is now being used under licence by more than one firm interested in large cable laying work, and further details of the system will probably shortly be published.

Mixed-Pressure Turbines for Collieries.

Opinions appear to be divided as to whether electric winding is the best method to be adopted in this country It is admitted that in Germany, where the shafts are of great depth and high speeds of winding are necessary, the electric winder is a useful piece of plant, but in this country the workings are comparatively near the surface, and the hoisting speeds to which we are accustomed are moderately slow. I understand that upon this basis a well-known mining consultant in this area favours the retention of the steam winding engine, and the utilisation of the exhaust steam in low or mixed-pressure turbines, with a suitable reservoir for equalising pressure, in order to produce electric power for other mine operations. A higher all-round efficiency is thus obtained from the winder, and electric power is produced at no additional cost, but that of the necessary plant and attendance. If this is the case a very interesting issue is raised, but there will probably be a difficulty in establishing an accurate comparison of economy effected by the two methods, owing to the absence, in most cases, of complete records of the costs of the unassisted steam winders which have been used in collieries.

MIDLAND NOTES.

BIRMINGHAM.

The question of the bearing of politics and political economy upon the electrical industries, raised in London a short time ago, came up last week at the meeting of the Birmingham Section of the Institution of Electrical Engineers, when a discussion was devoted to the paper by Mr. Lepine and Mr. Stelling on "German Electrical Industries." The President (Mr. Morcom) pointed out the difficulty of dealing thoroughly with matters affecting the industry, without reference to the conditions which governed its commercial prosperity. Speakers who followed him were fairly successful in avoiding controversial matters across the border line laid down by Dr. Kapp when speaking in London.

German Banks and Electricity.

The paper came in for not altogether favourable criticism, though it was admitted that the matters it dealt with were of importance. The reference to the part played by the banks in the development of the electrical industries in Germany was elucidated by two or three speakers. The President, for instance, pointed out that the German banks were much larger than the English ones, the Deutscher Bank, for instance, having a capital of £10,000,000, as compared with the £4,000,000 capital of Lloyd's Bank in England; while Mr. Orsettich explained the predominant partnership of the banks by the fact that the law in Germany as to joint stock companies was unfavourable to direct investment in industrial concerns by the general public. In order to prevent gambling in shares, the law prohibited the issue of shares under £50. The result was that the majority of the population had to put their savings either into the post office banks, or into the industrial banks. It thus fell to the banks to finance industrial undertakings, and in order that their investors might be fully protected, the banks were careful to secure representation on the boards of these companies. The powerful position occupied by the banks was also emphasised by Mr. S. P. Smith, who stated that the combination of financial and industrial magnates was so powerful, that it was able to influence considerably the fiscal policy of the Government. The result of the combination was such that manufacturers in Germany had things much their own way, and it was difficult for a customer to get any special ideas of his own carried out. He simply had to take what the manufacturer considered he ought to have, and one result of this, in Mr. Smith's opinion, was to be seen in the many unnecessarily large and elaborate installations to be found in Germany.

Electricians' Salaries.

The position of the electrical expert and of the technical expert generally in Germany was thought by all the speakers to be less favourable than it had appeared to the writers of the paper, and the salaries were put by the speakers at a lower average than that quoted. The general view was that there was considerable over-production of highly-trained technical forces in Germany, the

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effect of which, though undoubtedly good for the industry itself, had been to make the college-trained man a drug in the market. It was common, it was stated, to find first-class engineers engaged on work which, in England, would be done by a clerk or an ordinary workman. A number of instances were given from the experience of the speaker of highly-trained men in Germany who had written to friends in this country asking whether jobs could not be obtained in England, as it was quite impossible for them to get anything to do in Germany. Dr. Kapp, in proposing a vote of thanks for the paper, also mentioned the frequency with which German students of his acquaintance wrote to him as to the difficulties of obtaining employment. He was rather astonished to hear of the initiation of the three-shift system in Germany, because when he was there, there was such a shortness of business, that many of the electrical works had had to turn their attention to motor cars, machine tools, and rubber goods, and now he heard that they were making machinery for Japanese airships, and, in fact, filling their shops with whatever came along. Mr. Lepine, in replying, attributed the success of the Germans to an appreciation of science, in which they were ahead of this country.

Prosperous Aston.

The Greater Birmingham Enquiry on Saturday completed its eighteenth day with a prospect of continuing for another four or five days. In the later stages of the enquiry the neighbouring districts have had their innings, and the witnesses have included a number of electrical experts. Among these was Mr. Robert Foster, the engineer of the Aston Electric Supply Station. This department has figured very prominently in the investigation, mainly because Aston has had the distinction of selling its electricity more cheaply than Birmingham, and one of the most striking effects of the enquiry has been an undertaking on behalf of Birmingham that, if Aston is eventually included in the city, the Aston consumers and those in Erdington (an adjoining district supplied from Aston) shall not be charged at higher rates than those now prevailing, a concession to which apparently considerable importance was attached, to judge by its reception in the Chamber. Mr. Robert Foster, the Aston engineer, said, that whilst the Birmingham undertaking had been in existence 16 years, Aston's was only in the fifth year of its working. Yet during the past 12 months the total revenue from electrical supply was £22,212, and from meter rents and other sources, £703. The total cost had been £11,648, and the gross profit £11,267. The total cost per unit was ·69d., as against ·72d. per unit. in Birmingham. Mr. Foster strongly denied that Aston was making no profit. As a matter of fact, they did not charge for meter rents or for making services, both of which charges, he understood, were made in Birmingham. The number of units sold was 4,055,678, and Mr. Foster anticipated that in 1913–14 there would be a sale of 9¼ million units in Aston, securing a net surplus of £6,359 per annum. They had increased a million units during the past two years.

Criticism of Birmingham's Tramway Accounts.

The Birmingham undertakings have not escaped criticism from the experts representing the outside districts, and Mr. W. B. Keen, chartered accountant, who gave expert evidence, expressed an opinion that in regard to tramways Birmingham was not making sufficient provision for renewals. While Birmingham electricity profits were estimated to produce nothing in aid of the rates, Mr. Keen anticipated that by 1913–14 the Aston department would be furnishing profits available for this purpose equal to 4d. in the £.

Handsworth Developments.

Probably no department has been more keenly criticised than the Handsworth Electricity concern. Consequently, a strong impression was made by the evidence given by Sir Alexander Kennedy, who has been adviser and engineer to Handsworth since the commencement of their electrical undertaking. On being asked if there would be any possible advantage in annexation from an electrical point of view, Sir Alexander replied that the cheapest thing would be to keep the Handsworth station going. He considered it quite safe to forecast a profit of £2,500 on the Handsworth undertaking in 1914. An important development in Handsworth will be the substitution of electricity for the cable in connection with the tramway undertaking, and the effect of this, the expert considered, would be to raise the earnings from 8¾d. to 10d. per car mile, and out of that a profit would be obtained.

LANCASHIRE NOTES.

MANCHESTER.

Business in the district is settling down after the holidays. While firms are receiving an increased number of enquiries for smaller plant, fittings, accessories, etc., no very large contracts have been placed during the past fortnight. From the reports I have had from the electricity stations in the small Lancashire towns, it appears that, on the whole, development in power supply has been satisfactory during the past year, considering how poor the local trade has been. These supply authorities have no difficulty in getting the small manufacturer's load where it does not exceed 40 to 50 h.p. These are the sort of loads for which the gas engine was formerly considered the correct thing, but the manufacturer of to-day realises that the amount of time and attention required to keep the gas engine "in condition" is saved by taking a supply from the electricity station and installing the motor. For loads of above 50 h.p., there is in most places more difficulty in persuading the manufacturer to instal motors, especially where the price per unit is comparatively high and a supply of steam is available (as is often the case in old sub-divided works). In such cases a small steam engine is sometimes put in, or, where gas is cheap, a gas engine. It is noteworthy that where the supply has been taken for these larger loads, the results have always been satisfactory. The hiring out of motors by the supply authorities has proved of great assistance in catching the small power user, and, as a result, some of the small towns have relatively large loads. The little town of Middleton has over 500 h.p. in motors on its mains.

Lighting and Heating Developments.

It is not only in power supply, however, that satisfactory progress has been made. In many of the towns the street lighting is by arcs or incandescent clusters. The advantages of electricity for general inside and outdoor illumination, signs and wndow novelties are rapidly becoming appreciated even by quite small shopkeepers; and the extent to which electric light is so used in what dwellers in the cities are pleased to call "villages," makes one think why gas is used at all in the enlightened cities. Once one consumer is booked in a row, there is quite a rush for electricity by the remaining shopkeepers, the gas mantles being rapidly replaced by metallic filament lamps. Shopkeepers are well satisfied with electric light as to cost, and it has been noticed that those shops which have abandoned gas have obtained an increased number of customers since doing so. The public accepts, especially in the small town, the installation of electric light as evidence of prosperity, and prosperity as a certain sign of "bargains" from their point of view. Considerable further development is expected during the coming year in the way of small lighting consumers, and unless some great development takes place to improve and cheapen gas lighting, it looks as if electricity is going to push it altogether out of some of the local towns. Thanks to the various manufacturers of heating apparatus recognising the need for low-priced, cheap quality goods, and meeting it, stations have had no difficulty in getting heating consumers, even if the load has only consisted of a kettle. Radiators have become very popular, and are expected to provide a welcome addition to the winter load in the near future. With a view to encouraging the use of electric cooking apparatus, Bradford Corporation have at present several outfits hired out, and are charging a special low rate for this service. The experiment is proving successful, and will no doubt lead to a great increase in their day-load. It is worth noting that during the year electric heating apparatus has been sold in such large quantities, that the various works are far behind with deliveries.

Electrolytic Bleaching.

I recently had an opportunity of seeing a "Haas and Dr. Oettel" electrolyser at work, preparing chlorine solution for bleaching purposes. As I have found almost every

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station engineer ignorant of the possibilities of the "electrolyser" (of which there are several makes on the market), as a load, perhaps some account of its advantages may be of value. The fact that of this one make alone, over 600 have been put into use during the past five years, should show engineers that electrolytic bleaching is quite practicable. Over the ordinary bleaching powder solution, electrolytic bleaching possesses many advantages. Among these may be mentioned, the much greater bleaching power of the nascent chlorine—strength for strength, it does at least 20% more work; it contains no particles of lime or salts to rot the fibres of the material; it can always be accurately and readily adjusted to constant strength; the cleanliness of the process—there is no troublesome mixing of bleaching powder, and no smell (as all the chlorine is in the solution); no after treatment, or only very little, as there are no salt deposits to be got rid of. The electrolytic bleach, being only slightly alkaline, does not need strong acids to neutralise it, and, incidentally, spoil the fibres of the material. The cloth is left soft and brilliant in appearance, the bleach is permanent and does not weaken the fibres. Apart from its lower cost to produce, it leads to many economies in working, such as the saving of acid boiling; quicker bleaching with less loss in weight. Mr. Reuss, of Ernest Grether & Co., Manchester, who make the "Haas and Oettel" set, suggests the use of power in the day time for driving the works, and at night for making the bleach, thus getting a 24-hour load and the very low rates. With power up to ·33d., the electrolytic bleach pays considered on cost of chlorine alone, and ignoring the further savings. Great developments are expected shortly in the district with this, and it certainly seems to offer a useful development to those stations who have little night load, but who yet are obliged to keep running all night. 75 to 90 kw. hours are required to produce 23 lbs. of active chlorine (equivalent to 92 lbs. of bleaching powder); 1½ lbs. of active chlorine will bleach 220 lbs. dry weight of cloth.

Cotton Mill Conversions.

The Fine Spinners of Bolton have scrapped two old engines at one of their mills, and have recently placed an order with the local office of the Brush Co. for the complete equipment of the mill with electric-driving. The load is 600 kw., and they are relying on a single turbine. The mules and preparation machines are all group-driven. In the spinning rooms a shaft is taken down the whole length of the room, and driven from one end, in the usual standard way, by a direct-coupled motor. The alternator supplies current at 500 volts three-phase.

SCOTTISH NOTES.

GLASGOW.

After a lengthened period of unprecedented depression, there are undoubted signs of improvement on all sides. The best firms, however, complain of the difficulty which still exists in getting prices which will yield a reasonable margin of profit. In connection with wiring work, the prices at which certain firms are prepared to quote for house, shop and warehouse lighting remain a mystery even to the initiated, and ship-wiring, which for years was practically immune from the inroads of the second and third-rate contractor, is also now retained by the best firms with the utmost difficulty. Prohibitive prices are quoted in order to retain custom and in the hope that the present condition of chaotic competition may only be temporary.

Household Electrical Appliances.

Three industrial exhibitions held in Glasgow during the past few months have resulted in something like a boom of interest at least, in electric heating and cooking. The interest spread to the newspapers and a series of articles in a Glasgow evening paper brought the possibilities of electricity for domestic and industrial purposes prominently before the public. It is, perhaps, no exaggeration to say that the general discussion thus initiated has given electric heating and cooking a fillip throughout the country. Radiators, grillers, convectors, toasters, laundry and tailoring apparatus have been and continue to be rapidly improved in general efficiency and greatly reduced in price. Both the large Corporation supply authorities and the supply companies all over Scotland have taken up this side of the business with energy and enthusiasm, and large sales are anticipated by the makers of the devices in question during the next few months. It is being increasingly felt that the coal fire in the kitchen range is the principal sinner in polluting the atmosphere wherever there is a congested population, and the impression is abroad that municipalities must do all in their power to educate the mass of the people up to the possibilties of up-to-date, smokeless apparatus for heating and cooking. Towards this end the Glasgow Corporation are arranging an exhibition of smokeless heating and cooking devices. At first it was thought to have this exhibition in February, but it has now been definitely fixed for September.

Electric Motors.

With regard to the use of the electric motor for power purposes the outlook is even more hopeful. The Clyde Valley Electric Power Co., with a 60% increase over the business of the previous year anticipate that 1910 will see even a greater addition to their total output. Contrary to the prognostications of some of their critics, they are getting an increasing load from collieries within their area not only for coal cutting machinery but for winding and haulage gear. They have also considerable demands from a number of large steel works, and even their lighting demand, which is the minor portion of their business, has gone up 60% in connections made and over 100% in total capacity. The case of a saw mill which they recently connected to their mains for a power supply is worth noting. The firm in question find that the cash receipts from the sale of chips and sawdust meet the bill for electric current, and in addition they effect further economies through the decreased insurance premium for electric plant, as well as a reduced wage bill for attendance as compared with steam plant. The fact that there is a ready market for wood chips and sawdust encourages the belief that the electric motor will ere long be generally adopted for such works. The Glasgow Corporation Electricity Department, with an increase of 3,753 h.p. to their power load for the past year, have in view several large and important extensions on the part of a number of their largest power users.

Shop Lighting.

In connection with shop window lighting there is likely to be a rapid movement in favour of one or other form of invisible lighting. The trough reflector, fitted with pear-shaped metal filament lamps, has just been introduced to Scotland by the General Electric Co., although an ingenious contractor in Glasgow lit a show window in this way over a year ago. Messrs. Smith, of Murraygate, Dundee, have had some ten windows fitted with the G.E.C. trough reflector and Osram lamps. This method of window lighting is not only more effective than the older methods, but it is obviously much safer from a fire point of view. In Glasgow, the other day, a shop window in Buchanan-street went on fire through a short circuit in a lamp holder. Even such a rare occurrence would have done little or no harm if an invisible form of top window lighting had been installed instead of having lamps all over the window in direct contact with highly inflammable soft goods. Large drapery and other similar houses have, in Scotland, as elsewhere, gone in for early closing; but it is now being recognised that an efficient advertisement can be obtained by keeping the extended window frontage of such premises fully lit for a number of hours after closing time. For this purpose a cheap and handy form of time switch, which has been introduced here, is likely to have a large and ready sale. For general lighting in business premises, the larger candle powers of metal filament lamps have undoubtedly a future; 600 c.p. metal filament lamps are now being installed suitable for the 250 volts.

Electricity in Mills.

Reports come to hand daily of mills of various kinds all over the country abandoning steam plant in favour of electric drive. Two calendar mills in Dundee—Trade Lands and Victoria-road—have recently put in considerable installations both for lighting and power. The motors are of the B.T.H. and Westinghouse make. One of the advantages of the electric drive which appeals to mill owners is that repairs and overhaul of plant can be carried

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out piecemeal, and there is no need to wait till the plant is shut down at a holiday time, when time and a half and double time have frequently to be paid to the men called upon to do extra duty at these times.

Police Signal Boxes.

The Glasgow Police Department are busied with a scheme for putting police signal boxes throughout the City. On the top of each box will be an incandescent electric lamp, which can be lit from the central police station, and the policeman on the beat, seeing this lamp lit, will know that he is wanted to speak to the central authority, at the telephone inside the box. On the other hand, any policeman can readily by this means get into touch with the central station and obtain assistance, or otherwise deal with any emergency with which he may be suddenly confronted. Experiments are also being carried out by the Glasgow Corporation with distance control time switches for the lighting and extinguishing of lamps over fire alarm boxes at street corners.

AMERICAN NOTES.

NEW YORK.

A remarkable record has been made by the Edison Illuminating Company of Brooklyn. In the short space of four months the company has displaced no fewer than 38 gas engine plants ranging from 40 hp. down to 2 hp., which were being operated in machine shops, bakeries, small mills, and similar establishments. In all these places motors of varying capacity are now installed, and a comparison of relative cost of operation is largely in favour of the electric motor. Apart from the important matters of cleanliness, absence of noise and smell, ease of starting absence of fire risk, and all the other well-known advantages of the electric drive, the motor permits the owner to use small quantities of electricity when required, as against the necessity for running a gas engine at practically constant speed, whether or not a load is being carried, while in the larger units the inability of the gas engine to operate elevators and similar machines requiring high-starting torque has been a point in favour of electric service. Current is supplied in Brooklyn on a maximum demand system, under which the charge made is 10 cents per kw. hour for the first 25 hours per month use of the maximum demand; 5 cents per kw. hour for the second 25 hours per month use; and 3 cents per kw. hour for all energy furnished in excess of 50 hours per month use of the maximum demand. Whenever the portion of the bill, which is figured at 3 cents per kw. hour, exceeds $25, the discount on such portion is 5%; 10% is allowed when the amount is $50; 20% when it is $200; 40% when it is $400; and 50% when it is $1,000 and over.

Boston Power Developments.

The purchase by the Boston Elevated Railroad Company of 25 acres of land, close to the harbour at South Boston, whereon to erect a great generating station, is one of the most noteworthy developments of the current week. The Company is negotiating for the control and operation of all the important trolley lines in the neighbourhood of Boston, and if these negotiations are successful, as there is little doubt they will be, the Company will operate a system of 1,500 miles of track, and the South Boston generating plant is being designed in view of this proposition; but, in any event, an extensive remodelling of the existing system of distribution may be looked for, as well as the construction of a number of new sub-stations.

General Electric and the Western.

As already mentioned in these notes, there has been a good deal of talk lately about a combine, of sorts, between the General Electric Company and the Western Electric Company. These reports have crystallised during the week, and the announcement is now made that the Western has retired from the manufacture of heavy electrical apparatus, and is transferring its tools and plant for this work to the General, which will now make all the heavy apparatus for light and power; while the plant of the Western Electric Company will be devoted exclusively to the manufacture of telephonic apparatus and smaller electrical appliances. It appears that the continued growth in the demand for telephone apparatus indicates even a more expanded demand in the future, and the Western officials deem it wiser for the Company to specialise on smaller electrical appliances, just as the General Electric and the Westinghouse Electric and Manufacturing have specialised on larger appliances. At the General Electric Company's office it is stated that much of the heavy apparatus of the Western Electric Company had been made for many years by the General Electric Company, and that the present deal is an expansion of the existing relations.

Large Power Schemes.

Details are given this week of some important power schemes. A company, with $1,000,000 capital, has been organised at Woodstock to harness the Staunton river at Brookneal, 2 miles from Lynchburg, Va. The plant, it is estimated, will deliver 5,000 h.p. The Mayo River Power and Land Company has made surveys for a dam across the Mayo River in Western Chihuahua, Mex. This dam, which will be the first of several, is to be located about 56 miles above Navajoa, Sonora, on the new Southern Pacific railroad. About 25,000 h.p. will be developed by the first dam, but the amount will be considerably increased when the subsequent dams are built. The contract for two 3,000 h.p. Pelton impulse water wheel units has been placed by the Leheigh Valley Portland Cement Company, of Allentown, Pa. Each main Pelton unit will be of the double overhung type, and develop a maximum of 300 h.p. at 360 r.p.m. Alternators are of the Westinghouse manufacture and their rotating portions will be carried between each water wheel, the latter being arranged in batteries of two. Ultimately the plant will consist of 5 generator units. The contract calls for two 200 h.p. Pelton exciter water wheels, each exciter possessing sufficient capacity to energise the 5 units when ultimately installed.

$130,000,000 Electric Bell Line.

Proposals are now under the consideration of the New York Public Service Commission for the construction of a circular electric subway to run all round New York. The belt, it is suggested, should encircle Manhattan and the Bronx, extend under the East River to Brooklyn, and there connect with the Fourth Avenue subway now being built; and, later, when practicable, by way to Fort Hamilton and the Narrows to Staten Island, and also by a Fifty-ninth Street crosstown under the East River into Queens, reaching several Long Island points. The proposed subway system is to be built in about 24 sections of about 1 mile each, and with four tracks, which will run around the two Boroughs of Manhattan and the Bronx. The cost is estimated at $130,000,000, and the promoters are Messrs. E. J. Farrell and John J. Hopkins of this city.

110,000-volt Circuit Breakers.

The Westinghouse Company has recently manufactured and installed in the Great Falls generating station of the Southern Railway Company four groups of 110,000 volt oil circuit breakers. They are of both the hand-operated and the electrically-operated type, being normally closed by energising the operating solenoid from a low voltage local circuit, but also capable of being operated by a hand lever. A special feature of their construction is the isolation of each pole in a separate tank, each being thus entirely independent of the others, except for the pull-rod which operates the contacts. This rod is released by a tripping mechanism, allowing the contacts to open by gravity. The 47-inch break thus interposed into each phase occurs in the centre of the tank, in oil free from any possible sediment or moisture. By the arrangement of the operating mechanism, gravity assists in making a quick break during normal operation, while in case of any injury to the circuit-breaker parts the circuits naturally tend to fall open. A double break is made at each pole, spring-seated butt contacts assuring a firm closure. A small double pole, double throw switch, operated by the contact mechanism, provides a simple telltale, indicating the position of the breaker contacts, by lighting a red or green lamp. The tanks are of welded seam boiler steel, and fitted with a thick lining of specially treated insulation, which encloses the contacts. The terminals are of the condenser type, and allow the line wires to be brought in directly from overhead.

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Electric Railway Developments.

It is announced on behalf of the New York Central and Hudson River Railroad that early in 1910 electric motive power will be used as far as North White Plains, and the delay at Wakefield now made necessary by the change from electricity to steam will be done away with. Electric trains are now running to Mount Vernon, on the Harlem, and to Yonkers, on the Hudson division. Two new sub-stations for the Harlem division are being built at Tuckahoe and White Plains, so that the 11,000 volt alternating current generated at the Port Morris power house can be transformed to the 660 volt direct current used on the third rail. Two new sub-stations will also be built for the Hudson division. The electric rolling equipment shops at Harmon and White Plains are being completed. On the Harlem division a great deal of improvement work is being done. Grade crossings have been eliminated at Highbridge, Morris Heights and University Heights, and new stations built at these points. At Mount Vernon a new location of the tracks has called for a new station, and at Tuckahoe work of lowering the tracks 7 ft. and raising the streets and nearby buildings is now under way. A highway bridge at Dobbs Ferry, a new stone passenger station at Philipse Manor, and a new station at Ossining are under construction. Four tracks are being laid between Woodlawn and Wakefield, on the Harlem division, and between Mott Haven and Hastings, on the Hudson division, and the extension of four tracks through Ossining is being pusehd forward.

The Chicago Electrification Situation.

Opposition to the electrification of the Chicago terminals continue to grow in force. Thirteen steam railroad trunk lines were represented at a meeting of the local transportation committee of the Chicago City Council this week, at which the electrification of the lines was considered. The officers of the railroads contended that "electrification is impracticable; first, because of cost; second, because of danger to employees; third, because the science of electrification is not sufficiently matured to make it applicable to freight terminals." It was stated that the Illinois Central Railroad was the only steam railroad entering Chicago which had seriously considered electrification, but that the company had abandoned the idea of changing the motive power of its lines as the result of the study which it had made of the problem. It was suggested that a commission composed of representatives of the city and experts from the railroads be appointed to investigate the subject of smoke, because it was principally to abate the smoke nuisance that the city had ordered electrification. L. C. Fritch, chief engineer of the Chicago Great Western Railroad, who was formerly employed by the Illinois Central Railroad to study the advisability of changing the motive power on that company's lines into the city, suggested that the commission proceed on the assumption that electrification is not practical and that the members of the committee consider such matters as fuel, a central passenger terminal and the arrangement of a system for handling freight whereby most of the trains would be kept outside of the city limits.

Electrical Signalling of Trains.

Last week there was a further development of electrical railway signalling here. By the "normal danger system," which is gradually being installed on the New York Central's system between Buffalo and New York, the capacity of the road is to be increased by placing the blocks closer together. The block system keeps trains three miles apart, as the blocks are that long, and but one train at a time is allowed in a block. The "normal danger system" permits trains to run but one mile apart. Signals are placed at the end of every mile. They are worked electrically, the train itself making the connections which throw the signals to the stop position if they try to enter a block occupied by another train. With trains running at about three times the frequency under the new system as under the old, the capacity of the road will be multiplied by three. A four-mile section of the road between Lyons and Newark will be equipped soon, and shortly after the first of the year a section of ten miles between Rochester and Chili Junction will be likewise equipped. Fewer men will be needed under the new system to operate block switches.

Railway Troubles Remedied.

Flashing and arcing troubles on the Chicago City Railway, which caused great inconvenience, have been completely remedied by the installation of aluminium-cell lightning arresters. The rotary converters in use are of 1,500 kw. and 2,000 kw., and there was frequent and very pronounced flashing over and arcing from brush-holder rings and commutator bars to bolt heads and grounded parts of the converter frames, and, after various efforts to locate the source of the trouble, it was decided that it was due to static potentials caused by the rubbing of the brushes on the large commutators, the inductance of the path between the commutators of the rotary converters and the arresters preventing the static charge from finding its way to earth across the arrester points, and causing it to take the most direct path to earth. When the aluminium-cell arresters were put in, the trouble ceased. The arresters were permanently connected between the positive terminal of each rotary converter and ground, two 250 volt cells being connected in series between the bus ring of the converter and ground. In shunt with each of these cells is a balancing resistance of 20,000 ohms, without which it was found that the continuous discharge would unbalance the cells.

Legal Status of the Telephone.

A noteworthy decision has been made in the New York Supreme Court with regard to the legal status of the telephone. The question before the Tribunal was whether a demand for the payment of a note, made over the telephone, was a sufficient presentation, and whether the bank was relieved of the obligation, under the facts, of actually going to the makers' house, where the note was payable, and making a further presentation and demand there. The Supreme Court found no precedent, but held that all the essentials of a good presentation were met. Commercial transactions and conversations over the telephone had been recognised as of the same binding force as where the parties talked face to face. "The telephone is simply an instrument by which two persons may talk directly to each other. Suppose the holder of a note should call to the maker from across a street, as the maker stood in his doorway, and notify him that he had his note and ask payment. Would not such a demand be deemed in law a proper presentment, although the street separated the person holding the note and the actual place of payment? Can it make any substantial difference because the person holding the note happens to be some blocks away, provided he is able to reach the maker over the telephone and talk directly to him in that way?" So the transaction was held good in law, and the telephone status established.

The Havoc of a Wooden Wedge.

A mishap of an extraordinary character has been brought about in Nashville, Tennessee, by an object no more formidable than a piece of wood about 2½ in. long. By accident or design, this splinter had got driven in one of the frogs of the trolley car track, and the consequence was that a car coming along at full speed was turned off the rails and deflected across the street. The accident occurred in one of the main thoroughfares of Nashville along which ran a great network of electric light wires, telegraph wires, and telephone wires. The derailed car in its flight struck a telephone pole and snapped it in two, and its fall brought down between 50 and 60 others. In all, upwards of 6,000 wires were brought down, and a large proportion of them were broken. It took two days to bring anything like order out of the chaos thus caused, and it will be a fortnight or more before all the wires are restored.

The World's Largest Turbines.

What is probably the largest steam turbine engine ever constructed is being installed this week in the generating station of the City Electric Company of San Francisco. It was built by the Westinghouse Machine Company at the East Pittsburg shops, and has a capacity of 22,500 h.p. The unit runs at a speed of 1,800 r.p.m., and is declared to be the most economical prime mover in this country. This is the fourth turbine installed in this plant, there being three units in operation. The present units have a maximum capacity of 15,000 kw., and when the fourth unit is installed there will be a total capacity of 30,000 kw., making this the largest steam driven power plant west of Chicago.

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Current Items.

Brooklyn is educating the Chinaman up to the use of electricity. The Edison Electric Illuminating Company has supplied electric washing and wringing machines and electric irons to one large laundry, and now several others are following suit.

An ingenious adaptation of the Tungsten lamp has been fitted on the cars of the Fort Wayne and Wabash Valley Traction Company, and promises to be a great success. The filaments are short and heavy to prevent breakage from the jar of travel.

A pension system has been adopted by the Brooklyn Rapid Transit Company, under which each employé who has served 35 years will be entitled to receive 50% of his monthly pay when he reaches the age of 70, or is retired through incapacity between the ages of 65 and 69 years. The minimum limit of service to entitle the employé to participation is 25 years, the pension being graded down to 30% for such workers. The Company employs 13,000 hands.

The $1,600,000 granite dam across the Colorado River, which was washed out in 1906, is to be replaced by a reinforced concrete structure. At the Marble Falls, on the Colorado River, a dam is at present being built, and power will be supplied to Austin, San Antonio, and other cities. Approximately, 25,000 h.p. will be developed. The Madison Electric Power Company of Richmond, Va., proposes to construct an immense dam in the Dix river. The cost of the undertaking will be $1,000,000, and it will require one year to complete the work. The plant will have a generating capacity of 25,000 to 30,000 h.p.

The Westinghouse Electric and Manufacturing Company announce that the first six months of its fiscal year will show earnings more than sufficient to pay the regular dividends and all of the back dividends on the preferred stock. The net profits are now running at the rate of $300,000 a month. The total business for the year will amount to between $30,000,000 and $35,000,000.

Professor Wade Hibberd, who occupies the chair of Mechanical Engineering in Missouri University, has been writing on Salesmanship in the University's quarterly magazine. He says: "The day of the crafty, tricky, glib, ill-educated, loud and intemperate salesman is gone. Now he must be honest and have a reputation for honesty, be an expert in evidence, a trained logician, well educated and able to meet his customers on their own ground, of good health that his mind may be alert and personally attractive, acquainted with the practical physiology of typical customers, able to give proofs so pointedly that the purchaser can be brought quickly to the closing of the sale."

FRENCH NOTES.

PARIS.

"King" Pataud's renewed activity in connection with the ferment among electricians at the various central stations has already caused a great deal of inconvenience and is giving rise to keen and widespread apprehension. The present state of affairs is said to have originated in the Government's interference with the Electrical Artisans Trade Union. Over 2,000 members of that body have passed a vote expressing their "absolute confidence in the loyal and energetic man to whom they are deeply indebted." This will stir up Pataud to fresh pranks. It is particularly unfortunate, as this will retard the progress of electricity. Large consumers are in a quandary. They hardly know whether to instal their own plant for generating electricity, or to go to the large generating station. There is a decided move all over France, but notably so in Paris, for the smaller electricity undertakings to amalgamate with the larger. Customers are now debating whether they would be in a better position if depending upon small than upon big undertakings. The answer to this in electrical circles is that the bigger the supply centre the safer it would be, because it would prove easier for the Government to render effectual aid. Meanwhile fresh uneasiness has arisen over the short circuits, explosions and consequent failures of supply in the Quartiers de l'Europe, Clichy and elsewhere. These accidents are attributed to "sabotage," in other words malicious interference on the part of workmen.

An Amalgamation.

The houses of Schneider & Cie (Le Creusot) and Felten und Guilleaume Lahmeyer have formed a working arrangement whereby the former firm will be entitled to manufacture electrical appliances under the patent rights of the latter.

Electrical Appliances at the Port of Bordeaux.

The town of Bordeaux has decided to spend 370,000 francs on six electrical cranes for the equipment of the port, and also on electric lighting on the quay-sides.

GERMAN NOTES.

BERLIN.

It is computed that the recent snowstorm here involved damage amounting to two millions sterling as regards the Post Office alone. The repairs and restorations are far from being completed. The unfortunate part of the business is that most of the wires and poles brought down have been stolen, so that replacement is wanted instead of re-erection. The dealers in poles and wire are said to be taking full advantage of this circumstance, as the service must be reinstated as quickly as possible. It is also said that the poor of Berlin are not so short of firewood now as they have been during the earlier part of the winter.

Mono-Rail.

Herr August Scheil exhibited his new system at the Berlin Zoological Gardens on November 10, 1909. The rail was of the ordinary railway kind, with the electric mains supplying the car motors running by its sides, and was about 330 yards long. The carriage was about 20 ft. long and 4 ft. wide, with four double flanged wheels, with an axle frame for each pair. It weighed 2½ tons, and was built for four passengers and two motormen. Railway Minister Breitenbach made the first trip. The carriage remained almost perfectly upright even on sharp curves and with inequal distribution of its living freight. This is secured by a righting action, exerted by two gyrostats revolving in opposite directions on vertical cardan shafts. They were kept revolving by electricity at 8,000 turns a minute. The inventor states that they take two hours to come to rest after the current is cut off from them. For further safety, revolvable supports are attached to each side of the car, and can be brought into action in a few seconds. The experts present regarded the experiments as extremely satisfactory, although from the shortage of the line, it was impossible to travel at very high speed. People talk of a mono-rail speed of 150 miles per hour, but it remains to be seen whether Scherl's gyroscopic system will answer at such a speed as that, especially if two or more carriages are coupled together into a train. Exact data as to the consumption of electric power are wanting, but it is certain that the consumption per car is less in a train than it is for a single car.

Wireless Telegraphy.

On November 16, 1909, at about 7 p.m., the *Cap Blanco*, of the Hamburg Sudamerikanische Dampschiffsfahrt Gesellschaft, and the *Corcovado*, of the Hamburg American line, had an interesting experience in the Atlantic. The two steamers began to communicate when nearly 1,400 miles apart, and messages were received perfectly for some hours, and until the distance had been increased to 1,500 miles. The *Cap Blanco* was simultaneously speaking the *D Ypiranga* at a distance of 1,200 miles.

Wireless telegraphy has been established between Yap, in the Western Carolines, and Angaur, in the Pelew Islands. The two islands are over 300 miles apart. Angaur is now connected with the whole world, as Yap has a cable to Celebes and Shanghai, and also to Guan, whence there is a cable to San Francisco. The moving spirit in this last development of wireless telegraphy was the Deutsche Sudsee Phosphat A.G. of Bremen, which has rich phosphate mines in Angaur.

Current Notes.

The Elektrizitatswerk Lonza has had a bad year on account of the sharp crisis in the electro-metallurgic and carbide industry caused by the slump in aluminium, and also because the completion of their new works has been unexpectedly delayed.

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BUSINESS NOTES AND NEWS.

LIGHTING AND GENERAL—Home.

BEDFORD.—The Town Council have adopted the Electricity Committee's resolution that it shall be optional for any consumer whose annual consumption of electricity for lighting purposes reaches or exceeds 3,120 units (equivalent to £65 value of current at 5d. per unit) to pay for such consumption either at the existing rate of 5½d. per Board of Trade unit, or at the following differential rate, viz.: 6½d. per unit for all units consumed from sunset each day until 8 p.m.; and 4½d. per unit for all units consumed during any other period of the 24 hours from which charges a discount of ½d. per unit shall be made from all accounts settled within one month after the date of delivery of the same. These terms are subject as under: (*a*) The consumer must agree to be supplied at such differential rate for at least 12 months. (*b*) Should it be found that the consumer at the end of any completed year has not reached the consumption of 3,120 units, then he shall pay to the Corporation a sum calculated at the rate of 4d. per unit for the difference between his consumption and 3,120 units. (*c*) These terms are also subject to the consumer paying the extra rental (if any) for the necessary two-rate meter or meters.

BELFAST.—Mr. P. C. Cowan M.Inst.C.E., Local Government Board Inspector, held an inquiry into the application of the Corporation for powers to borrow £62,000 for the extension of the electricity plant. Mr. T. W. Bloxam, the Electrical Engineer, said in regard to the necessity for the extension of the works, the main factor was the probable increase in the demand for next year and the subsequent year. He estimated the demand for the years 1911 and 1912 as follows: Winter of 1910, 4,570 kw., and the winter of 1911 3,130 kw. The total plant capacity for lighting at present was 5,800 kw. Of this it was necessary to reserve as spare sets one large unit, 1,000 kw., and one small unit, 400 kw. This reduced the available plant capacity to 4,400 kw. Therefore, at winter, 1910, the demand would exceed the capacity of the plant available by 4,750, less 4,400 kw., and at winter, 1911, by 5,130 less, 4,400 kw. The present generating station had sufficient capacity for an additional 4,000 kw., and in order to utilise the available space to the best advantage, he proposed to instal one 1,500 kw. turbo-generator and condensing plant for this extension, which would at the present rate of increase, be sufficient for the next two years. Proceeding, witness went over the various items of the proposed expenditure, and said it was estimated that there would be a return of 10 or 11% on the capital. Two of the engines at the electric station were utilised for the purposes of the tramways during the day, and the third engine was occupied at dinner hour and 5.30 o'clock in the evening. They had 2,170 electric light consumers at the end of December, 1909. They claimed that there were only four similar undertakings in Great Britain that could produce the unit more cheaply than was being done in Belfast. The Commissioner said that he would report favourably on the application.

BRAY.—Mr. Sowter, Electrical Engineer to the Council, reported that the new gas engine by Messrs. Mirrlees, Bickerton & Day, Ltd., was up to the standard and the guarantee, and the test had been very satisfactory. It was decided to advertise for tenders for the loan of £1,000, to be expended on the electricity works improvements.

EDINBURGH.—Mr. Frank A. Newington, Electrical Engineer to the City, has issued a graphic table giving curves showing the highest and lowest output during 1909. The maximum load was on December 22 and amounted to 15,300 h.p., the maximum being at about 4.30 p.m. The smallest output was on June 25, when the maximum load then reached was only 4,500 h.p., the highest load of the day being at 10 p.m.

FAREHAM.—Mr. Hawes (of Messrs. May & Hawes, electrical engineers) reported, with references to the new electric light works, that that day one of the new systems had been permanently changed over, and part of the town was for the first time being supplied from the new plant. The second system was practically ready for the change-over, which would be made very shortly. With reference to the arc lamps, the brackets were being erected, and probably on the most convenient day next week the lamps would be in place ready for use. The running of the system was eminently satisfactory, and the results of the fuel-consumption tests had somewhat exceeded the expectations of the engineers.

FLEETWOOD.—A Local Government Board enquiry is to be held into the application of the Urban District Council for powers to borrow £1,000 for electric light and power supply plant.

GLASGOW.—At the Corporation's Sub-Committee on Air Purification last meeting, Mr. W. W. Lackie, the electrical engineer, says that in the offices of that department at 75, Wateroo-street, they have only one fire in use in one room. The quantity of fuel consumed in this fire per annum was about four tons. They have one hot water furnace, in which coke (62 tons per annum) is burned, for the heating of the offices by hot water. He could very easily substitute a radiator for the one fire in use. He would be very pleased to go over the offices of any of the other departments where coal fires were in use and see if it was practicable to adopt electric radiators for heating. In their generating stations they had about 45 steam boilers, and they burned something like 84,000 tons of coal, but it was burned in the most up-to-date furnaces, and the issue of smoke from them was practically nil. No other form of fuel could be substituted for coal in the meantime. After discussion, it was agreed that a summary of the reports by the officials should be prepared, and pending this consideration of the subject was delayed.

HAVANT.—At the Urban District Council meeting it was reported that a deputation had waited on the Havant Gas Co., with reference to the Bill to come before Parliament called the Havant Electricity and Gas Bill. They had previously made application to the Portsmouth Corporation to ascertain if it was possible for them to supply the Havant Council with electric light. The effect of the Company's proposed Bill would be to block further negotiations with the Portsmouth Corporation for electric light. After the meeting the deputation from the Company promised to delete all the electricity clauses provided the Council would let the Bill go through unopposed. The Bill was designed to obtain powers to purchase land adjacent to the Company's works. At the next meeting the Council would be asked to pass a formal vote on the matter.

HENDON.—The District Council had under consideration at their last meeting a letter from the North Metropolitan Electric Power Supply Co., intimating that they had been requested to afford a supply of electrical energy for the purpose of the proposed railless cars which the Metropolitan Electric Tramways (Ltd.) proposed to run between the Burroughs, Hendon, and Golders-green Tube Station, and asking for consent to the erection and use of overhead wires. The clerk was instructed to make inquiry as to the actual route proposed to be taken, the service of cars proposed, and the suggested fares. When this information is forthcoming, the Council propose to give the matter further consideration.

LONDON (St. Pancras).—The Electricity Committee propose renting part of a wharf on the canal, in order to be able to store coal and have access to the condensing water mains. They have decided not to join in the Associated Municipal Engineers (Greater London) advertising scheme, and even to discontinue advertising the Electricity Department in the local press. An extension of the lighting mains is to be made to Burghley-road, at an estimated cost of £19.

LOUGHBOROUGH.—The statement of accounts of the town electricity undertaking for the half-year ended September 30, shows receipts amounting to £1,021 5s. 0½d. There were 83,171 units sold at 4d., and 88,991 at 1d. The expenditure totalled £1,171 0s. 7d., showing a loss carried to the net revenue account of £149 15s. 6½d. The engineer reported that nine new lighting customers had been obtained during the past month, and that the units generated had increased—compared with the corresponding month of last year—by 71·49%, while the units delivered to feeders showed an increase.

MONAGHAN (Ulster).—A proposal is before the Urban Council to obtain a loan in order to introduce electric light in the town. Meanwhile, the local electricity company has offered to tender for public lighting. The Council at present pay £140 for street lighting by gas.

WINCHESTER.—A special Committee of the City Council, appointed to consider and report on matters affecting the Corporation arising under the deed transferring the Winchester Electric Lighting Order, 1895, from the Corporation to the Winchester Electric Light and Power Co., Ltd., brought up a voluminous report with the recommendation that the Council give immediate notice to the Company to purchase the undertaking, and to request the Company not to incur further capital expenditure without obtaining the approval of the Council thereto. It was stated that the undertaking was one of the most successful of its kind in the Kingdom, and that it could be extended without additional expenditure. The report was referred to a special meeting of the Council, when the question will be thoroughly gone into.

LIGHTING AND GENERAL—Overseas.

BERGEN (Norway).—The Malangs Falls, on the Maalselv river, have been purchased by a company with the object of providing electric lighting and power to the new iron ore fields at Ramfjordnaes (see the *Board of Trade Journal*, December 16, p. 540). The purchasers of the falls are said to be a Norwegian-American company.

BRUSSELS.—A company has been founded in Brussels under the title of Elektricitats-Gesellschaft von Odessa. The capital

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is 8 million francs in 80,000 ordinary shares of 100 francs each. There are also 80,000 founders shares of unstated value. The ordinary shareholders are promised 5% and an equal share with the founders in the balance of the net profits. The company is largely underwritten by already existing concerns, such as the Societe Financiere de transports et d'entreprises industrielles and the Berlin Gesellschaft fur Elektrische Unternehmungen. These two take 12,000 shares each and the Societe generale Belge d'entreprises electriques, in which the Allgemeine Elektrizitats Gesellschaft is interested, takes 20,400.

BUDAPEST (Hungary).—H. M. Consul-General reports that a great eruption of natural gas has occurred in the district of Kissármás, Co. Koloz, in Transylvania. Boring has been carried to a depth of 302 metres (about 990 ft). It is calculated that the gas escapes at the rate of two cubic metres a second, and with a force of 20,000 h.p. The gas is practically perfectly pure and contains only about ½% of foreign nitrogenous matter The right to the use of the gas has been bought by the Government, and it is proposed to erect large electrical works on the spot.

TRACTION—Home.

ABERDEEN.—In the matter of the question of supply of electrical energy to the Suburban Tramways Co., Ltd., by the Corporation, counsel's opinion has been obtained as to the method of award of the arbiter, and the Electricity Committee decided to remit the whole matter to the Council for authority to give effect to the advice of counsel that alternative grounds of action as indicated in their opinion be included in the summons. Since this, however, a further letter has been received from the Company, so the whole subject has been referred back to the Electricity Committee.

BELFAST.—Messrs. Gilmore & Co. report that the electrical outlook for this year is excellent. They were fairly busy last year, among their contracts being:—Complete electric light installation for the Star Manufacturing Co., at their new premises, Donegall-road; lighting of new offices in Rosemary-street, for Messrs. Morrell & Johnston; alterations and additions at Queen's Arcade and Donegall-square North, for Mr. W. S. Allison; complete installations at new Motor Garage, Brunswick-street, for Messrs. Leslie Porter, Ltd., and at Castle Tea Rooms, Donegall-place, for Mr. Johnston. Messrs. Gilmore & Co. have also recently carried out the lighting of St. John's Church, Lagan Bank-road, as well as a complete installation at the new Mission Hall, Ballyhackamore, and alterations and additions at Elmwood and Duncairn Presbyterian churches, and at the Ulster Hall and the Y.M.C.A. Hall. They have also carried out some extensive alterations and additions at Whiteabbey for the Whiteabbey Flax-Spinning Co., Ltd.

BIRKENHEAD.—Local efforts are being made to induce the directors of the Wirral Railway to avail themselves of their powers to electrify the line, which runs from Seacombe Ferry to Hoylake and West Kirby, with branches to New Brighton and Birkenhead Park. The line is largely used by business people, but it is felt that the train service is too slow, and competition by motor omnibuses is threatened.

CREWKERNE.—The Board of Trade have recently confirmed the undermentioned Order made by the Light Railway Commissioners: Crewkerne, South Petherton, and Martock Light Railway Order, 1909; authorising the construction of a Light Railway in the County of Somerset, from Crewkerne to South Petherton and Martock.

DUBLIN.—The City Council have adopted the Electricity Committee's proposal that the charge for electricity for lighting purposes should be increased by 10%. It was decided that this addition should be sanctioned for one year only.

MANCHESTER.—It is announced that big contracts for the sinking of new mines and the installation of extensive surface works, including electricity generating stations, have just been placed by a number of leading Lancashire colliery owners. The total cost of these developments will, it is stated, be not far short of £1,000,000 sterling.

READING—The Corporation Tramway Sheds have been let for political meetings, the first one on January 1 being in support of Mr. Rufus Isaacs, when Mr. Lloyd George was the chief speaker. The Tramway Department benefited financially not only from the letting of the sheds, but from the additional receipts from passengers carried to and from the building by car. A temporary flooring was laid down, and this was removed a few minutes after the meeting closed, and the cars ran into the sheds as usual the same evening. This opens up a possible source of substantial revenue for tramway undertakings.

SUTTON COLDFIELD.—The Town Council have to extend the electricity mains to Wylde-green, at an estimated cost of £3,500. An application is to be made to the Local Government Board for powers to borrow that amount.

TAVISTOCK.—A proposal to borrow £10,000 for an electricity supply scheme, which would involve an estimated annual charge of £500 for working expenses, has been referred back for further consideration. A proposal to obtain expert advice for an expenditure of not more than £10 was not persisted in.

TRACTION—Overseas.

ADELAIDE, SOUTH AUSTRALIA.—The State Legislative Assembly have adopted the Commissioner of Public Works Bill for the electrification of the Glenelg Railway, at a cost of £115,000. This line was constructed at a cost of £162,000, and last year returned a net profit of 9% on the cost.

BERNE, SWITZERLAND.—Railway concessions have been granted to (1) Mr. Arthur Bider, of Langenbruck, and Mr. E. Jenny, of Waldenbourg, for a period of 80 years, for the construction and working of an electric railway from Waldenbourg to Balsthal, with a branch from St. Wolfgang (Balsthal) to Mümliswil, the total length being 9½ miles; (2) Mr. F. Manatschal, of Coire, for a period of 80 years, for the construction and working of a steam railway from Zernez to the frontier near Münster (Ofenberg Railway), the total length being 33 miles; (3) Messrs. Schärer & F. Luder of Koppigen, for a period of 80 years, for the construction and working of an electric railway from Herzogenbuchsee to Kirchberg *viâ* Koppigen, and from Koppigen to Lyss by way of Utzenstorf. A concession has also been granted to the "Société des Tramways Lausannois" for the construction and working of an electric tramway from Georgette to Port de Pully; and (1) an 80 years' concession granted to Messrs. Daucourt, Chavannes, Ceppi & Vallat, of Porrentruy, for the construction and working of a railway from Damvant to Lugnez *viâ* Porrentruy, having a total length of 16 miles; and a similar concession granted to Mr. A. Jordi, of Bienne, Mr. Jean Stebler, of Safnern, and Mr. F. Kunz, of Meinisberg, for the construction and working of an electric railway from Bienne to Meinisberg; the length of the line will be 6½ miles.

BUENOS AIRES.—A decree has been issued approving the contract with the Buenos Aires City and Port Tramway Co. for the construction of an electric tramway from the neutral lines of the Port, crossing between the Basin and Dock 1, thence towards the north to the corner of Calle Maipu and Avenida Rosales. (This was conceded to Messrs. Gandulfo and Valdez, who transferred it to said company.)

TOKIO, JAPAN.—A company has been formed to construct and work an electric tramway for the city and its suburbs.

COMPANIES REGISTERED.

A. W. MACDONALD, LTD.—Capital £12,500, in £1 shares. Objects: To carry on the business of pattern makers, model makers, mechanical and electrical engineers, millwrights, founders, timber merchants and builders of all kinds of engines, vehicles and vessels. Private company. Registered office, 154, Vincent-street, Glasgow.

B. F. C. SYNDICATE, LTD.—Capital £5,000, in 4,750 Ordinary shares of £1 each and 5,000 Deferred shares of 1s. each. Objects: To carry on the business of importers, exporters, manufacturers, merchants, agents, financiers, miners, electrical and mechanical engineers, suppliers of electricity, ironfounders, contractors, metallurgists, etc., and to adopt an agreement with J. T. Wynne. Private company. Registered office, 2, Norfolk-street, Strand, W.C.

BROUGHTON MACHINERY CO., LTD.—Capital £1,000, in £1 shares. Objects: To take over the business of a dealer in electrical and mechanical machinery carried on by Martha E. Mercier at 291, Bury Newroad, Broughton, as the Electrical and Engineering Stores. Private company.

COMPAGNIE GENERALE ELECTRIQUE DE LA CHAMPAGNE LTD.—Capital £80,000, in £4 shares. Objects: To instal and exploit works for the distribution of electric power in the Valley of Guippe, Rheims, and in Aisne, Ardennes, Marne all in France, and elsewhere; to build works and lines of transport in the Department of Marne and the bordering departments for the production, transportation and distribution of electric power. Minimum cash subscription, seven shares. The first directors (to number not less than two nor more than five) are J. Bouchet and H. Lamort (managing director) and others (if any) to be appointed by the signatories. Remuneration of managing director, £240 per annum; of Chairman £150; of other directors £100 each per annum. Registered office, 1, Broad-street-place, E.C.

J. G. JACKSON, LTD.—Capital £2,000, in £1 shares. Objects: To carry on the business of manufacturers of, agents for, and dealers in milling machinery and agricultural implements of every description, electrical and mechanical engineers, civil and consulting engineers, iron and steel founders, electricians, &c. Private company. Registered office, 34, West George-street, Glasgow.

SCOTTISH POWER CO.—Capital of £160,000 in £1 shares (75,000 preference, 75,000 ordinary "A," and 10,000 ordinary "B"), to acqure the share capital of the Scottish Central Electric Power Co., and to construct light or other railways, electric or other tramways, electric light energy and power supply works, etc.

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SUTER'S PATENTS, LTD.—Capital £1,000, in £1 shares (500 Preferred Ordinary and 500 Ordinary). Objects: To carry on the business of electrical engineers, electricians, etc. Private company.

LIENS REGISTERED.

CHARING CROSS WEST END AND CITY ELECTRICITY SUPPLY CO., LTD.—Trust deed, dated 9th December, 1909 (supplemental to trust deed of 31st March, 1908), to secure £50,000 Debenture stock (ranking pari passu with the £600,000 covered by the principal deed). Property charged—As per principal deed. Holders—Union of London and Smiths' Bank.

COATBRIDGE & AIRDRIE ELECTRIC SUPPLY CO., LTD.—Mortgage, dated December 20, 1909, to secure £4,700, charged on company's undertaking and property, present and future, including Coatbridge and Airdrie undertakings and benefit of certain agreements. Holders—County of London Electric Supply Co., Ltd., Moorgate-court, E.C.

EDISON AND SWAN UNITED ELECTRIC LIGHT CO., LTD.—Trust deed, dated 25th November 1909 (supplemental to trust deed dated 19th June, 1900), to secure £100,000, ranking pari passu with outstanding stock secured by principal deed. Property charged—Certain assets. Trustees—London Trust Co., Ltd., 37, Lombard-street, E.C.

NAIROBI ELECTRIC POWER AND LIGHTING CO., LTD.—Particulars of £5,000 Third Debentures, created 25th November, 1908, filed pursuant to section 93 (3) of the Companies (Consoldiation) Act, 1908, the amount of the present issue being £1,000 (ranking *pari passu* with two former series securing £6,000 and £4,000 respectively). Property charged—The company's undertaking and property, present and future, including uncalled capital, but excluding £1,500 deposited or to be deposited in the joint names of the Crown Agents for the Colonies and National Bank of India, Ltd., uncalled capital on 10,000 Preference and 6,000 Ordinary shares, and contract dated 26th July, 1906. No trustees.

MINEHEAD ELECTRIC SUPPLY CO., LTD.—Particulars of £5,000 Debenture stock, created by resolutions of November 29 and December 21, 1909, and secured by trust deed, dated December 22, 1909, filed pursuant to section 93 (3) of the Companies (Consolidation) Act, 1908, the whole amount being now issued. Property charged—Freehold and leasehold land and buildings at Quay-lane, Minehead, and Alcombe, Somerset, and the company's general assets. Trustees—T. Joyce and F. Risdon.

CONTRACTS OPEN.

HOME.

ACTON.—Urban District Council.—Annual supply of cable, steel tubing, meter boards and fuse boxes. (Particulars, Council's Electrical Engineer, 130, Churchfield-road, W.). January 18.

CAMBERWELL.—Borough Council.—Electric lamps. January 24.

LONDON, E (Stepney).—Borough Council.—(a) Three water-tube boilers and accessories; (b) one 2,000 kw. turbo-generator and accessories, converting machinery, switch gear, &c. (Specifications, £5 5s. each section, Borough Electrical Engineer and Manager, 27, Osborn-street, Whitechapel, E.). January 24.

MANCHESTER.—Corporation Tramways.—Steel tramway poles. (Specifications, £2 2s., General Manager, 55, Piccadilly, Manchester). January 18.

PLYMOUTH.—Corporation Electricity and Street Lighting Departments.—No. 1, arc lamp carbons; No. 2, electricity meters; No. 3, transformers; No. 4, paper insulated cables; No. 5, lubricating oils, &c.; No. 6, engine waste, &c. (Specifications, 10s., Borough Electrical Engineer, Prince Rock). January 25.

ROCHDALE.—Corporation Tramways Committee.—No. 1.—Poles, bracket arms, and accessories; No. 2.—Overhead line materials, trolley wire, section boxes, and accessories; No. 3.—Points and crossings. (Specifications, £1 1s., Engineer, Mellor-street). January 17.

TYNEMOUTH.—Corporation.—One electric jib crane. (Particulars from Electrical Engineer at works). January 20.

OVERSEAS.

BREE (Belgium).—Tenders will be received, up to 11 a.m. on February 26, at the Hotel de Ville, Bree, province of Limbourg, for the establishment of a central electrical station in connection with the provision of electric light to the town. The plan and conditions may be seen at the Hotel de Ville, Bree.

BRUSA.—Municipality.—Concession for construction and exploitation of electric tramways. (A.). January 29.

LAUNCESTON (Tasmania).—City Council.—Electric tramway rail bonds and accessories. March 31.

OSTEND.—Municipality.—Eight electric cranes.—(Specifications, 1s. 8d., plans 5s. 8d., M. Geraert, 38, Rue de Louvain, Brussels). February 18.

ROME.—Italian State Railways.—55 electrical drilling tools, 27 of 20mm. and 28 of 50mm. bore. (Particulars, 16, Via Ludovisi). January 30.

TENDERS REQUIRED.

OLDHAM.—Corporation Electricity Committee offer for Sale the whole or any part of the Plant at the Rhodes Bank Generating Station, consisting of:—4 Lancashire Boilers, 28 ft. by 7 ft. 6 in.; 4 Lancashire Boilers, 28 ft. by 8 ft.; 2 Willans-J. P. Hall & Co.'s 36 kw. Direct-coupled Sets, Shunt Wound, 200–260 volts; 2 Willans-J. P. Hall & Co.'s 60 kw. Sets, Compound Wound, 500–550 volts; 3 Willans-Siemens' 225 kw. Sets, Shunt Wound, 400–480 volts; 1 Willans-Siemens' 225 kw. Sets, Compound Wound, 500–550 volts; Condensers, Pumps, Steam and Exhaust Pipes, Switchboards, etc. Further particulars can be obtained from Mr. S. Wilmott Newington, Borough Electrical Engineer, Electricity Works, Greenhill, Oldham.

TENDERS ACCEPTED.

ST. PANCRAS.—The Electricity Committee have received the following tenders for a new switchboard, to be supplied to the specifications of the Chief Electrical Engineer, and have recommended that that of Messrs. Northcote, Heaver & Co. be accepted on the ground that they are a local firm: British Thomson-Houston Co., Ltd., £87 15s.; Northcote, Heaver & Co., £90 19s.; Bertram Thomas, £95 5s.; E. F. Moy, Ltd., £109; A. Seage & Co., £115

PUBLICATIONS.

The Local Government Review for January (price 1s.) contains an excellent selection of articles and notes. Dr. Samuel Rideal concludes his articles on "The Sterilisation of Public Water Supplies," giving practical notes on purification by the electric production of chlorine and ozone as carried on at Nice, Paris, and Philadelphia. The various systems are succinctly described, and the processes approved. Dr. Rideal also reviews favourably the "Electrozone," "Oxychloride" systems, as well as that adopted at Poplar for the production of chloride solutions by electrolysis. Another thoughtful article is that by Mr. A. S. E. Ackerman, B.Sc., A.M.Inst.C.E., on "The Brennan Mono-Rail System," which he considers offers very considerable advantages over ordinary tramways. He estimates the saving on capital account would amount to at least 40%, while a very considerable reduction would be effected on the upkeep of the road, as well as on running expenses.

Messrs. S. Davis & Co., of St. Swithin's-lane, E.C., have compiled a useful "Electrical Engineers' Diary" for 1910 (price 2s. 6d.). It is intended for consulting engineers, electrical contractors, central station engineers, and all users of electrical apparatus, and certainly contains a selection of tabular matter and short articles likely to appeal to these classes. The diary portion gives three entries to the page, with a ruled-off space for "Mems." at the bottom. These pages are square ruled for sketching and plotting curves.

Messrs. Everett Edgcumbe & Co., Ltd., are sending out a monthly tear-off calendar, with amusing sketches by Hassall, depicting the grotesque ideas that electrical terms suggest to his mind. It is very funny.

The Premier Electric Control's calendar is a handsome-looking affair, with tear-off monthly leaves and a day adjustment contrivance, which, automatically places before the business man certain "Resolutions for the Year 1910," possessing distinct merits from at least one point of view. Our readers should write to the Premier Electric Control, Ltd., and see for themselves.

EDUCATIONAL.

FARADAY HOUSE.

The following arrangements for special lectures to be delivered during the Lent Term, have been made by the Governors of Faraday House:—"Electrical Measurements," by Mr. John Rennie, M.I.E.E., of the Board of Trade Electrical Standards Laboratory; "Accumulators," by Mr. W. R. Cooper, M.A., B.Sc., M.I.E.E., A.M.I.C.E.

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TRADE NOTES.

Mr. G. Braulik, manufacturer and exporter of all electrical supplies, 8, Lambeth-hill, London, E.C., informs us that, owing to the large increase in business in his engineering department during last year, he has decided to separate that branch from his ordinary supply business, and for that reason has commenced a new department, which will be carried on under the name and style of "The Braulik Engineering Co., 8, Lambeth-hill, London, E.C." Mr. E. Eugene Brown, M.I.E.E., has joined the firm, and will supervise all technical engineering specialities in which they deal and also partly manufacture in England. The specialities in which this department will mainly deal with (and for which they have sole agencies) are the following: Dynamos, alternators, and motors; turbine plants; economisers; gas, oil, and petrol engines; suction gas plants; pumps; measuring and recording instruments of all kinds, electrical and mechanical; motor controllers, regulators, and starters; switches and switchboards; special insulating varnishes and materials, and vacuum drying plant; also cranes and lifts; telephone and telegraphic apparatus of all kinds; and arc lamps for all purposes.

Messrs. T. Harding, Churton & Co., of Atlas Works, Leeds, have appointed Mr. B. T. Dale, of 62, Clayton-street, Newcastle-on-Tyne, as agent for the sale of their alternating current motors in the Counties of Northumberland, Durham, Cumberland, Westmoreland, and the Cleveland districts of Yorkshire. Mr. Dale has had a wide experience in electrical engineering and was for several years with the Newcastle-on-Tyne Electric Supply Co., Ltd. He will be prepared to advise intending customers upon all matters connected with electric driving, for which his long experience with the Electric Power Co. has particularly qualified him.

FINANCIAL NOTES.

A cable message announces that the Brisbane Electric Tramways Investment Co., Ltd., receipts for month of December, 1909, was £18,330, compared with £16,655 for 1908; increase £1,675. Aggregate for 12 months, 1909, £198,322; 1908, £177,583. Increase £20,739.

SOCIAL.

The Bryant Trading Syndicate, Ltd., of "British Metalite" Lamp fame, not content with taking their employés for an outing at Brighton last summer, invited them *en masse* to the pantomime, "Babes in the Wood," at the Marlborough Theatre, Holloway. The whole of the pit stalls were reserved for their accommodation, and the management of the theatre is to be complimented upon the admirable manner in which they combined with the syndicate in order to ensure a comfortable and enjoyable evening. A pleasant surprise in the form of a box of chocolates awaited each guest. We are assured by the Bryant Trading Syndicate, Ltd., that the cost of such outings is more than reimbursed by the resultant *esprit de corps*, which goes far towards the success of the "British Metalite" lamp.

PERSONAL.

Mr. Arthur P. Haslam, M.I.E.E., has commenced business on is own account and opened an office at Suffolk House, Laurence Pountney Hill, Cannon Street, London, E.C., where he is prepared to act as London representative for two or three manufacturers of electrical or engineering specialities. Mr. Haslam has had twenty-five years' experience in manufacturing, estimating, inspecting and testing work, and has held responsible positions with both Messrs. Mordey and Dawbarn and The Brush Electrical Engineering Co., Ltd. We wish him every success.

ELECTRICAL TRADES BENEVOLENT INSTITUTION.—The second Festival Dinner of the Electrical Trades Benevolent Institution will be held on Wednesday, February 23 next, and that upon this occasion Dr. Gisbert Kapp, President of the Institution of Electrical Engineers, has kindly consented to preside.

NEW ZEALAND MINES.

ELECTRICALLY DRIVEN PUMPS.

In his annual report, Mr. Frank Reed, inspecting engineer, Mines Department, New Zealand, states that the most important mines throughout the Dominion are putting down electrically-driven pumps, or have already done so. As the application of this power for such a purpose is an innovation in the country, he has prepared a list for the purpose of illustrating the type of pump generally favoured. Particulars are given below:—

Waihi Grand Junction.—Sulzer vertical three-stage: estimated height to be pumped, 250 ft.; estimated capacity in gallons per minute, 666.

Waihi G.M. Co.—Three-throw ram: height to be pumped, 600 ft.; gallons per minute, 1,500.

Barewood G.M. Co.—Three-throw ram; height to be pumped 600 ft.

New Zealand Crown Mines.—Duplex ram (2 units); height to be pumped, 1,000 ft. (two stages); gallons per minute, 1,135.

Talisman Consolidated.—Cornish.

Ross Goldfields (Ltd.) (alluvial).—Multistage Worthington turbine (4 units): height to be pumped, 400 ft.; gallons per minute, 3,500.

THE INSTITUTION OF CIVIL ENGINEERS: STUDENTS' MEETINGS.

At the Students' Meeting, held at the Institution on Friday, the 7th, Mr. Henry R. J. Burstall, M.Inst.C.E., in the Chair, Mr. Donald Southwell Richardson, Stud. Inst.C.E., read his paper on "Oil Fuel." The author, having described the various oil fuels, proceeded to discuss the economic advantages of oil over coal. He concluded with a description of the various methods of burning the oil and illustrated his remarks with a number of lantern slides of oil-fuel burners.

THE ELECTRICAL ENGINEERS (London Division).—Orders for week ending January 22, 1910: Officer Commanding, Col. R. E. B. Crompton, C.B. Monday, January 17, "A" Company, Technical Drill, 7 to 9.30 p.m.; Tuesday, January 18, "B" Company, Technical Drill, 7 to 9.30 p.m.; Wednesday, January 19, Gymnasium, 6.30 to 9.30 p.m.; Thursday, January 20, "C" Company, Technical Drill, 7 to 9.30 p.m.; Friday, January 21, "D" Company, Technical Drill, 7 to 8.30 p.m.; Infantry Drill, 8.45 to 9.45 p.m.; Saturday, January 22, "A" Company, Week-end Run at Coalhouse Fort; Parade at Fenchurch-street Station, 3.15 p.m.; Service Dress, with putties and greatcoat; toilet requisites to be carried in haversack. (Signed) P. H. Campbell, Capt. R.E., Adjutant for O.C., E.E., L.D.

"Adnil"
ONE METER SYSTEM
FOR LIGHTING AND POWER CIRCUITS.
THE INTRODUCTION OF THIS SYSTEM WILL BE A GREAT BENEFIT TO SMALL CONSUMERS AND A MEANS OF OBTAINING INCREASED REVENUE FOR SUPPLY COMPANIES.
WRITE FOR FULL PARTICULARS TO
Adnil Electric Co. Ltd.
(MARPLES & LEACH),
"Adnil" Building, Artillery Lane, Bishopsgate,
Telephone :— 3840 London Wall. LONDON, E.C. Telegrams :— "Adnil, London."

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PATENTS.

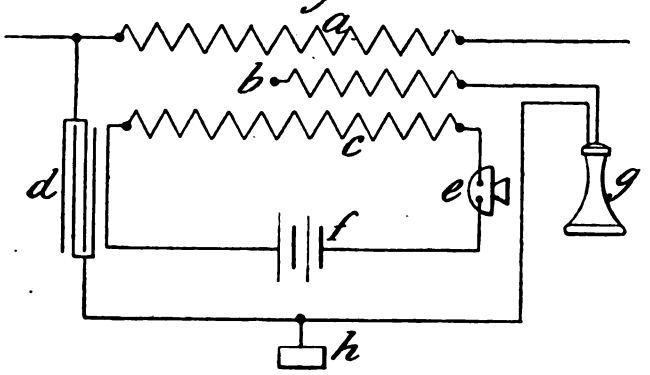
Plates and Electrodes.

28075.—1908. A. BILARD, Paris. This is a supporting arrangement for plates and electrodes for batteries and accumulators. The object is to diminish the wear of the negative element by means of an insulating sheath, which surrounds the conductor and unites the active metal with a stopper, which serves to convey the current to the active metal and at the same time to close the receiver. The stopper is so formed that it fits closely on a conducting ring connected to the negative terminal. The conductor, formed of rigid material, and its insulating sheath are bent to support the electrode by its lower end.

Telephone Circuits.

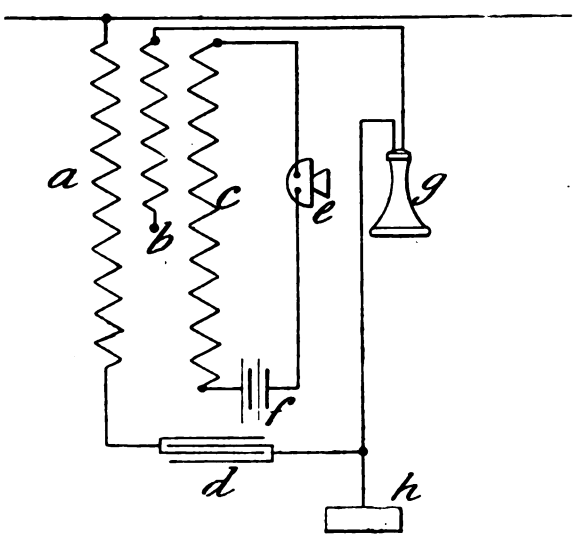
604.—1909. A. H. NICHOLSON, Wendover. This invention aims at eliminating noises due to induction and is particularly applicable to circuits used simultaneously for telephony and telegraphy. In common practice there is inserted in the line wire or in leak from the line wire, the secondary of a transformer, the primary circuit of which includes the usual transmitter and battery. The present invention adds to this secondary winding another winding,

Fig. 1.



one end of which is blind while the other end is connected with the telephone receiver. This second secondary winding may be wound together with the ordinary secondary winding and may have the same number of turns or a greater or smaller number. The other terminal of the receiver is connected either with the return, which may be earth, or with that end of the ordinary secondary winding to which the blind end of the second secondary winding is nearer. Fig. 1 is a diagram of the arrangement in which the secondary is included in the line wire and Fig. 2 that in which it is in derivation with the line wire. *a* is the

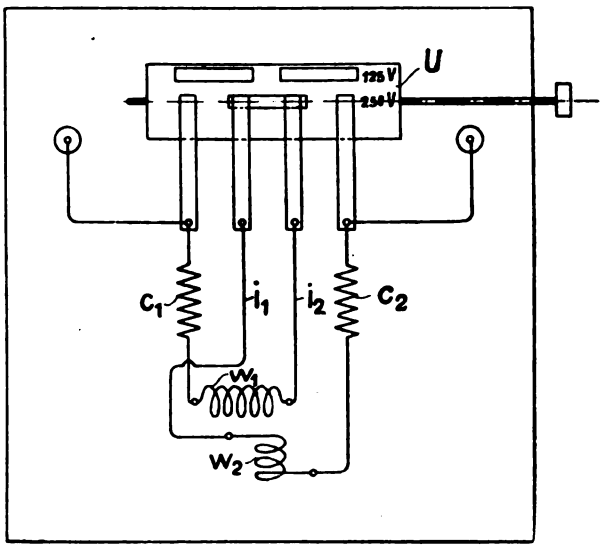
Fig 2.



secondary winding and *c* the primary winding of the transformer; *e* the telephone transmitter and *f* the battery. Wound with the secondary *a* is an auxiliary winding *b*, one end of which is free and the other connected with the telephone receiver *g*, and through it with the earth or return connection *h* and the condenser *d*, which is interposed between one end of the secondary and the connection *h* to prevent diversion of the telegraphic currents.

Arrangement of Connections for Electric Tension Measurement.

10003.—1909. DR. HORN, Leipzig. Electric measuring apparatus of dynamo-metric construction for several ranges of measurement are constructed in such a manner that the range for the higher tension is obtained by connecting additional intermediate resistances, or by providing a series of standard resistances which can be connected up one at a time, according to the range required, as shunts to the fixed and moving coils. This has the disadvantage of increasing the consumption in the instrument. If, for instance, the consumption of a voltmeter of 125 volts by full deviation of the pointer and with the resistance necessary for the equalisation of temperature is 10 watts, this consumption will be 20 watts if the range of 250 volts is to be obtained by means of an intermediate resistance. The new arrangement obtains the double range of measurement without increasing the consumption of the instrument. The consumption, for instance, will be 10 watts for both 125 volts and 250 volts. Heretofore the plan has sometimes been adopted of dividing the fixed and the moving coils into two equal parts, which then, for 125 volts would be connected in parallel, and for 250 volts in series. This also had the disadvantage of necessitating two pairs of spiral springs for the current connection of the divided moving coils. It has also been proposed in instruments of this class to connect the fixed and moving coils either in series



or in parallel for the purpose of extending the range of measurement. The present invention avoids these disadvantages as it permits the undivided fixed and the undivided moving coil to be connected in parallel or in series. This is obtained by connecting the fixed and the moving coil each with a resistance of such a size that two branches of an equal resistance are obtained. The diagram illustrates this new arrangement of connections for two ranges of measurement. The fixed and the moving coil are wound as at present for the highest tension, for instance, for 250 volts and the intermediate resistance is divided into such parts c_1 and c_2 that the resistances $w_1 + c_1$ $w_2 + c_2$. w_1 is the resistance of the fixed and w_2 that of the moving coil. The intensities of the current i_1 and i_2 are also the same. If the branches (w_1+c_1) and (w_2+c_2) are connected in series by means of the commutator U, the instrument can be used to make measurements of 250 volts with a consumption of 10 watts only. If, however, these branches are connected in parallel, 125 volts can be measured and the consumption of the instrument will also be 10 watts. This economy of current is of especial va ue for recording instruments with a high degree of consumption, where also a certain error of temperature must not be exceeded. If, for instance, r_1 or r_2 is the co-efficient of temperature of the two branches then the mean co-efficient of temperature for the connection in series is:—

$$r = \frac{r_1 + r}{2}$$

because $w_1 + c_1$ is equal to $w + c_2$. If, however, the branches (w_1+c_1) and (w_2+c_2) are connected in parallel, then in this case the co-efficient of temperature is also

$$\frac{r_2 + r_2}{2}$$

i.e. r

Electric Lift Control.

1086.—1909. J. G. CHILDS, London. This is an improved electrical system for the control of lifts from the various floors and from the lift car. The system comprises two solenoids, so that the car moves in one direction or the other according to the solenoid excited. At each floor is a pivoted switch controlled by two solenoids. One of the solenoids serves as a relay to close a contact in parallel with the control push when the latter is depressed so as to retain the switch in its operative position when the push is released, and thus keep the main control solenoid excited.

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Neutralising Inductive Disturbances Due to Electric Traction Systems.

466.—1909. The British Thomson-Houston Co., Ltd., London, E.C. In electric railway systems which employ alternating current for their operation, the object is to neutralise the inductive disturbances which often arise and affect electric conductors in proximity to them, for instance, telegraph or telephone conductors. Fig. 1 is a diagram of an electric railway system equipped with the new invention, and Fig. 2 is a modification. In Fig. 1, 1 is a source of current, such as a single-phase electric generator with one terminal connected to an outgoing conductor 2, and the other terminal connected to the rails 3. 4 is a return conductor, which is connected at intervals by conductors 5 to the rails 3. The terms "out going" and "return" are used for convenience as, of course, when the current is reversed the direction of the conductors is reversed. Transformers 6 have two sets of windings, one connected in series with the outgoing conductor 2, and the other connected in series with the return conductor 4. The arrows point out the direction in which the currents flow on the system at a certain instant of time. It will be seen that when the current

Fig. 1.

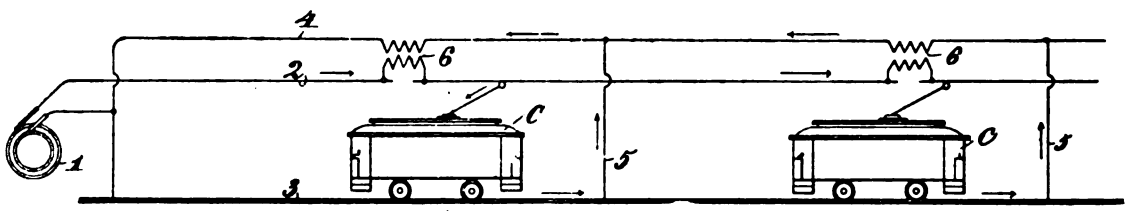
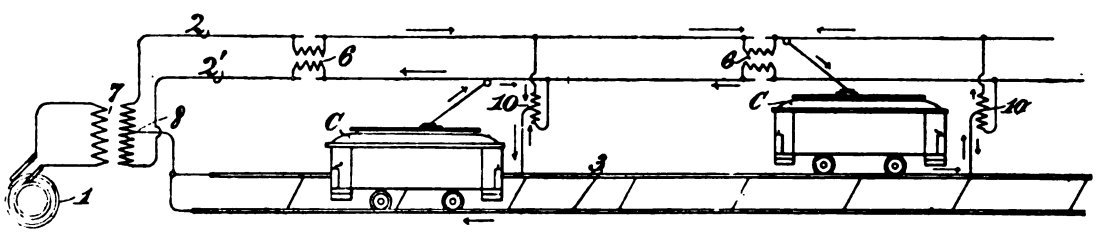


Fig. 2.



is flowing outward in the outgoing conductor 2, it will return by the return conductor 4, and will be of substantially the same quantity in each conductor owing to the action of the transformer 6. It will be obvious that the return current in the conductor 4 will neutralise the inductive disturbances due to the outgoing current in the conductor 2, and hence any disturbing effect upon the conductors in proximity to the system, due to current in one of the conductors, will be neutralised by the disturbing effect due to the other. In Fig. 2 is a modification of Fig. 1, for neutralising both the electro-static and electro-magnetic effects due to the conductors of a railway system upon conductors of adjacent systems. The connections shown in Fig. 1 only neutralise the electro-magnetic effects as the return conductor 4 is at the potential of the earth, and hence will not neutralise the electro-static disturbances due to the conductor 2, which is not at earth potential. In Fig. 2 the arrows show the direction of the current at any one instant in the system, and it will be seen that the outgoing current in conductor 2 is neutralised by the return current in the conductor 2^1, the currents being of substantially equal value because of the transformers 6. This neutralisation between the conductors 2 and 2^1 will be a neutralisation of both electro-magnetic induction and electro-static induction upon any conductors in proximity to a system equipped with this invention.

Wood for Batteries.

2641.—1909. P. Marino, London. The wood to be used for separating the electrodes of secondary or storage batteries is first treated with steam under pressure to free it from pyroligneous acid, and then with ozone to oxidise the vasculose and extract it from the wood in the form of resinous acids. The wood is thus rendered porous and permeable so that it permits the free movements of the ions, the escaped gas, and the perfect diffusion of the electrolyte. The wood may be provided with a number of imperceptibly fine holes in order to further increase its porosty.

Secondary or Storage Batteries.

2683.—1909. P. Marino, London. In the manufacture of electrodes for storage batteries, an agglutinant composed of pure glycerine to which is added a solution of alkaline silicate is employed. A small quantity of starch is well stirred into the mixture, and an impalpable lead power is added. The whole is well mixed into a homogeneous mass.

Electric Lamps for Vehicles.

25389.—1908. E. Aron, London, E.C. The head lights have two or more glow lamps in them. These lamps are of different candle-power and controlled from a switch. On going from a dark road to a well lighted thoroughfare, one or more of the lamps is, or are, switched off.

Static Induction Generators.

21529.—1909. B. E. Baker, Hartford, U.S.A. The discs used in these machines are built up from successive layers of mica. Between the layers is a binder of some fibrous material. The whole mass is bound together with dry shellac. These discs are claimed to be strong, inexpensive, and to have high insulating qualities.

Arc Light Electrodes.

23171.—1909. Gebruder, Siemens & Co., Lichtenberg. The invention consists in incorporating phosphoboric acid in arc light electrodes. This acid is obtained by the action of boric acid on phosphoboric acid. It is claimed that phosphoboric acid conduces to steady burning and renders harmless many impurities which the carbon contains.

Electrical Traction Systems.

1067.—1909. E. Munro, London, E.C. The overhead conductors comprise two outer conductors of similar polarity and a third current carrying conductor at a different level from the other conductors and arranged to connect the frame of the vehicle to earth.

Refractory Electric Conductors.

17619.—1908. C. T. Fuller, Schenectady, U.S.A. A reducible compound of a refractory metal is mixed with a binder and shaped into wires. The wires are surrounded by some carbon absorbing means and simultaneously fired. These conductors are claimed to be strong, homogeneous, and permanent in electrical conductivity.

Magneto Ignition.

22271.—1908. L. J. Milton, Chicago, U.S.A. The magneto generator has sets of magnets of different lengths, progressively diminishing from the centre to the circumference. Pole pieces are attached to the magnets and vary in section in such a manner that the cross section of magnetic material is that required to take the magnetic flux which it will be required to carry for the purpose of obtaining a smaller generator than usual for a given output.

Regulation of Continuous Current Motors.

24794.—1908. P. Scharf, Berlin. In addition to the ordinary brushes located in the neutral plane, several pairs of brushes are arranged in the direction of the pole fields and connected with each other in pairs by magnetic coils or a short circuiting conductor.

Electric Incandescent Lamps.

8146.—1909. R. Hoffelt, Berlin. After carbonisation, the filaments of the lamps are coated with arsenic trichloride, or phosphorous tri-chloride, or the corresponding bromides or iodides, and then made incandescent. The object is to remove the hydrocarbons from the filaments, and at the same time to effect the shrinking of the filaments.

Producing Very Slightly Damped Electrical Oscillations.

6424.—1909. Gesellschaft fur Frahtlose, Telegraphie, m.b.H., Berlin. In this apparatus the slightly damped oscillations are produced by the shock excitation method. A very short spark gap is employed, having parallel electrodes made of a material which conducts heat as well as, or better than, gold.

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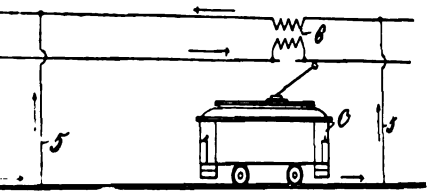
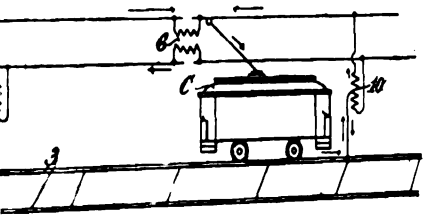


Fig. 2.



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TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns per week. Ending	1909-10.	1908-9.	Increase or decrease. Week.	Current year.	Miles of track open. 1909.	1908.	Accounts for past year. Ending	Total receipts.	Passengers carried.	Car miles run.	Receipts per Passenger.	Car mile.	Mile of track.	Cost per car mile.
		£	£	£	£				£						
Aberdeen Corporation	Jan. 5	1,642	1,659	— 16	— 845	27¼	27¼	May 31	71,930	17,517,304	1,566,119	·98	11·02	4,940	5·93
Ayr Corporation	Sept. 18	671	562	+ 108	—	8	8	—	—	—	—	—	—	—	—
Baker Street and Waterloo Ry.	Nov.	8,141	6,070	+2,071	—	4·25	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	Jan. 2	1,279	988	+ 290	— 89	24·003	13·52	—	—	—	—	—	—	—	—
Birmingham Corporation	Jan. 1	7,699	6,380	+1,319	—	56·792	58·52	—	—	—	—	—	—	—	—
Blackburn Corporation	Oct. 6	1,100	1,293	— 173	—1,036	24·53	28·3	—	—	—	—	—	—	—	—
Blackpool Corporation	Aug. 26	2,152	2,050	+ 102	+ 732	—	—	—	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams	,, 8	2,304	2,309	— 24	—	—	—	—	—	—	—	—	—	—	—
Bolton Corporation	Oct. 10	2,416	2,337	+ 79	— 259	42	42	Mar. 31	117,799	25,492,902	2,492,147	1·1	11·34	2,804	6·50
Bournemouth Corporation	July 21	1,681	1,723	— 42	— 23	29½	29½	,, 31	86,225	13,991,328	1,766,068	1·47	11·71	2,912	7·22
Bradford Corporation	Jan. 1	5,411	4,386	+1,025	+6,905	98	54·81	,, 31	235,258	47,839,569	5,331,007	1·17	10·59	2,378	—
Brighton Corporation	Jan. 9	780	753	+ 27	+1,939	9·5	—	—	—	—	—	—	—	—	—
Bristol Tramway Company	Jan. 7	5,433	4,935	+ 498	—	57	51½	Dec. 31	265,362	46,652,389	5,756,842	—	—	—	—
Burnley Corporation	Jan. 8	1,235	1,128	+ 107	—	19½	19½	Mar. 31	64,261	12,355,958	1,202,330	1·23	12·83	5,971	7·92
Burton Corporation	Jan. 2	295	260	+ 35	— 179	6½	6½	,, 31	14,918	3,221,595	430,913	1·04	8·30	1,460	5·85
Cardiff Corporation	April 3	2,000	1,957	+ 43	—	—	—	,, 31	109,979	25,058,146	2,497,169	—	10·57	—	—
Carlisle Tramways Company	June 19	170	175	— 5	— 89	—	—	—	—	—	—	—	—	—	—
Central London Railway	Jan. 8	5,532	5,693	— 161	—	6·32	5·77	Dec. 31	350,150	41,898,373	1,456,781	2·01	5·769	55,404	30·27*a*
Charing X, Euston, & Hamp. Ry.	Nov.	6,822	6,092	+ 730	—	7·75	—	—	—	—	—	—	—	—	—
City and South London Railway	Jan. 9	3,417	3,510	— 93	—	7·26	7·26	—	—	—	—	—	—	—	—
Colchester Corporation	July 14	200	219	— 39	—	8	—	Mar. 31	10,983	2,308,721	349,639	1·09	7·74	1,477	6·56
Cork E. T. and L. Company	Jan. 6	429	467	— 38	— 38	9·89	9·89	Dec. 31	24,044	5,737,478	896,945	—	6·43	—	4·43
Croydon Corporation	Dec. 24	1,877	1,560	+ 317	+5,739	11¼	—	Mar. 31	74,132	16,277,418	1,884,137	1·06	9·56	3,703	7·109
Darwen Corporation	Oct. 1	239	256	— 17	— 201	7·23	7·23	,, 31	13,899	2,557,654	245,584	1·30	13·68	1,922	9·40
Dover Corporation	Sept. 18	230	252	— 22	— 395	7	—	,, 31	11,593	2,697,672	316,754	·98	8·78	—	—
Dublin and Lucan Electric Ry.	Jan. 7	113	129	— 16	— 16	7	7	—	—	—	—	—	—	—	—
Dublin U.T.	Jan. 7	5,364	5,143	+ 221	+ 72	54½	54½	—	—	—	—	—	—	—	—
Dundee City Tramways	Oct. 6	1,332	1,305	— 27	— 569	—	26½	May 15	60,573	16,367,911	1,281,552	·875	1·9	2,371	7·46
East Ham Corporation	Jan. 8	960	882	+ 78	+ 4,903	15	15	Mar. 31	47,430	15,355,703	1,091,586	·73	10·26	—	6·96
Glasgow Corporation	Jan. 1	17,929	17,683	+ 246	— 9,309	189	181	May 31	907,494	226,948,290	20,766,722	·96	10·49	5,080	5·89
Gloucester Corporation	Oct. 6	395	425	— 30	+ 535	15	—	—	—	—	—	—	—	—	—
G.N., Piccadilly and Brompton	Nov.	13,429	9,354	+4,075	—	9·25	—	—	—	—	—	—	—	—	—
Halifax Corporation	—	—	—	—	—	52·574	37	Mar. 31	81,872	20,378,672	1,786,390	11·40	11·13	1,528	8·40
Huddersfield Corporation	Dec. 4	1,613	1,357	+ 256	+ 2,663	28	28½	,, 31	84,704	16,200,020	1,960,329	1·29	10·37	2,421	5·10
Hull Corporation	Jan. 8	2,731	2,500	+ 231	+ 4,800	29	26	,, 31	128,722	30,964,254	3,022,844	1·	10·22	—	6·04
Ilford Corporation	Jan. 1	583	381	+ 202	+ 1,593	10	10½	,, 31	25,328	6,385,466	634,446	·87	9·58	2,066	6·42
Ilkeston Corporation	Jan. 5	114	118	— 4	— 239	4	4	,, 31	7,214	1,968,850	198,415	9·1	7·9	1,803	7·04
Kirkcaldy Corporation	Sept. 8	269	266	— 7	—	7½	7½	May 15	14,993	4,874,199	459,066	·711	7·838	1,856	5·26
Lancashire United Tramways	Dec. 29	1,362	1,220	+ 142	— 819	39	39	Dec. 31	68,904	12,554,593	2,244,344	—	—	—	—
Leeds Corporation	Sept. 18	6,896	6,624	+ 272	+ 3,662	108	96½	Mar. 31	340,368	75,734,083	7,694,989	1·06	10·62	3,527	5·51
Leicester Corporation	Sept. 11	2,162	2,130	+ 32	—	—	—	—	—	—	—	—	—	—	—
Liverpool Corporation	Nov. 6	10,803	10,687	+ 116	— 1,977	109	104	Dec. 31	572,822	124,043,239	12,231,799	1·108	11·24	5,508	7·94
Liverpool Overhead Railway	Jan 2	1,305	1,271	+ 34	—	6·65	2·40	June 30	79,004	11,171,515	1,106,386	—	—	—	—
London County Council	Dec. 25	40,006	35,926	+ 4,080	+72,449	128½	121	Mar. 31	1,274,660	279 166,461	25,591,028	1·08	11·74	—	6·79
Lowestoft Corporation	Dec. 11	155	150	+ 5	+ 80	3½	—	Sept. 30	11,399	2,645,206	370,320	1·03	7·36	2,279	6·12
Maidstone Corporation	Dec. 25	168	182	— 14	—	5½	—	—	—	—	—	—	—	—	—
Manchester Corporation	Sept. 11	15,631	15,297	+ 334	— 2,871	183	181	—	—	—	—	—	—	—	—
Metropolitan District Railway	Jan. 8	10,712	9,925	+ 787	—	24	24	—	—	—	—	—	—	—	—
Metropolitan Railway	Jan. 2	17,357	16,734	+ 623	+ 672	24½	24½	June 30	680,357	99,846,735	—	1·46	—	—	—
Nelson Corporation	Oct. 16	151	131	+ 20	+ 7	2½	2½	Mar. 31	7,362	2,060,712	204,740	·85	8·63	1,907	—
Newcastle-on-Tyne Corporation	Jan. 1	4,110	3,813	+ 297	— 1,301	60½	59½	,, 31	211,085	46,203,164	4,411,745	1·10	11·48	3,504	6·36
Newport (Mon.) Corporation	Oct. 9	663	638	+ 25	— 311	14½	14½	,, 31	35,531	8,174,003	798,029	1·04	9·89	2,450	7·21
Oldham Corporation	Jan. 24	1,778	1,516	+ 262	— 386	—	—	—	—	—	—	—	—	—	—
Portsmouth Corporation	Oct. 10	2,046	1,809	+ 237	—	28½	28½	Mar. 31	97,741	21,247,048	2,309,439	1·10	10·15	—	—
Reading Corporation	Jan. 6	599	590	+ 9	— 57	13½	13½	,, 31	32,769	7,933,572	915,481	—	8·93	—	4·65
Rochdale Corporation	Dec. 26	1,240	1,126	+ 114	+ 746	20·9	20·93	,, 31	56,558	10,196,148	1,252,925	1·32	10·83	2,693	6·47
Rotherham Corporation	Feb. 4	555	587	— 32	—	—	—	—	—	—	—	—	—	—	—
Salford Corporation	Sept. 27	4,596	4,662	— 66	— 3,326	78	74½	Mar. 31	244,065	45,771,611	5,486,150	1·25	10·67	3,185	—
Scarborough Tramways Co.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Sheffield Corporation	Jan. 2	6,742	5 536	+1,206	+ 3 631	39½	37	Mar. 25	289,745	17,568,686	7,065,380	·896	9·842	4,225	5·04
Southampton Corporation	Dec. 29	1,090	831	+ 259	— 173	18	18	,, 25	52,647	10,121,887	1,157,451	1·25	11·33	—	7·30
Southend-on-Sea Corporation	Aug 21	995	557	+ 438	+ 1,483	—	—	—	—	—	—	—	—	—	—
Stockport Corporation	—	—	—	—	—	25	25	Mar. 31	52,004	9,155,172	1,335,911	1·34	9·342	1,830	4·75
Sunderland Corporation	Jan. 27	1,310	1,336	— 26	— 7,984	—	—	—	—	—	—	—	—	—	—
Swindon Corporation	Dec 11	126	114	+ 12	—	—	—	—	—	—	—	—	—	—	—
Torquay Tramways	Aug. 26	630	647	— 30	—	8·41	—	Dec. 31	15,065	2,880,420	353,297	1·40	1·023	—	—
Wallasey U.D.C.	Jan. 8	832	817	+ 15	+ 808	12·68	12·45	Mar. 31	43,823	8,331,038	891,540	1·2	11·79	3,453	7·72
Warrington Corporation	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
West Ham Corporation	D c. 23	2,541	2,616	— 74	+ 5,066	27	14·7	Mar. 31	122,881	35,502,836	2,556,854	·789	10·95	4,417	6·79
Wolverhampton Corporation	Nov. 3	841	823	+ 18	— 206	21¾	—	,, 31	44,432	9,440,369	975,714	—	10·929	2,190	6·509

a Train Miles. *h* Half-year's figures.

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NOTES.

DYNAMOMETER WATTMETER.

Dr. Charles V. Drysdale has contributed a remarkable paper on "The Theory of the Dynamometer Wattmeter," which will appear in due course in the Institution's proceedings. He observes that although much has been written on the instrument, "no very complete theory of its errors has been given, notably as regards the effects of eddy currents and wave-form," which has induced him to go into the matter very fully. He traces error to four causes: Reactance in the shunt circuit; mutual induction between the coils; eddy currents induced by the main or shunt coil fields in masses of metal or in the material of the coils; electrostatic attraction between the coils. The last, he points out, can always be eliminated by connecting the instruments so that there is no appreciable difference of potential between the coils. He works out at considerable length the whole theory step by step, and gives formulæ for detecting and correcting errors. Finally, Dr. Drysdale arrives at the conclusion that "a wattmeter which is free from eddy currents, and in which the resistance exceeds 1,000 ohms per millihenry of equivalent shunt inductance, will never have an error of more than 0·001 in the power factor under practical conditions. As the above condition is very easily secured," he continues, "with ample torque and small power consumption, it may be concluded that a well-made dynamometer wattmeter is superior to any other device for alternate-current power measurement."

RUBBER FOR ELECTRICAL WORKS.

How are we to test rubber for insulating purposes in electrical work? Purely electrical tests, as Professor A. Schwartz declared in his paper before the Manchester Local Section of the Institution, will not suffice. This is easily understood when we remember that the qualities that are required in a good sample of rubber are: Elasticity, compressibility, extensibility, tenacity, flexibility, adhesiveness, resistance to certain chemical agents, impermeability to water, solubility in certain liquids, as well as high resistance and dielectric strength. It is true that we rarely require all these qualities at once, but a combination of two or more is generally necessary, and certainly insulating power involves several of these qualities. We must go beyond electrical tests to arrive at a satisfactory idea of the persistence of the phenomena looked for, and this involves both physical and chemical tests. As Professor Schwartz says, the physical tests deal with effects, the chemical tests show us causes. Therefore, the physical tests are those which more directly concern the purchaser and user. Great care is required not only in the carrying out of such tests, but in the preparation of samples. The lecturer uses an ingenious hysteresis machine which he fully describes in his paper, showing how adaptable it is for rubber of all qualities and for all purposes. He comes to the conclusion that the points which a satisfactory physical test should ensure would seem to be the following:

(*a*) The employment in the mixing of a given percentage of rubber of a quality that shall not fall below a given standard.

(*b*) The restriction of the employment of recovered rubber and substitute within limits as to both quantity and quality.

(*c*) The degree of vulcanisation imparted.

(*d*) The character of the mineral filling used.

While the Professor thinks it would be hopeless to expect any one test to fill all the above requirements, he holds that the necessary tests can be carried out on the hysteresis machine on the following lines:

1. The hysteresis loop for a given trade of covering to lie within certain limits as to load, extension, and area.
2. The hysteresis loop after the specimen has been heated under specified conditions as to time and temperature should not vary from the loop under (1) by more than a specified amount.
3. The increments of extension for successive cycles to fall within specified limits.

The discussion on this paper is reported elsewhere.

SILVER-COPPER DEPOSITING.

Mr. Samuel Field, of the Royal College of Science and the Northampton Institute, in pursuing his investigations in the conditions which determine the composition of electro-deposited alloys, made a lengthy series of experiments connected with silver-copper depositing. Both of these metals are electronegative as compared with zinc, and it might be anticipated that the deposition of the two metals together would proceed normally in a cyanide solution, but it was found that this was not so under all conditions. Mr. Field reminds us that according to Gore copper is positive to silver in most solutions, but not in hydrofluoric acid or ammonia. Oswald found that the P.D.'s between the metals and normal solutions of their salts was copper—0·60 volt; silver—1·01 volt. Nevertheless, close as are these two metals in the electrochemical series, the above solutions are not equivalent in respect to ions, for silver is more freely dissociated. In cyanide solutions, however, there are only relatively small amounts of the metal ions. For this reason Mr. Fieldadopted a solution of double cyanide of silver and copper, with potassium cyanide containing 25 grains of each metal per litre. After a long and instructive series of experiments, the investigator came to the conclusion that while copper and silver are apparently so close on the electrochemical scale, yet the difference between them is very marked. For instance, in the case of these salts as sulphates and nitrates, it is found that there is an enormous preponderance of copper, yet silver can be deposited out at moderate current densities with barely a trace of copper showing. The same conditions obtain, he says, for copper and zinc in their sulphates or nitrates, but, whereas copper and zinc are most readily deposited together from solutions of their double cyanides, there seem to be only very narrow limits between which the same laws apply to copper and silver. In both cases, an excess of potassium cyanide renders simultaneous deposition more difficult.

MUNICIPAL ELECTRICITY.

Belated as are the Local Taxation Returns for England and Wales for 1906-7, dealing with the finances of corporations other than the City of London and Metropolitan Boroughs, they afford important matter for consideration. We find that the amount of money borrowed and expended on tramways came to close upon twenty-one and a quarter millions sterling, and on electricity works to very nearly twenty millions and a half sterling. The total revenue from the four trading undertakings (tramways, electricity, gas and water), was £17,875,000, and the expenditure £16,666,000, leaving a very nice little profit. But water supply does not pay. The actual surplus from tramways was £482,000, from electricity works £172,000.

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Part of these surpluses were placed to reserve or used in extensions, the remainder went in relief of rates. But, of course, it is not every concern that pays. As a matter of fact some tramways had to be helped from the rates, to the total amount of £52,900, but £388,600 went to diminish rates from this source. As regards the electricity undertakings the respective sums were £26,800 and £90,900. When the time comes it will be found that this has been steadily improved upon.

UNEXPECTED RADIO-TELEGRAPHIC RECEIVING STATION.

Our contemporary, the *Revue Industrielle*, gives an amusing and somewhat startling account of how "wireless" messages were unintentionally intercepted. At a certain establishment, we are told, it was remarked that the light from a suspended arc lamp fluctuated strangely. It was then observed that the fluctuations corresponded to variations represented by the Morse code, and it was found that the lamp had become the receiver of a distant radio-telegraphic station. As the sound emitted by the lamp varied in exact ratio with the fluctuations of the light emitted, it was easy for anyone conversant with telegraphic practice to read the messages without the assistance of delicate antennæ or other complicated appliances. If such phenomena are constant, and not a mere freak of observation, they certainly deserve study, for this kind of unintentional interception is decidedly awkward.

RAIN AND ELECTRICITY.

In view of what our Berlin correspondent says about electricity in agriculture, Dr. G. C. Simpson's expression of opinion before the Royal Society, that in all probability the earth was a source of negative electricity, is of interest. Another point was connected with the Doctor's experiments on the nature of the electricity in rain and snow. Observations which he had made at Simla with regard to the electricity of rainfall showed that rain brought down more positive electricity than negative electricity. According to the previously received theory the very opposite ought to have been the case, and therefore some doubt had been expressed on the subject. Recently, however, he had received communications from Potsdam and Vienna giving an account of investigations in those cities which confirmed his conclusions. It was well known that negative electricity was always leaving the earth. How then did it get back if not in the rainfall? In meteorological language, it looked as though the earth itself was a source of negative electricity, which was always coming from it and going into space.

ELECTRICAL ENTERPRISE IN AUSTRALIA.

Mr. J. D. Gillan, Electrical Engineer to the Victorian Public Works Department, has been discoursing on local State legislation in matters electrical. There are twelve Acts in force. For the most part these Acts are based on the English Acts, but some of the clauses have been made more stringent. Orders are only available for 30 years, whereas in England the term is 42 years. Beofre a company can supply electric current to consumers it must obtain an order through the municipality, and this necessitates a poll of the ratepayers. In the case of large country shires, sparsely populated, this entails considerable expense, and amended regulations will probably be brought before Parliament this year. The Tramways Act provides for the issue of orders to municipalities, and gives authority for their powers to be delegated to companies; but the most satisfactory procedure is to secure authority by a special Act of Parliament. Strictly speaking, the Act only allows an electrical installation without an order when current is not distributed beyond the boundaries of the premises on which it is generated; but, with the Ministers' consent, wires can be carried across public thoroughfares to branch works, and such like, so long as the current is not sold.

OBSTRUCTIVE REGULATIONS.

Mr. Harper, the Melbourne City Electrical Engineer, mentioned that when the City Council endeavoured to make a different charge for power and lighting there was opposition from the Gas Co., and it was necessary to get the Act amended. Also, when the maximum demand charge was instituted it was contended to be an infringement, and a lawsuit followed. Finally, both the High Court and the Privy Council took a broad view of the case and held that the law could only step in where "undue preference" was shown. In N.S.W. there is no Electric Light Act, so that the Sydney Council has not the restrictions to contend with that there are in Melbourne. Another criticism was levelled at the Coal Mines Bill before Parliament, which gives authority to the State to generate and dispose of electricity. The Bill specially exempts the State from the regulations of existing Acts. He holds that it is incumbent on all undertakers to watch this Bill, as there is nothing to prevent the Government competing with those who are compelled to work under the Act.

"A 2,750 D.C. SYSTEM."

Mr. M. Farrer, A.M.I.E.E., resident engineer of the Twickenham and Teddington Electric Supply Co., Ltd., writes to us: "With reference to the article in your issue of December 31, 1909, entitled, 'A 2750 Direct Current System,' I would like to point out that although the writer of the paper claims to have been a witness of certain of the incidents he describes in connection with the working of the H.T. switchgear, I have no knowledge whatever of Mr. Barringer and certainly no one of that name has ever worked in the station. The author has evidently obtained his information second hand, which may, perhaps, account for some of the exaggerations and errors in an otherwise well written paper. My object in writing is to assure you that, though we have our troubles, like other undertakings, we do not lead quite such a strenuous life as Mr. Barringer would make his readers to believe."

GAS ANALYSIS BY ELECTRICAL METHODS.

Dr. A. Koepsel has invented an apparatus now put upon the market by the firm of G. A. Schultze, Charlottenberg, Berlin, for determining the composition of a gaseous mixture by estimating its resistance. The apparatus is said to be specially applicable to the determination of the amount of hydrogen in water-gas and of carbon dioxide in flue gases. The principle of the method is to employ a constant current to heat a wire passing through a tube filled with the gas to be analysed. It is obvious that the temperature of the wire will vary inversely as the conducting power of the surrounding medium, and it is said that it affords a good means of ascertaining the quantitative composition of a mixture when it is known what gases are present, and when the temperatures attained in mixtures of known quantitative composition have been previously ascertained. We may remark that there is one great difficulty. The conducting power of all gases except hydrogen is very low, they differ therefore by small quantities. Hence reliable results must depend upon great accuracy in the measurement of the temperature of the wire. This is presumably estimated from its resistance, and it is doubtful whether it can be determined sufficiently exactly.

TWO EXHIBITIONS.

Two exhibitions are announced for this year which should have a close connection with electrical engineering.

At Manchester, an Industrial Exhibition is to be held from May 12 to June 25 in the new exhibition buildings now in course of erection. This undertaking is being organised by the International Trade Exhibitions, Ltd., of Broad-street House, London, E.C., already favourably known in connection with the Electrical Exhibition held at Manchester in 1908. There will be numerous sections, those most closely concerning us being the lighting, ventilating, and heating, and machinery as applied to industries.

The second is a Naval, Mercantile Marine and Engineering Exhibition, to be held at Olympia, West Kensington, from August 31 to September 24, which is being organised by Mr. F. W. Bridges. It will include sections of electrical apparatus (power, light, telegraph, and telephone); marine engineering; gas, steam and oil engines; lifts and lifting appliances; river and lake craft (including electric launches); transport plant; light railway and tramway permanent way and rolling stock; and inventions.

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ELECTRICITY AND GAS AT HASTINGS PIER.

By E. KILBURN SCOTT.

At the shore end of St. Leonard's pier there is an engine house about 15 feet cube, containing two 13 kw. direct current generating units, each consisting of a Crossley four-cylinder vertical engine running at 750 r.p.m. driving a dynamo by the Phœnix Dynamo Co., of Bradford. The dynamo gives 210 volts, and about 5,000 metallic filament lamps are already connected two in series, and about as many more are to be added shortly.

The story as to why the Pier Co. has its own generating plant is quite interesting. It appears that the Hastings Corporation was approached for a special quotation for current for 5,000 lamps, and the price quoted was 6½d. a unit, the same as for customers in the town. (It should be mentioned that the theatre and hippodrome get it for 4½d.).

At the same time the Hastings Gas Co. was asked what they could do, and their offer was to lay down the two gas engine dynamo sets above mentioned, to run them and supply current at 1½d. a unit. The offer stands for four years, but it is so profitable, even at 1½d. a unit, that there is every probability of the Pier Co. buying the plants and running them themselves before the four years are up.

From what the writer could gather, to run the two generating sets on a total load of 120 amps. at 210 volts for one hour costs 2s. 2d. for gas, the price of gas being 2s. 10d. a thousand, the same as for customers in the town.

The writer was particularly pleased with the appearance of the generating sets. The gas engines are entirely enclosed, similar in design to a petrol engine, indeed, they can if necessary be run with petrol, the ignition is low tension, and there is no trouble whatever with the governing. If one of the cylinders fails temporarily, the attendant just gives the other three a richer charge, and they take the full load quite easily.

Starting is done by a "Swape" handle just as for starting a motor-car engine. The engine cylinders are cleaned out once a fortnight, and for convenience of removal the gas is lead from the gas-bag by four armoured rubber pipes 1½ in. diameter, which can be moved right out of the way when cleaning is in hand.

There are no arc lamps, the big lights at the ends of the pier being Sugg's and Keith's high-pressure gas lamps. To give the necessary pressure of about 24 inches, two small gas engines and pumps are installed.

This Hastings Gas Co. is quite an uncommon one, as the officials do not waste time arguing about gas *versus* electricity, but they just "butt" in and supply both. The gas works at Bexhill has quite a nice electric generating station for supplying light and power to the gas works and for charging accumulators for outside customers, etc.

In some of the rooms it would be dangerous to use gas lights, so the company doesn't worry along with safety lamps, but, like sensible folk who want to make dividends and live a reasonably quiet life, they install the *safe* electric incandescent. Also, as a good deal of water is required in, or on, or somewhere about the retorts, they have installed electric pumps to put it there.

Nor is this all, the gas company has quite a large staff of electric wiremen, and they execute a fair amount of the electric wiring work of Hastings. The Corporation Electric Light Co. doesn't like it, but they have to "lump" it, for the work is really well done; the Gas Co. see to that. One of their jobs was the whole of the electric wiring of the pier.

As the Hastings Municipal Electric Light Department doesn't pay, perhaps the best thing to do would be to hand it over to the Gas Co. to run for them at a rental. Judging from what the writer has heard of the management of the Gas Co., they will soon knock out some dividends.

ARC LAMP PATENT DISPUTE.

The Gilbert Arc Lamp Co., Ltd., ask us to state, with reference to the notice of opposition against Mr. C. E. G. Gilbert's Patent, No. 27303, of 1908. by Mr. H. P. Bleckly, of the Abbey Electrical Co., recently published in the electrical technical journals.

DETERMINATION OF THE MOMENT OF INERTIA OF A CONTINUOUS CURRENT ARMATURE.*

By DR. GISBERT KAPP.

For the experimental analysis of frictional and other losses by the so-called "running-out test" the knowledge of the moment of inertia of the armature is required. There are two well-known methods for determining this: one by the addition of a fly-wheel of known moment of inertia, the other by the application of a brake of constant and known torque. In the first method the running-out time is lengthened, in the second it is shortened. In so far the first method is preferable as being less liable to errors of observation which are likely to arise when readings of time and speed have to be taken very quickly. On the other hand, the preparation of a special flywheel is costly, and its weight may alter the frictional resistance in the bearings, so that to eliminate this new source of error one is obliged to prepare two pieces, one the flywheel proper of such shape as to give a maximum moment of inertia, and another of equal weight, but so shaped that its moment of inertia shall be as small as possible. Apart from the expense, there is the limitation that the method is only applicable if there is room on the shaft for a flywheel. This limitation also applies to the brake method, though the expense of rigging up such a brake is much smaller than that for a flywheel and its counterpart. Where there is no room on the shaft either for a flywheel or a brake pulley, neither method is possible, and then the running-out test cannot be used for the analysis of losses.

In the following I shall describe a method for finding the moment of inertia by making a running-out test without interfering in any way with the machine mechanically. The method has also the merit of requiring no special apparatus and being, therefore, inexpensive. The leading feature of this method is to substitute electrical for mechanical action, but before entering into details it will be useful to say a few words about the two orthodox methods.

Brake Method.—Round the shaft itself, or preferably round a small pulley on the shaft, is laid a composite band consisting of a strip of leather, to which is joined a very thin strip of metal. Both ends are weighted, the larger weight being put on to the end of the metal strip, and the band is laid over in such way that the friction between band and pulley tends to lift the larger weight. The higher it is lifted the smaller becomes the arc spanned by the leather and the larger that spanned by the metal strip. Since the friction of the leather is the greater, the tendency to lift the large weight diminishes as the weight rises, and thus the system has a condition of equilibrium, and exerts a constant retarding torque on the shaft. This torque is the product of the radius of the pulley and the difference between the two weights. To make the test accurate, the brake torque should be of about the same order of magnitude as the retarding torque of journal and brush friction, and thus the running-out time, which for convenience and accuracy of observation is none too long to begin with, is by the addition of the brake considerably shortened. To make a reliable test by this method requires, therefore, considerable skill.

Flywheel Method.—Since by this the running-out time is lengthened, the attainable accuracy is greater. The flywheel is generally prepared in the form of a plain solid disc, preferably of boiler plate, because the moment of inertia of such a body can be accurately calculated from its diameter and weight. It is equal to that of half the mass concentrated in a point on the circumference. Let W be half the weight of the disc in kilogrammes and r the radius in metres, then the moment of inertia is—

$$I = \frac{W}{9{\cdot}81} r^2 \quad . \quad . \quad . \quad . \quad . \quad (1)$$

and the power in watts corresponding to a speed gradient of $\frac{du}{dt}$ is—

$$P = 9{\cdot}81\, 4\, \pi_u^2\, I \frac{du}{dt} \qquad P = 388\, u\, I \frac{du}{dt} \quad . \quad . \quad . \quad (2)$$

* Original communication to the Institution of Electrical Engineers.

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where u is the speed in revolutions per second and t the time in seconds. To make the test in the usual way, we have to prepare the disc flywheel of large diameter and its counterpart, which may conveniently be a long cast-iron cylinder of equal weight. Its diameter is very much smaller, and the two moments of inertia will be in the proportion of the squares of the diameters.

The disc shape has only been adopted because the moment of inertia can easily and accurately be calculated, but if we had another means of finding it, the shape of the flywheel would be immaterial. Any existing flywheel or heavy pulley could be used, provided it will stand the centrifugal stress; and we are able by a simple preliminary experiment to determine its moment of inertia. This may be done by suspending the wheel bifilarly or trifilarly with its axis vertical, and observing the time of swing round the axis. Let l be the length of the suspension (thin steel wire cables may conveniently be used) and a the distance of each of the suspending wires from the axis of the wheel, then the time of a complete period is

$$T = 2\pi \sqrt{\frac{I\,l}{W\,a^2}},$$

l and a being given in metres. From this expression we deduce—

$$I = \frac{91\,a^2 W}{n^2\,l}, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

where n is the number of complete periods gone through by the swinging system in one minute.

The expense of preparing a special flywheel may thus be saved by using any kind of wheel and swinging it on a bifilar or trifilar suspension. The counterpart of equal weight must, however, be specially prepared, and its moment of inertia determined either also by bifilar swinging, or if it is a plain cylinder, by calculation. In high-speed journals where the specific pressure is small, the frictional resistance is almost independent of small variations of specific presure, so that the expense of preparing a counterpart need not be incurred. To make the treatment general, I assume, however, that a counterpart is used.

Let I be the moment of inertia of the armature alone, I_1 that of the flywheel, and I_2 that of the counterpart, then by making a running-out test first with the flywheel

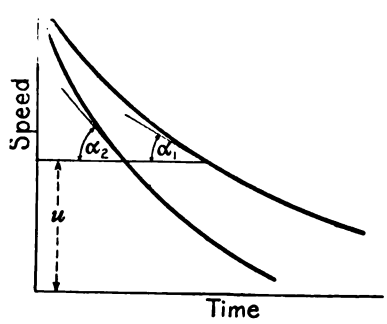

Fig. 1.

and then with the counterpart we obtain the two time-speed curves, as shown in Fig. 1. For any particular speed u we have two equations, namely—

$$2\,\pi\,u\;61{\cdot}6\;(I \times I_1)\;tg\;a_1 = F\,u \times L \quad . \quad . \quad (4)$$
$$2\,\pi\,u\;61{\cdot}6\;(I \times I_2)\;tg\;a_2 = F\,u \times L \quad . \quad . \quad (5)$$

where F u denotes the frictional loss in watts and L all the other losses (hysteresis, eddy currents, and windage) at that particular speed and excitation. If the machine is non-excited during the running out test, then L is merely the windage loss.

The moment of inertia of the armature is—

$$I = \frac{I_1\,tg\,a_1 - I_2\,tg\,a_2}{tg\,a_2 - tg\,a_1} \quad . \quad . \quad . \quad . \quad . \quad (6)$$

Since I is now known we can, from (4) or (5), determine F u × L, and if the curves in Fig. 1 refer to the non-excited machine, also F u alone, since for very low speeds the windage loss is negligible. Thus the value of F may be determined, but only for this particular low speed. Dettmar has found experimentally * that F may be considered as approximately proportional to the square root of the speed. The friction and windage loss may then be be expressed by F $u^{1.5}$ × V u^v, where L = V u^r represents windage loss, which is proportional to u^r. By

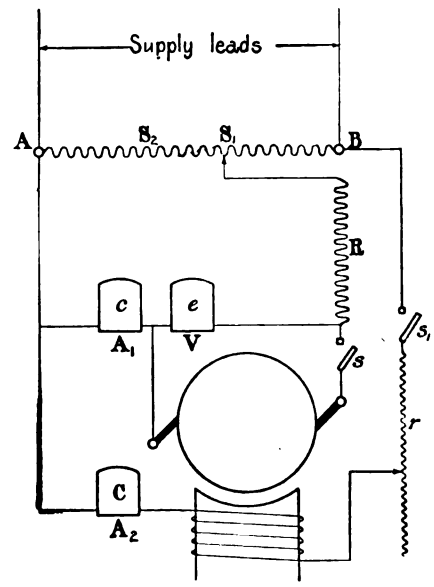

Fig. 2.

analysing the running-down curves of various machines, I have found the exponent v to lie between 2·2 and 2·5. The magnetic losses can be determined in the well-known way by making other running-out tests with the machine excited, though for this purpose the electrical methods developed by Mr. Housman, Mr. Dettmar, and the author for the separation of losses are preferable.

I shall now describe the new electrical method, not for the separation of losses, but merely for the determination of the moment of inertia of the armature. The machine is run light as a motor, the connections to the constant voltage supply mains being made as shown in Fig. 2. A B is a main current regulator, and R a resistance, the value of which need not be accurately known. The field is magnetised from the mains, and the excitation is regulated by a rheostat r. The ampere-meter A_2 measures the exciting current C, which should be kept as low as possible for full speed and a reasonably small armature current c, which latter is measured on the amperemeter A_1. The voltmeter V indicates the brush voltage e, and this for a low armature current may be taken as equal to the induced voltage, so that the product $e + c$ represents at any moment the power given out or taken in by the armature. If the switch s is left closed and the slider on the main current regulator be run back to point A, then the inertia of the armature will be the source of power not only to cover the normal losses, but also the ohmic loss in R. It will, therefore, very quickly come to rest, and a test made on these lines would be open to the same objections as mentioned above in connection with the brake test, and, in fact, even more so, because the speed-time line would be

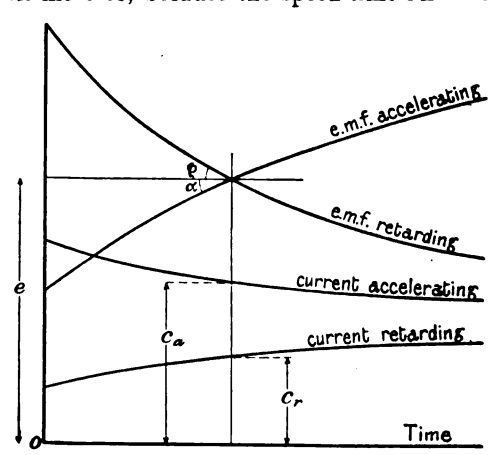

Fig 3.

still steeper. But if we set the slider on the main current regulator some distance from A, so that the armature receives power electrically, then we can prolong the time

* Arnold, *Die Gleichstrom*, Maschine i., p. 496.

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of running out to any desired degree and thus obtain any desired slope on the retardation curve. This permits of longer intervals being used between the readings and a correspondingly greater degree of accuracy. The excitation is kept constant throughout the test so that, apart from a slight correction for armature and brush contact resistance (which can easily be made if desired), the brush voltage is proportional to the speed, or—

$$e = u\,\beta,$$

where β is a coefficient depending on the excitation, and is determined once for all by taking a speed and E.M.F. reading when the machine is running steadily.

Let L now represent all the losses at a particular speed u, then the power equation for that speed is—

$$e\,c = \mathrm{L} + 2\,\pi\,u\,\mathrm{I}\,2\,\pi\,\frac{d\,u}{d\,t}\,9{\cdot}81,$$

$$e\,c = \mathrm{L} + 4\,\pi^2\,9{\cdot}81\,u\,\mathrm{I}\frac{d\,u}{d\,t},$$

$$e\,c = \mathrm{L} + \frac{388}{\beta^2}\,e\,\mathrm{I}\frac{d\,e}{d\,t} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (7)$$

By manipulating the main current regulator, or simply a rheostat put in series with the armature, which can be lengthened and shortened so as to slow down or speed up the machine, we can make two runs at the same excitation —one to get retardation, the other to get accelleration of the armature. By plotting the observed voltage and current against time, we get the curves shown in Fig. 3. Let e be the E.M.F. at the crossing-point and let the corresponding values of the currents be c_r for the retardation curve and c_a for the acceleration curve. The tangents to the curves for e at the crossing-point give the volt gradients, that for the retardation curve being negative. We thus get the following equations :—

$$e\,c_r = \mathrm{L} - \frac{388}{\beta^2}\,e\,\mathrm{I}\,tg\,p \quad . \quad . \quad . \quad . \quad . \quad (8)$$

$$e\,c_a = \mathrm{L} + \frac{388}{\beta^2}\,e\,\mathrm{I}\,tg\,a \quad . \quad . \quad . \quad . \quad . \quad (9)$$

and deducting (8) from (9) we have—

$$c_a - c_r = \frac{388}{\beta^2}\,(tg\,a + tg\,p)\,\mathrm{I}$$

$$\mathrm{I} = \frac{\beta^2}{388}\,\frac{c_a - c_r}{tg\,a + tg\,p} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (10)$$

The special case that $p = 0$ and the retardation curve is a straight line means that the machine is running steadily, taking c_0 ampere to drive itself. In this case we have—

$$\mathrm{I} = \frac{\beta^2}{388}\,\frac{c_a - c_o}{tg\,a} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (11)$$

Thus the test is reduced to one steady run at e volts, by which β and c_0 is found, and an acceleration run during which observations of voltage and current as a function of the time must be taken. The observations need, however, only be taken over a limited range from a little below e to a little above e; only sufficient to draw the tangent to the E.M.F. time curve accurately.

I have tried this method on machines up to 30 k.w. and found it reliable, that is, the values of I obtained by it were in accord with the values obtained by the brake method. The electrical method would seem to be specially advantageous for large flywheel sets and large machines generally, where an extra flywheel or a brake would be impracticable.

ELECTRICAL STANDARDS OF MEASUREMENT.

An Order in Council was issued on the 10th of January under the provisions of "The Weights and Measures Act, 1889," revoking the Order in Council dated the twenty-third day of August, 1894, approving the several denominations of standards as new denominations of standards for electrical measurement. In the Schedule attached thereto the limits of accuracy attainable in the use of the said denominations of standards are stated as follows :—

For the Ohm within one hundredth part of one per cent.

For the Ampere within one tenth part of one per cent.

For the Volt within one tenth part of one per cent.

The new Order sets forth that since then an International Conference on Electrical Units and Standards held in London, whereat the denominations of standards were defined as follows :—

The International Ohm is the resistance offered to an unvarying electric current by a column of mercury at the temperature of melting ice 14·4521 grammes in mass of a constant cross sectional area and of a length of 106·300 centimetres.

The International Ampere is the unvarying electric current which when passed through a solution of nitrate of silver in water deposits silver at the rate of 0·00111800 of a gramme per second.

The International Volt is the electrical pressure which when steadily applied to a conductor whose resistance is one International Ohm will produce a current of one International Ampere.

The Board of Trade, deeming it to be desirable that the denominations of standards for the measurement of electricity should agree in value with the International Electrical Units within the limits of accuracy attainable. A new Schedule, as annexed, has been issued :

"SCHEDULE ABOVE REFERRED TO.

"*I. Standard of Electrical Resistance.*

"A standard of electrical resistance denominated one Ohm agreeing in value within the limits of accuracy aforesaid with that of the International Ohm, and being the resistance between the copper terminals of the instrument marked 'Board of Trade Ohm Standard Verified, 1894 and 1909,' to the passage of an unvarying electrical current when the coil of insulated wire forming part of the aforesaid instrument and connected to the aforesaid terminals is in all parts at a temperature of 16·4 c.

"*II. Standard of Electrical Current.*

"A standard of electrical current denominated one Ampere agreeing in value within the limits of accuracy aforesaid with that of the International Ampere and being the current which is passing in and through the coils of wire forming part of the instrument marked 'Board of Trade Ampere Standard Verified, 1894 and 1909,' when on reversing the current in the fixed coils the change in the forces acting upon the suspended coil in its sighted position is exactly balanced by the force exerted by gravity in Westminster upon the iridioplatinum weight marked A and forming part of the said instrument.

"*III. Standard of Electrical Pressure.*

"A standard of electrical pressure denominated one Volt agreeing in value within the limits of accuracy aforesaid with that of the International Volt, and being one hundredth part of the pressure which when applied between the terminals forming part of the instrument marked 'Board of Trade Volt Standard Verified, 1894 and 1909,' causes that rotation of the suspended portion of the instrument which is exactly measured by the coincidence of the sighting wire with the image of the fiducial mark A before and after application of the pressure and with that of the fiducial mark B during the application of the pressure, these images being produced by the suspended mirror and observed by means of the eyepiece.

"In the use of the above standards the limits of accuracy attainable are as follows :—

"For the Ohm, within one hundredth part of one per cent.

"For the Ampere, within one tenth part of one per cent.

"For the Volt, within one tenth part of one per cent.

"The coils and instruments referred to in this Schedule are deposited at the Board of Trade Standardizing Laboratory, 8, Richmond-terrace, Whitehall, London."

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ELECTRODEPOSITION OF METALS.*

By FREDERICK MOLLWO PERKIN and WILLIAM EARL HUGHES.

In the following note it is proposed to give a short account of an extended series of experiments carried out in order to ascertain the most efficient form of apparatus for the electrodeposition of metals. Part I. deals with the form of apparatus, and Part II. describes how the apparatus finally adopted can be used, not only most efficiently for the rapid deposition of metals, but also to obtain single electrode potentials. It was originally our intention to publish this more fully, but owing to the circumstances we are unable at present to continue it, consequently we think it advisable to publish a short account of the work so far as it has been carried out.

In 1906 one of us described "A Simple Form of Rotating Electrode for Electrochemical Analysis" (Trans. Faraday Society, ii. 91). It consisted of a spiral of platinum used as the cathode which was rapidly rotated within another wider spiral of stout platinum wire serving as anode. For small quantities of metal this electrode yielded very good results, and the deposition could be carried out very rapidly. Further experiment showed, however, that when large quantities of metal were contained in the solution there was a tendency for the deposit to be powdery and non-adherent in form. It was supposed that this was due to the high current density upon the outward surface of the electrode and the very small density upon the inner parts of the spiral. In fact, the bulk of the metal was invariably deposited upon the outer surface of the wire, the inner surface often being quite free from deposit.

Experiments were therefore instituted with a view to finding a more serviceable electrode. It consists of sheet platinum spun up so as to form a narrow thimble, the upper end being open and having a stout iridio-platinum wire fused on to it by means of three short wire supports. This electrode is fixed into a small chuck, and rapidly rotated by means of an electromotor, the speed of rotation usually being from 750-950 revolutions per minute. When in use about two-thirds of the length of the thimble is dipped into the electrolyte, the active surface being about 16·3 sq. cm. If dipped too deeply into the solution there is a tendency for the liquid to splash into the interior of the cylinder, and this would, of course, lead to erroneous results.

For some time we employed an anode of stout platinum wire with this thimble cathode, but it was found that there was a tendency for the deposits to be mottled and streaky. This was particularly the case with cobalt. With this metal the deposit was of a light and dark velvety appearance, although absolutely adherent. The dark parts followed the anode wire in the direction of the cathode. We therefore substituted a cylinder of platinum gauze of very fine mesh; with this a practically uniform surface density was obtained, the only place where it was somewhat lower was on the rounded end of the thimble, but as the rounding off is gradual there is no abrupt change, and the deposit is quite adherent. At the very central point of the end there is practically no deposit at all.

If desired, this electrode can be employed, in which case the gauze cylinder functions as cathode.

With the thimble electrode as cathode the following, as one of a large number of determinations for cobalt, will serve as an example. The phosphate solution of Perkin and Prebble was used (Trans. Faraday Society, i. 103):—

Current Density per Sq. Cm.	E.M.F. (in Volts)	Revs. per Minute.	Time.	Co Present (in Grm.).	Co Found (in Grm.).
0·0-2·16	4·2-8·9	750-800	10 min.	0·03735	0·03740

The deposit was bright and metallic and satisfactory in every respect from an electrochemical point of view. When the metal was deposited on the gauze electrode even more satisfactory results were obtained.

Although the combination of rotating thimble anode and gauze cathode was very satisfactory, still we thought that possibly better results might be obtained if greater agitation of the electrode could be secured, and this proved to be the case. On substituting a closely wound spiral of iridio-platinum wire for the thimble electrode we obtained a much greater agitation of the electrolyte and a still more brilliant deposit on the gauze, even with very high current densities.

The following two numbers taken at random from a large number of experiments will serve to illustrate the cases:—

Current Density per Sq. Cm.	E.M.F. (in Volts)	Time.	Revs.	Co Present (in Grm.).	Co Found (in Grm.).
I. 0·04-0·06-0·07	4·3-8·2	10 min.	750-850	0·03735	0·03730
II. 0·02-0·04-0·117	4·4-8·6	8 „	750-850	0·03735	0·03725

Larger quantities can readily be deposited in approximately the same space of time. It is the traces which are always the most difficult to remove. This apparatus has been used with satisfactory results in a large number of determinations of different metals during the last two years.

In the experiments the current was commenced at the lower number, and then within 2, 3, or 5 min. raised to the highest as indicated by the index numbers.

In the case of copper the following numbers were obtained, starting with a high current. The actual amount of copper in the solution was 0·1265 grm.:—

Current.	Deposit.	Time.
Amp.	Grm.	Min.
5	0·1262	14
5	0·1264	10
5	0·1263	30
5	0·1260	10

The vessel for holding the electrolyte was the funnel employed by Price and Judge, and also by Perkin (Trans. Faraday Society, ii. 91). For use in potential measurements we modified the funnel by having a side tube fused into it at about the centre.

From very considerable experience with various kinds of rotating electrodes we consider that the last described combination of anode and cathode is very efficient. It is especially so when used with the glass funnel, because in this case the removal of the electrolyte and subsequent washing of the deposit is an extremely simple matter. We are inclined to think that it is better to rotate the anode and to keep the cathode stationary. This, of course, is particularly the case when potential measurements are to be taken, or when an auxiliary electrode cell is employed to graduate the potential. The whole apparatus with the electrodes and side tube is then exceedingly simple, and it is not expensive.

The modification of the glass funnel for potential measurements, as mentioned above, consists of a side tube fused into the middle of the funnel. The capillary end of the auxiliary electrode cell is inserted down this tube so as to come just at the back of the cathode. The small tube is bent as closely as possible against the side of the funnel in order that the capillary, when in position, may come as near as possible to the back of the cathode.

In our experiments the containing vessel for the electrolyte was combined with the glass cell used by Dr. Sand (Q.J.C.S., 1907, 373), by dipping the capillary tube of the latter into the side tube of the glass funnel. Dr. Sand in making his measurements employed a capillary electrometer. We, on the other hand, have employed a potentiometer with a mirror galvanometer; and with this combination we were able to obtain concordant results. As auxiliary we employed the $\frac{Hg_2SO_4N_2HSo_4}{I}$ cell, the e.m.f. of which, according to Ostwald and Luther, is 0·956 volts. Our connecting solution consisted of 10 N.NH_4NO_3, which is practically a saturated solution. We employed this solution in preference to Na_2SO_4 or KCl, because Dr. A. C. Cumming (Trans. Faraday Society, ii. 213) states that its use gets over the difficulty of liquid contact potential.

With this apparatus we have carried out work on copper and cobalt; using as electrolyte 10 c.c. of a solution of $CuSO_4$, $5H_2O$ of strength, 0·075 grm. per c.c., and 40 c.c.

* Paper read before the Faraday Society, January 18, 1910.

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of water, we obtained a break at approximately 0·55 volts. The addition of 1 c.c. of nitric acid (1·4 sp. gr.) lowered the e.m.f. at the cathode.

In the case of cobalt a solution of the double salt $CoSO_4(NH_4)_2SO_4$, $6H_2O$ was used, the strength of the solution being 0·025 grm. per c.c.; 10 c.c. of it were taken, and then 40 c.c. of a 10% solution of NaH_2PO_4, and 1·5 c.c. of a 5% solution of H_3PO_4 were added. The break in this case occurred at about 0·2 volts.

FACTORY ORGANIZATION.*

By JAMES RIDER (Middlesbrough).

Too many factories have had their usefulness seriously crippled because a definite and complete plan as to their scope, division into departments, location of sections, etc., has not been considered with sufficient care before commencing erection, and consequently the cost of operation has been adversely affected.

All factory organization, sooner or later, resolves itself into a question of expense. It is, therefore, of supreme importance when designing a complete equipment to carefully consider the relation which each section bears to the other, how far the ordinary productive operations can be made to also serve the progress or transport of the manufactured article from one part to another, and particularly to see that as far as ever possible the geographical disposition shall prevent duplicate or unnecessary handling or haulage. In a new and entirely undeveloped business this is extremely difficult, and sometimes impossible, more especially when the business is of a general nature, but in the particular branches of industry with which the members of this society are most familiar, it is possible in a great measure to anticipate and provide for development.

The author has in mind a works which was laid down some 15 or 16 years ago, and in the original plans the possible and probable future extensions of each of seven or eight sections were provided for. Railway sidings, loading docks, warehouses, etc., were all constructed so that when the time came, as it did, for the workshops to be enlarged, everything came into its place without any dislocation of work or increase in expense of transport. Again, the place was laid out so that each separate productive operation automatically brought the article at each stage of manufacture to the point where it was most convenient to handle it, either for loading and despatch as a semi-finished product, or for the next succeeding process. Of course, such planning and provision for the future involves a larger initial expense in purchase of land, but when the interest on the extra first capital cost is set against the economies which invariably follow on cheap handling, the balance of advantage is usually greatly in favour of the bolder and more confident policy.

Taking, for example, a large engineering establishment, making its own castings, etc., obviously it should be laid out so that the pattern shop and foundry are adjacent to each other, whilst the other shops will be so planned that the castings will proceed from bay to bay as each succeeding operation brings them nearer to the completed state, ready either for erection or despatch. Again, the raw material will be brought in so that the various processes through which it passes, and which reduce its gross weight will all help to accelerate its handling. Within reasonable and prudent limits it is false economy to attempt to save first cost in mechanical equipment, particularly in lifting and transport appliances. The labour cost in production is, with scarcely any exception, the most important factor, and anything which increases the labour capacity of each hour, tends to secure economy and low production costs. In cranes and lifting tackle generally, it pays to have everything made so as to deal, at differential speeds, with light or heavy lifts by means of the same machine, and, to take the advice of Mr. Alexander Siemens to the Iron and Steel Institute, whatever is the estimated maximum demand expected to be made on any machine or motor, provide for at least 50% more, and the saving in repairs, wear and tear, depreciation, etc., will more than compensate for the extra cost. Similarly, particular attention should be paid to lighting, and any other provision which will help to secure the safety and physical comfort of the workpeople. Whenever possible roof lighting should be arranged on the weaving shed or sawtooth principle, with a north light, thus avoiding the extreme heat which requently, even in our unkind English climate, involves much discomfort in summer time, and discomfort always means less perfect work. As a point of organization alone, it pays to study the convenience and comfort of employés.

Following these, but really bound up in them, is the provision for stores or general supplies. Too often the store building is detached from the main factory, or is in one corner. It is desirable, if possible, to make this building run along the end of, and at right angles to the various shops of the main factory, making its internal arrangements correspond as far as practicable with each shop, and so secure that the needs of each section are served with a minimum cost of time and labour. Such an arrangement is also more economical in administration than that obtaining in some places where separate store buildings with their separate attendants involve both extra labour and more expensive oversight. A comparatively long, narrow store building, with a small trolley-way running the full length, and, if possible, a light overhead crane, is greatly to be preferred to a central general store with a more or less congested arrangement of bins and racks set in nests behind and around one another.

Having considered the geography of the factory, the next and most important consideration is its administration. To borrow terms used on some of our great railways, this may be divided into two parts—operating and commercial. Operating administration naturally includes works management, and should be strictly defined. The success of a factory depends very largely, but by no means exclusively, on a good works manager, who in his turn is obliged to rely, in matters of detail, upon his departmental foremen and assistants. The works manager's office should be placed so as to give him the best possible oversight of the shops, and each foreman's office should be placed in the particular section under his care. The whole attention of the operating staff, from the works manager down, should be devoted to production, and should not be taken up with details of stores and cost-keeping, which properly belong to the commercial department of the administration. Unfortunately, too frequently, the operating staff look very jealously on the commercial staff, and all too readily assume that the office is always wanting to criticise and find fault with the works. No factory organization can be perfect, or properly successful if there is not a good understanding between works and office, and therefore the importance of removing all office work from the sphere of the operating department will be at once recognised. It is the business of the works to produce at the highest scale of efficiency at the lowest rate of expense, and that is usually quite sufficient to occupy the attention of every works manager and his staff. They receive their instructions from the office, in the case of an ordinary manufacturing concern, through the order clerk, and, in engineering establishments, either through a special orders department or from the drawing office. The importance of the drawing office is not always sufficiently recognised as having a most important bearing on economical and successful production. Just as every salesman should know the needs of the market, so the needs of the shop in every engineering works should be known in the drawing office. This especially applies when new designs of machinery, or parts, are being prepared. It not unfrequently occurs that a draughtsman, through insufficient knowledge of shop tools and appliances, by designs which may be quite in keeping with the complete scheme in hand, but which are not capable of being conveniently and cheaply handled by the machinery available, causes the cost of manufacture to be greatly increased, a result which might have been avoided had he possessed a complete knowledge of the machinery in the shops. Each draughtsman responsible for designs should certainly be fully conversant with all the equipment by which his designs would be carried out. In this connection also, the desirability of close and harmonious working between works and office is apparent. The works can often offer most useful and valuable suggestions to the drawing office, which, if accepted, in the proper spirit, can be turned to great advantage. Whenever possible, junior draughtsmen should receive part of their training in the shops.

* Paper read before the Rugby Engineering Society, January 13.

But the most important factor in works or factory organization is that of cost of production, including the method of obtaining accurate information upon it. This is pre-eminently part of the business of the commercial department, more particularly as regards obtaining and compiling and arranging the records. The cost office is usually part of the accountant's department, and this is very properly so, because it is the duty of the accountant to keep track of all expenditure in labour and material in such a way as to see that the accounts of the same come into agreement with the general accounts of the business. Dealing more particularly with engineering works, production cost is chiefly made up of labour and material, and it is imperative that the records should be accurate and reliable. Dealing first with labour, it is assumed that ordinary care is taken, at a general time office, to obtain exact account of the total time spent on the works by each workman. This total time, however, is sub-divided into a small or large number of parts, depending on the class of work done. There are many systems of time recording, but few which surpass or equal that of the job card, *i.e.*, one card to each job done by the workman. The job may involve only one operation on one article, or one operation on a group of standard articles. Whichever it is, it is desirable to check and distinguish each separate job. It is undesirable to leave too much, or indeed any, recording to the workman himself, and therefore shop clerks are required to see that the records are properly made and kept. In some shops, as a man finishes a job, he takes his time card to the shop time office, and asks for another in exchange. This plan is open to objection, because it involves the necessity of a workman leaving his bench or machine, and may conceivably cause congestion at the shop office. If this method is followed, however, it is better to have more than one office, conveniently placed so as to serve a comparatively small section of the shops, and so reduce as far as possible the amount of time spent by workmen in bringing in their cards. It is much better, however, to employ the same number of time clerks in patrolling the shops, checking the men's cards, and changing them when required. The foreman will appoint the man his work, giving him a ticket, which will contain (as far as possible printed on a standard form) his instructions. The shop clerk will see that this corresponds with the work the man has in hand, and will check the time of commencement and completion. A system of this kind will ensure the largest amount of " running time," or " hourly burden," for each machine. The time cards for each workman will be collected and checked with the main time office records, so as to see that all time booked in the works has been accounted for. For the unfinished work in hand at the close of the week, a new card will be given by the time clerk who collects the cards. Each time card will contain brief details of the work done as well as the time spent, together with the order number, and when the cards are collected and brought into the office, it will be a simple matter to collect all cards applying to a particular job, and so have full labour cost record at hand. The procedure with regard to material will be rather different. Assuming an order is given out for one or a group of standard machines, such order, emanating from the drawing office, should be accompanied with a complete list of all the parts required for each machine, the drawing or print showing the operations required to finish each part. This order will be sent to the work's manager's office, from whence requisitions will be forwarded to the stores for all material required. Some of this may be castings which have to be made, in which case the works manager will send an order to the foundry foreman, who on completion of his order will return it to the works manager, marked as finished, and at the same time send a delivery note on to the machine shop. This delivery note will be in duplicate, one copy being retained by the machine shop foreman, and the other, having been signed by the machine shop foreman to signify his receipt of the costings, will be returned to the foundry foreman, to be filed by him as his voucher for a completed job. Other material may include parts to be supplied from the general stores stock, which will be drawn out by requisitions from the various foremen requiring them; and also parts which may have to be purchased from outside sources. For these the storekeeper will send requisition to the head office, from whence orders will be sent to the outside supplier.

In order to prevent waste and duplication of supplies, each order sent to the works manager should be in duplicate in every detail. One copy will be retained by the works manager, and the other copy will be sent to the storekeeper. As each requisition for material for the particular order is received the storekeeper or his assistant will check it with the original order, and by this means see that no material is called for in excess of that required. If such excess is demanded, then it will be the storekeeper's duty to ascertain the reason, and, if necessary, obtain authority to issue excess. Of course, in the event of castings or other material developing defects when being machined, such defects not having been previously discernible, a statement to this effect on the new requisition will be sufficient to justify excess supplies. It is very necessary, when surplus material remains on hand after completing an order, that such surplus should be returned to the store immediately, and credited to the order against which it had been charged originally. As manufacture progresses, the records of labour and material expended on each order will be received by the costs section of the accountants' department of the factory, and be so arranged as to afford accurate information both as to the rate of progress of manufacture and the cost to date. This information ought to be used continuously in order to ascertain how far actual cost corresponds with estimates, and when so used frequently suggests special attention being given to particular orders at a time and in a way which prevents undue delay and excessive cost in completion. The author, from personal experience and practice, knows that such records as have been referred to can be readily available on a Friday afternoon for all labour and material used up to the previous Tuesday night, and this is quite near enough for all useful purposes. In this connection let it be noted that all these records are actual and definite, avoiding estimates entirely.

In businesses where the production is standardised and there is a great amount of repetition work, it is possible, by a judicious system of grouping, to reduce the account keeping to a minimum without detracting from the utility of the records. Where this appears to admit a possibility of missing changes in costs of individual parts, a check can be easily imposed by occasionally issuing special separate production orders, and taking out individual cost accounts for them. It is only a matter of office accounting, and will not necessitate any modification of works routine.

It will be seen from the foregoing that a careful organized store or stock-keeping system is necessary. This doe not require to be expensive, but much avoidable loss is often caused because sufficient attention is not given to detail. Just as in commercial book-keeping, it is necessary to have separate accounts for each individual customer, however small, so it is equally necessary to have separate records of each article which is of sufficient importance to require keeping in stock. The author has had the opportunity of becoming personally acquainted with many methods of store or stock-keeping, and has reason to believe that sufficient care is not devoted to this part of factory organization. By the judicious use of card ledgers, analysis sheets and similar appliances for making up the accounts, it is possible to always keep the factory well and fully supplied without carrying an excessive stock. Moreover, it is desirable, and indeed necessary, to keep a constant check on stocks. It is surprising how many large concerns still cheerfully submit to the confusion and dislocation of a big yearly or half-yearly stock-taking. Speaking with an actual personal experience of both systems for over 20 years, the author does not hesitate to say that he has very little confidence in the accuracy or reliability of stock accounts taken hurriedly in a few days of work under pressure. If the author were an auditor of a public company, he would require a very substantial provision for possible error to be written off accounts taken in this way. A proper and inexpensive system of account keeping may be coupled with a plan of continuous stock-taking. By this system a competent clerk can check every item in stock, comparing it with the ledger records, ascertaining at once if there is any deficiency, and if so, instituting enquiry and obtaining adequate explanation. Under any other system it is not possible to prevent excessive waste, or even to detect pilfering, which in very small, but frequently valuable articles, might be carried on to a serious

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extent. Moreover, an auditor invariably accepts with more confidence the account which is taken carefully and methodically, rather than that which is compiled under less accurate conditions. In such a system as the author recommends, the stock-taker checks the quantity in stock at a given date, compares it with the ledger record, and signs the latter at the date of the stock-taking. An account of this kind taken once a year is usually accepted by all auditors, who for their own satisfaction may select at random a few representative articles, and, at the time of audit, may have the actual stocks compared with the ledger account, and so prove the reliability of the system. It will be found in actual practice that a system of this kind is in the end much cheaper and more satisfactory than other methods, under which large deficiences have sometimes shown themselves at the period of making up annual accounts, and these deficiences have then had to be written off against general profit and loss accounts, instead of against the particular costs of the work on which the material has been used. A good stock-keeping and stock accounting system is absolutely essential to accurate and reliable costs, and without the latter it is not possible, at least in competitive branches of business, to achieve success and prosperity.

Again, it is most important that cost-keeping records should be kept up to date. As previously mentioned, it is possible to have all cost accounts for a large business made up on a Friday to include all expenditure up to the previous Tuesday evening. The system under which this was done required that the amount charged for labour to the various cost accounts should actually exactly balance with the nett amount of wages to be paid. The very fact that this was the case gave confidence to directors and others who had occasion to make use of the accounts, for they felt that the material records, which were similarly checked and balanced, could also be depended upon. The usefulness of cost accounts is largely nullified if they are not properly made out and kept close up to date. In a large manufacturing business with which the author is acquainted, the factory is divided into eight departments. Every Friday the manager receives a full and accurate account of the cost of operating each department for the previous week, and every month a profit and loss account showing the actual result of working in each of the eight sections is made out. The figures are not estimates, but are the original and final figures which, being summarised, balance with and form the profit and loss account finally prepared for the annual accounts. The system is inexpensive, and enables the management to keep a constant check upon all expense in labour and material, and at once detect and deal with extravagance or carelessness. It is not possible to apply such a system to the whole of a large engineering concern, but it could with very little difficulty be applied to a foundry, which is one of the departments in many factories where there is no proper costing system, and where money can be made or lost almost more easily than anywhere else. Many directors and managers are frightened at the sight of black-coated clerks, and carelessly (and really ignorantly) class them as unproductive, and necessary evils, but the accountant's department of a factory, with its cost and stock records, if not a money making, is, or might and ought to be, a money saving department. And here let it be said in passing, that it is entirely wrong in principle to let the works or works manager's department be occupied in any way with accountancy. A works manager should first be satisfied that the office system is complete and reliable, and then should be glad to be relieved of all responsibility for the compilation of the accounts, which, placed always and frequently at his disposal, would give him an independent and impartial record on which to check the work of his assistants and keep them up to time. It will be recognised that on these lines, there must be a good understanding between works and office, and a wise and enlightened works manager will recognise that the accountant is his friend and helper, whilst the accountant will know that he is not the critic but the colleague of the works manager.

Arising out of the consideration of costs of production, is that of rate of production. The estimating department, which should constantly check its data by reference to cost records, should, on each order, acquaint the works manager with the nett estimated cost, and as he refers to the progressive cost accounts, he will see to what extent cost agrees with estimate, and will occasionally be enabled to materially improve on the same. Incidentally, this comparison provides a check on the position of the work, and the probability of its completion by the due date specified in contracts.

One of the weakest parts of factory organization is that relating to fulfilment of delivery promises. One reason why there is so much default on this point is, that it is very rarely the business of any one department or person to follow up orders in each stage. There is frequently serious delay in getting drawings and instructions into the shops. Then delays of other kinds arise, perhaps insignificant in themselves, but sufficient in the aggregate to make a serious difference to the time for completion of the work. Presumably, when a particular order is received, the drawing office is allotted a specific time for completing works drawings. The author has known of urgent orders where such drawings have not been commenced six weeks after the placing of an order, all because there was no person whose duty it was to see that these details were attended to promptly. Slackness in this, means frequently that material required is late in being ordered, and other manufacturers are equally slack in their methods, further delay ensues, and then, to avoid penalty or cancellation of orders, overtime is worked, and cost at once goes up and profit very probably disappears. It is assumed that each business will have one person who, either with other duties or solely, is occupied with commercial direction of the concern. He may not be a technical man, for that is not actually necessary, but if he is a capable organizer, and possessed of tact, and, what is of supreme importance, possessed of authority, he will be in a position to require each department to come up to time with its work, or explain why there is delay, and by keeping the departments in touch, will ensure that they co-operate rather than act independently of each other. The company whose promises can be depended upon will almost invariably be found to be a profitable concern, for confidence very often secures preferential treatment when others are placed, and such a company will be able to work with more regularity, and consequent reduction of expense, than others whose volume of work fluctuates between extreme pressure and slackness.

A very important matter in factory organization is that of indirect expense. The term is not intended, in this paper, to refer to head-office administration, but to expenses in the factory or works. It is possible to accurately and definitely allocate expenditure incurred in direct production, and to institute comparisons, and effect economies. But incidental labour, and material, repairs and maintenance, and similar items, some of which are insignificant in themselves, require the careful consideration which they rarely receive. Skilled or direct labour must be attended by general or indirect labour. Machinery requires attention, and in this connection it is much cheaper, whenever possible, to anticipate breakdown and prevent its occurrence. But unless carefully watched and checked, these things are apt to grow out of all proportion to direct manufacturing expense. A simple and effective system of accounting, by which wages are analysed and summarized, and account taken of material used on general account, will show where labour and material have been expended. This, by a suitable method of allocation under departmental references, will indicate the operating burden of each department. A return should be prepared each week and supplied to the management, showing (1) the direct labour costs in each department, and (2) the indirect or running expenses in (*a*) labour, and (*b*) material, etc., of each department, and the proportion of such indirect expense to the direct manufacturing labour. It has been found in some places that indirect labour averages about 10% of the direct labour, and, whatever the average may be, variation should be closely followed. In this connection it is desirable not merely to furnish figures, but to show the result on a chart, with curves indicating the fluctuations of (*a*) direct labour, (*b*) indirect labour, (*c*) indirect material, and ( ) the percentage proportion of (*b*) and (*c*) combined in relation to (*a*). A sharp rise in (*a*) may mean overtime, which requires to be looked into and explained, or increased work, and, therefore, a higher labour bill.

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Advance in (*b*) and (*c*) may be capable of various explanations, some of which may call for special attention. (*d*) ought to be a curve with least possible variation, only satisfactory when in a downward direction. But this return, and its accompanying curves, is one of the accounts which should be quite indispensable to the works manager.

The author has, in this paper, sought to set out a few items associated with factory organization, the importance of which has been impressed upon him in various businesses with which he has been associated or acquainted. He has been permitted by the courtesy of several large and important firms to visit their works and inspect their systems, and has here put in summarized form some of the most important considerations which have suggested themselves.

Successful factory organization appears to be possible only when each section of the undertaking attends to its own business. Where the works department seeks to add office work, particularly in costing and stores administration, to its duties, the result has never proved satisfactory. Where the office has attempted to run the works on the same lines as keeping a set of books, the result has been equally unfortunate. Red tape is not necessarily system, and a business does not exist for a system, but a system for the business. The supreme consideration would appear to be that the body commercial and manufacturing is composed of many members, but all members have not the same office. It is only when all work harmoniously, each in its own sphere, directed from one head, that organization becomes the parent of success.

TESTING RUBBER FOR ELECTRICAL WORK.

Professor A. Schwartz's paper on the above subject, discussed in our Notes, when read before the Manchester Local Section of the Institution of Electrical Engineers, was very fully discussed, and we append a brief summary of the chief points made by various speakers :—

Preparing the Samples and the Value of Mixtures.

Mr. Whalley : Cutting sample test pieces with a knife would be liable to introduce errors by weakening the strip. This had been found to be the case by previous workers. It was necessary to have mixtures, for some work, in which the percentage of rubber is small, owing to the difficulty in mixing the mixtures containing larger proportions of rubber. When the proportion of rubber in the mixture is more than 50%, considerable trouble is experienced in making it thoroughly homogeneous. It is then necessary to drive the two sets of mixing rolls at different speeds, and the heat produced by the friction of the rolls on the mixture has a tendency to vulcanise it. The improvement in the qualities of the mixture by the use of a higher percentage of rubber, does not increase so rapidly as the cost of the mixture. In testing vulcanised rubber cables it was the usual practice to test them 10 days after the vulcanising. It had been found that some cables would test out good just after vulcanising, but broke down when under final test with the braiding on. He though the constant load test might lead to errors. For each mixture there must be one load which would give best results. The curves showed that some substitute mixtures were stronger than pure rubber. Besides the quality of the rubber itself, there were many other factors determining the durability of the insulation. Temperature, position, conditions of working, etc., all played a part.

Sub-Permanent Set After Stretching.

Mr. Beaver : The sub-permanent set in a piece of rubber after stretching is well known to rubber experts, and it is usual to stretch the sample before giving it out for test. As to a possible explanation for this phenomenon, he thought it was due to some alteration in the molecular structure of the rubber, produced by the heat developed in it. There was an analogous effect with bitumenous compounds.

Effect of Heating.

Mr. T. H. C. Brooking : A common method of testing samples of rubber was by stretching them between the fingers in parallel with the standard piece. However, by this method it was possible to manipulate the result. He thought the effect of further heating was of great importance and should be investigated.

Hysteresis Co-efficients.

Mr. Cramp : From a consideration of Stanest's law and the laws given by the author in the paper, it seemed possible to get out "hysteresis co-efficients" exactly as is done for iron. These co-efficients would prove useful as means of comparison. He understood that "200% extension" meant that the sample was stretched to three times its original length, and "100% extension" to twice the original length, and so on.

Polarisation and Hysteresis.

Dr. Marchant : There might be some connection between the well-known polarisation effect of rubber and the hysteresis effect. He had tested some Cingalese rubber with good mechanical properties, but which was very poor electrically. He did not consider a mechanical test was at all conclusive in proving the suitability or otherwise of a sample of rubber for electrical work.

Value of the Tests.

Mr. C. F. Smith : The machine and the tests proposed would prove of great value to the rubber manufacturers generally and not to cable makers alone. Regarding the initial large loop in the series of successive loops, there was an analogous effect obtained by putting indirectional current on to the primary winding of a transformer; the value of the secondary voltage gradually dropped. Mr. Atcheson concurred with the last two speakers.

Vulcanised Cables.

Mr. Watson (Chairman) had always thought, and thought still, that for underground work in towns, vulcanised rubber cables possessed many advantages on account of their flexibility and ease in handling. However, the troubles which many people had had with the cables in use discounted these advantages and made engineers chary of employing them. If some guarantee of their durability in use could be obtained, they might regain favour. While the results of Prof. Schwartz's investigations and his testing machine would be of great assistance in the production of the most durable mixtures, he did not think the test would be conclusive as regards the electrical properties.

Prof. Schwartz (in reply) : It had been proved conclusively that the results of electrical tests on cables were of no value as indications of their durability. It was necessary, therefore, to look for this information from other tests. Regarding the testing of samples by stretching in the hands, no doubt with practice it became possible to get a very good idea of the value of the rubber in that way, but there was always the human element in it. He had some tested samples of known composition, and he proposed that the rubber experts present should each test these and write down, independently, their opinion of each one. A comparison of the results would show how far that method of testing could be relied upon.

RUMOURED CANADIAN ELECTRIC MERGER.

The Montreal correspondent of the *Standard of Empire* says :—There have been from time to time during the past few years rumours of a scheme for the amalgamation of the Montreal, Light, Heat and Power Co., the Shawinigan Light and Power Co., and the Montreal Street Railway. The companies have common interests to a certain extent, the Montreal Light, Heat, and Power Co. distributing the Shawinigan Co.'s current, and the street railway being operated by the current of the two. The same group of investors is largely interested in all the concerns, which practically control the supply of electric power used in the city and the city and suburban tramway lines. The revival rumours are accompanied by others to the effect that a system of tubes will be established connecting the centre of the city and the chief railway passenger stations with the outskirts, and possibly with the south shore of the St. Lawrence. The expenditure involved in such works would be heavy, and an application would have to be made to London for the money. There is as yet, however, no definite statement from the promoters in this regard.

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VACUUM DATA.

Cost of working central stations is receiving more and more attention as the stress of pioneer work is giving place to keener competition and more accurate estimation of results. The cold science of economics comes in to temper the more liberal and imaginative side of experimentation. And so we see greater care being paid to the choice of coal, its purchase on a B.Th.U. basis, supervision of the stokers, with premiums allotted for wise stoking, and a general overhauling of working *minutia* of every description, all of which is rendered the more necessary, as improvements in appliances are brought forward, often greatly complicating methods and results. A good example of this is afforded by Mr. R. M. Neilson's paper on "Investigations as to the most economical vacuum in electric power stations, employing steam turbines and cooling towers," which he read before the Glasgow Section of the Institution of Electrical Engineers. As the author pointed out, the extensive use of steam turbines in electric stations has given an increased importance to the questions of vacuum and condensing plant. Of course, the advantages of high vacuum where a turbine is used is generally recognised, and, therefore, when one is introduced into an existing plant, little difficulty is met with; but, Mr. Neilson contends, the matter assumes altogether a different complexion when it is a question of planning a new station with turbo-alternators, or making additions to an existing plant. In this case it is necessary to decide what items in first cost are affected by vacuum, and what items in annual expenditure are influenced thereby. It was with these objects that he carried out close investigations and plotted a valuable set of curves. For the purpose of investigation, Mr. Neilson took a station fitted with three turbo-alternators of 3,000 KW. each, but capable of carrying a considerable overload, though not economically. Water-tube boilers were assumed, and surface condensers, and electrically-driven condenser auxiliaries, the condensing water being cooled in natural draught cooling

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towers repeatedly used. All things considered, the items on capital expenditure that have to be taken into consideration are the boiler plant and the condensing plant; while on the side of annual expenditure, influence is practically only felt as regards interest and depreciation on plant and coal. That is, taking broadly a station with a plant load factor of anything between 10 and 30%, and equipped with cooling towers. Fresh complications arise if the factor is in the neighbourhood of 5%, if in place of cooling towers, water direct from a river, canal, or the sea is used. In the first case, a lower vacuum than the average would be necessary; in the second, a high vacuum would be both possible and advisable. The first set of curves are worked out for a plant with a 10% load factor, and show the influence of vacuum on cost of running as regards interest, depreciation, repairs, rates and taxes, and insurance, (these items being taken at 17%). We find that the most economical vacuum as regards condensing plant to be below 25, and for boiler plant between 28 and 28¼, but the smoothed curve, giving the sum of the two curves, works out at 25½, then rising rather suddenly. With a plant load factor of 20% the smoothed curve shows the most economical point to be between 25¼ and 25½, with slow rise to 27; but with a plant load factor of 30%, the smoothed curve gives us an almost straight line between 25 and 26¼, with very slight rise to 27. However, coal consumption is the most important factor. There is very considerable variation according to price of coal. In any case, the more expensive the coal, the less economical is a low vacuum. The best point as regards coal seems to be about 27¾, but, as remarked, this applies more particularly in the case of expensive coal. The next step taken in this investigation is to smooth the plant and the coal curves. In the case of a 10% plant load factor, we find the most economical vacuum with coal at 18s. per ton is between 27 and 27¼; with coal at 14s. per ton, between 26¾ and 27; with coal at 10s., between 26½ and 27¾; and with coal at 6s., between 26¼ and 26½. With a plant load factor of 20%, the most economical vacuum, with coal at 18s., is between 27¼ and 27½; with coal at 14s., 27¼; at 10s., 27; and at 6s., 26¾. With a plant load factor of 30%, with coal at 18s., the most economical vacuum is between 27¼ and 27½; at 14s., at 27½; at 10s., at 27; and at 6s., between 26¾ and 27. For details of how these data have been arrived at, we must refer the reader to Mr. Neilson's paper. One point is to be observed, the type of turbine used, its connection with the condenser, and the provision made for utilising vacuum will influence results; but such influence appears to be less below 27½ than above this figure. Investigations of this kind, however, as Mr. Neilson himself was careful to show, are not so much intended to put forward hard and fast data, as to show the way for investigating any given problem connected with a special case. They are also most useful as indicating points for consideration not only in management and planning of stations, but also designing of plant, for plotting of vacuua curves on these lines brings out prominently the influence of different types of steam boilers, condenser, and turbine equipments on effective working.

CORRESPONDENCE.

TO CORRESPONDENTS.

All communications intended for the Editor should be addressed "The Editor, 149, Fleet Street, London, E.C." Anonymous communications will not be noticed. Letters should reach the Editor not later than Tuesday afternoon to be included in that week's issue of the Journal.

The Editor is not responsible for, nor does he necessarily endorse opinions advanced by correspondents.

QUESTION 1212.

Sir,—There are several points in the answer to Question 1212 given in your issue of January 7th, which call for explanation. Why is the formula, viz.: $I = \frac{C P \sin^3 \alpha}{h^2}$, used instead of the more general one: $I = \frac{C P}{D^2} \cos \theta$; where I = Horizontal illumination at point A. D = Distance of lamp along ground from A and θ = the angle between the perp. at A and line joining lamp to A.

Or formula $I = \frac{C P}{D^2} \times \sin \theta$, where vertical illumination is measured.

The minimum illumination is assumed to be ·03 candle foot. If this is illumination on horizontal plane, then it is equally due to lamp on either side and consequently when calculating distance of lamp the figure should be halved *i.e.*, ·015 should have been used instead of ·03.

What is the reason for taking the height of the arc lamp as 30 ft.? This is an unusual height for any type of lamp —the general figure for open type arcs of size given is 20 to 24 ft.

The type of arc lamp chosen for comparison is the single carbon open type. Why should a single carbon lamp be chosen? The double carbon lamp is generally used and the effect on the estimates given, if it were used, would be that while the capital cost per mile would be increased by a comparatively small sum, the operating costs per annum would be reduced by a very substantial amount. The wages for attendance, etc., would be nearly halved and wastage on carbons reduced to practically nothing.

A 10 amp. open type arc generally burns 18/12 mm. carbons. Why are 14/9 mm. carbons quoted? Even if the 18/12 mm. size is used the £5 5s. per 1,000 ft. of carbon (including waste, etc.) is certainly much too high a figure.

Yours, etc.,
W. J. J.

RADIO-TELEGRAPHIC MEASUREMENTS.

Sir,—I promised the Secretary of the Institution of Electrical Engineers to make a complete reply to all the remarks made orally and in writing on my paper on the above subject, read December 16 last. As, however, Dr. Erskine-Murray has transferred the discussion to your columns, I must answer him personally here, and now lest it should be thought that his objections are unanswerable. It is quite easy to show by a few figures that although some of his objections to my results are qualitatively correct they are quantitatively invalid, because he has not considered the proportion between the results and the correction.

His first point is that the charging current of the condenser passes through the wire under test and contributes to heat it. No doubt it does; but the heat so added is insensible in comparison with the heat due to the oscillatory current. In the experiments with the No. 14 and No. 16 copper wire the condenser used consisted of six Leyden jars and an extremely short spark gap. The charging current of the jars measured by a hot wire ammeter was 0·06 amp; this current being a low frequency current at a frequency of about 50. Hence the resistance on which it operates is the low frequency resistance of the wire under test. The oscillatory current was a current of the order of six amperes and the high frequency resistance of the wire was nearly six times its low frequency resistance. Hence the heat heat produced by the charging current is

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to that due to the oscillatory current in the ratio of $(\cdot16)^2 \times 1$ to $(6)^2 \times 6$ or in the ratio of 0·0036 to 216.

Accordingly the correction is quite insensible. In the case of the other wires this neglected correction was never more than a very small fraction of 1 %.

His next point is that I have calculated the high resistance by a formula for undamped instead of damped oscillation. Here, again, it is easy to show that the correction is negligible. Taking Dr. Barton's formula, to which he appeals (see *Phil. Mag.*, Vol. 47, p. 437, 1899), we find that Dr. Barton shows that the correction for damped oscillatory to undamped high frequency oscillatory resistance (R/ R/) is $s\sqrt{s+}$ R, where $s = \sqrt{1+k^2}$ and k is the damping factor. Now it is easy to show that $k = d/\pi$ where the d is the semi-period decrement. In my experiments spark gap was kept short to keep d low and measurement showed it to be about 0·04. Hence $k = 0{\cdot}04/3{\cdot}14 = 0{\cdot}013$ and $s\sqrt{s+} = R1{\cdot}007$.

The correction, therefore, is 0·7 %, or less than 1 %, and not 4 % as stated by Dr. Murray. As I made no claim for a higher accuracy than 1 %, and as there are other sources of error which may be more important, I did not think it necessary to concern myself with this correction. Dr. Erskine-Murray's contention, therefore, that I have not measured the high frequency resistance of the wire is merely a proof that he himself has not reduced these corrections to arithmetic to ascertain how far they are important.

In the third place he puts forward the diagrams on pages 112-115 of his translation of Ruhmer's book as an anticipation of my spark photographs. Any one who possesses this book can see that these diagrams are merely photographs taken on a moving plate or film of the thin thready, secondary spark of an induction coil. They are not wireless telegraph sparks at all. There is no means of ascertaining what is the time interval between the images, which are waving about all over the place, and they bear no comparison with the exact means I have provided in my instrument for connecting the sparks in a condenser discharge, or radio-telegraphic transmitter. If he thinks they do, I can only recommend him to make the attempt to correct the sparks of some high-speed spark transmitter by his method without adopting the special means used by me and see what sort of a result he is able to obtain. As regards his question on the trains of sparks obtainable with a hammer break: I may have misunderstood him, as I had to depend on brief notes taken for me whilst he was speaking, and I do not even now understand his point. Perhaps when he sends in his corrected proof of remarks to the Secretary of the Institution he will make it plainer.

Yours, etc.,

J. A. FLEMING.

University College, London,
Jan. 15, 1910.

COOLING MEDIA TEMPERATURE IN SOFT IRON STAMPINGS.

By R. G. GIFFORD, M.Sc., Student.

(*Continued from page 33.*)

In Tests IV. and IVA. this was found to be 1·65, therefore, as was expected, $\frac{T_i}{T_o}$ decreases as the amount of oil decreases.

From the above tests, curves were formed giving the mean temperatures of the oil corresponding to the iron temperature curves. From these it is evident that $(T_i - T_o)$ is very nearly a constant for a given value of W, as was anticipated, and therefore the value of $_oC_o$ from iron to oil is the same for both tests, viz., $9{\cdot}4 \times 10^{-3}$. The temperature rise of the case also tallies approximately with that for Test IV. The value of $\frac{T_o}{T_c}$ as derived from this test is 2·0, T_o being the mean value of couples 4 and 8 nearest the case, and T_c the temperature rise of the case.

In Test IV. this value was 1·53, so that $\frac{T_o}{T_c}$ increases as the oil decreases. It has been shown that this should be so.

Using this value of $\frac{T_o}{T_c}$ to find $_oC_c$ from oil to case the values become $_oC_c = 4{\cdot}3 \times 10^{-3}$, which is sensibly the same as found with the larger quantity of oil, viz., 5×10^{-3}. The surface in contact with the oil in this test was nearly 2,000 sq. cms. The value of $_cC_a$ from case to air will remain the same in Test IV., viz., $1{\cdot}7 \times 10^{-3}$, as the watt-temperature curves of the case for both tests nearly agree.

TEST V.

Oil Cooling, assisted by Water Worm.—In this test a coil of lead pipe was submerged in the oil above the apparatus, with the object of cooling the oil by passing a stream of cold water through the coil.

The length of piping used was 28 ft., its internal and external diameters being respectively $\frac{5}{16}$ in. and $\frac{7}{16}$ in. The smaller the diameter of the pipe, consistent with allowing sufficient water to pass, the more effective will be the cooling, as more surface is exposed to the oil for the same total cross-section of the cooling worm. The quantity of water supplied was measured by collecting it in a tank placed on a weighbridge. The supply was kept as nearly as possible constant at about 200 lbs. per hour corresponding to a velocity of 1·65 ft., or 0·5 metres per second in the worm. The temperatures of the ingoing and outgoing water were measured by thermo-couples placed inside the pipe. The temperature of the oil at various parts in the neighbourhood of the water worm was also measured. The results of this test are shown in the table below.

The power was not reduced below 90 watts as the temperature rise of the iron was already very low. The iron loss could not be raised above 120 watts without going beyond the limits of the wattmeter, and owing to lack of time it was impossible to make and calibrate new resistances for the purpose of reading higher inputs.

TABLE XIII.

Oil Cooling with Water Worm.

Room Temperature. °C.	Mean Rise of Iron. °C.	Temperature of Oil at Worm. °C.	Water Supply in lbs. /hr.	Temperature of Cold Water Supply.	Temperature Rise of Water.	Watts Input to Iron.
16·7	16·5	21·0	196	13·0	1°C.	115
15·0	14·0	20·2	198	13·5	0·8	90

The above results, however, are sufficient to show how exceedingly effective this method of cooling is, as the water rapidly absorbs the heat from the oil without rising greatly in temperature, due to its high specific heat.

The calculated values of the watts carried away by the water are 102 and 83·5 respectively, or about 90% of the watts dissipated by the iron pass into the water. The surface of the coil exposed to the oil was about 3,000 sq. cms.

If T_o be the temperature of the oil outside the coil, T_w the mean temperature of the water, W the watts passing into the water, and S the surface of the coil, then

$$_oC_w = \frac{W}{S\,(T_o - T_w)}.$$

In the first case $_oC_w = 4{\cdot}55 \times 10^{-3}$
In the second case $_oC_w = 4{\cdot}46 \times 10^{-3}$ } from Table XIII.

We therefore find the coefficient of conductivity from oil to water through the thin metal pipe is about

$$_oC_w = 4{\cdot}5 \times 10^{-3}.$$

SUMMARY OF RESEARCH.

The main conclusions to be drawn from the foregoing tests may be summarised briefly. By far the most effective method of cooling transformers is that of oil cooling, assisted by the circulation of cold water through a coil of pipes immersed in the oil.

As the water absorbs a high percentage of the total energy loss, it is unnecessary to provide a case with a large cooling surface. This method should, therefore, be adopted for large transformers when there is a good supply of cold water available. If this is not available the same water can be used continuously with the use of an outside cooling arrangement and a circulating pump. If, owing to a temporary breakdown of the pump, the water supply is stopped, no great danger need be apprehended

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as the enormous thermal capacity of the oil and the water in the coil prevents any large rise in temperature for a considerable time.

On no account should a joint be made in the coils inside the case, as this leads to a liability to leakage, the slightest trace of moisture in the oil reducing its dielectric strength very considerably.

With regard to unassisted oil cooling, this is much more effective than any type of air cooling, as the conductivity of iron to oil is so much greater than to air.

Dealing with the use of the separating sheet to assist the cooling of the transformer, it is very probable that more satisfactory results would have been obtained if the surface of the sheet had been of a dull black nature instead of the comparatively bright brass used, as a dull black surface is a worse reflector of heat than a bright surface.

Condition of Cooling.	Coefficient of Conductivity.	Coefficient of Resistance.
Iron free in air ..	$1{\cdot}3 \times 10^{-3}$ to 2×10^{-3} for temperature rises of 20° to 60° C. ..	770 to 500
Iron enclosed in case	$1{\cdot}125 \times 10^{-3}$ to $1{\cdot}35 \times 10^{-3}$ for rises of 20° to 60° C.	900 to 740
Iron cooled by air blast	$1{\cdot}9 \times 10^{-3}$ to $2{\cdot}4 \times 10^{-3}$ depending upon volume of blast	525 to 410
Oil Cooling.		
Iron to oil ..	$9{\cdot}4 \times 10^{-3}$	106
Oil to case ..	$4{\cdot}5 \times 10^{-3}$	220
Case to air ..	$1{\cdot}7 \times 10^{-3}$	600
Oil to water through metal piping	$4{\cdot}5 \times 10^{-3}$	220

The cooling by air blast, although effective, necessitates the use of blowers and air filters, and further, if for any reason the blast be stopped, the temperature of the transformer will quickly rise to a dangerous degree.

Natural cooling in air is simple and economical, but this method can only be applied to transformers of small size, as the energy loss, for the same induction and frequency, is proportional to the cube of the linear dimensions, whereas the cooling surface is only proportional to the second power, and therefore the heat to be dissipated per sq. cm. of surface rises rapidly with increase in size, producing a higher temperature rise of the transformer.

The various values of the co-efficient of conductivity obtained in the tests may be recapitulated. The co-efficient of resistance is also given, this figure being better for purposes of rapid comparison than the co-efficient of conductivity.

The watt temperature curves for all the Tests I. to V. are plotted in Fig. 5, and show the comparative efficiencies of the various methods of cooling the iron.

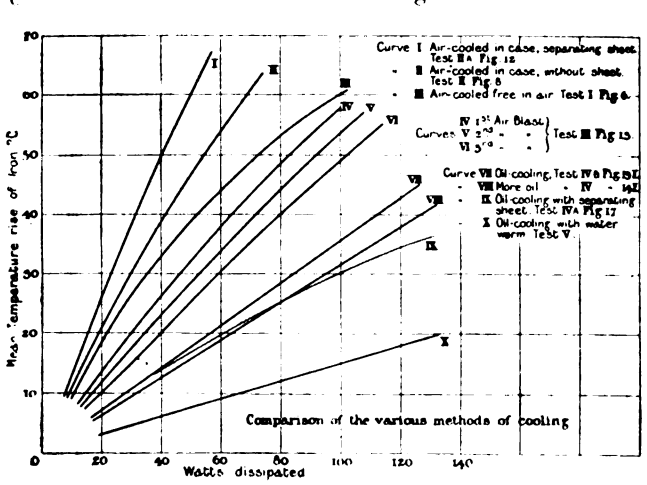
Curve I Air-cooled in case, separating sheet. Test II A Fig 12
II Air-cooled in case, without sheet. Test II Fig 8
III Air-cooled free in air Test I Fig 6
Curves IV 1·5 Air Blast, V 2·0 " , VI 3·0 " } Test III Fig 13
Curve VII Oil-cooling, Test IV B Fig 15
VIII More oil " IV " 14
IX Oil-cooling with separating sheet. Test IV A Fig 17
X Oil-cooling with water warm Test V
Comparison of the various methods of cooling
Mean temperature rise of iron °C
Watts dissipated
0
20
40
60
80
100
120
140

FIG. 5.

The above work has only dealt with the cooling of the iron core of transformers. A considerable amount of heat, however, about equal to that of the iron loss, is contributed by its windings. A similar research to the above might therefore be conducted with the object of determining the conductivity co-efficients for various types of coils—concentric and sandwiched—under similar conditions of cooling to those employed in this research.

In conclusion, I have to thank Professor Kapp, at whose suggestion the research was carried out, for the facilities afforded me, and also the engineering staff of the University of Birmingham for permission to use some of the apparatus required in the tests.

FIRE INSURANCE REGULATIONS.

We have received from the Electrical Department of the Phœnix Assurance Co., Ltd., of which Mr. S. G. Cassell Russell, M.I.E.E., is the technical adviser, the new issue (39th edition) of their rules for electric light and electric power installations. It contains some notable additions. To rule 2, on conductors and insulation, is added a new test for rubber insulation. It states that: "The dielectric, after being stretched to three times its own length for 24 hours at normal temperature, shall return to within 15% of its original length within one hour."

In view of recent discussions, rule 9, on flexible wires and cords, is of great importance:

"Flexible wires and cords should be kept well away from inflammable materials, and must not be placed between floors and ceilings, in walls, roofs, or partitions, or where they are liable to mechanical injury.

"Flexible cords should not be used for wiring the interior of electroliers.

"Flexible cords must not be in contact with gas piping or other earthed metal work, or be attached to nails.

"Flexible cords must not be joined to hard wiring, except by means of screw connections in a fireproof junction box.

"The insulation of flexible cords must consist of two coats of pure para rubber of high quality, or, of one coat of pure para rubber of high quality next the copper, and two coats of vulcanising rubber.

"With regard to the pure rubber insulation the minimum radial thickness of each coat must not be less than 10 mils, *i.e.*, a total of 20 mils of rubber; one lap of cotton to be next the copper, and two laps of cotton over the rubber—and the whole then braided with silk or cotton.

"With regard to the coats of vulcanising rubber insulation, the minimum radial thickness of the coats of rubber must not be less than a total of 34 to 38 mils, and the whole to be braided with silk or cotton.

"With regard to the insulation resistance of flexible cords and wires, it must not be less than 600 megohms per mile after 24 hours immersion in water, for vulcanising rubber, and 1,000 megohms per mile (dry test), for pure para rubber insulation.

"Flexible cords, except when used in connection with pendant lamps hung well clear of material, must not be used in shop windows containing inflammable goods."

Rule 43 on special risks is now made to take in shop windows.

Rule 45 on temporary installations is amplified as follows:

"The installation must be controlled by a switch and fuse on each main conductor at the points of entrance of supply. The switches must be interlocked and be opened when the lights are not in use.

"Unprotected insulated conductors must be kept well apart, free from inflammable materials, and from gas piping or other metal piping: they must not be liable to mechanical injury.

"Flexible cord must not be used.

"All changes of section in wires must be protected with double fuses.

"Small circuits from fuse boards must be protected with double fuses.

"Lamps must be kept at a safe distance from inflammable material."

In connection with the last two rules the claim put forward for Osram lamps, as shown by the General Electric Co. on page vii., is well worth noting.

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PUBLICITY.

In this Section of "The Electrical Engineer" we give Publicity to New Inventions and Specialities.

FOSTER ARC LAMP WORKS.

In further reference to the notice we gave the manufactures of this Company in our issue, we have now pleasure in publishing some views of the interior of the works.

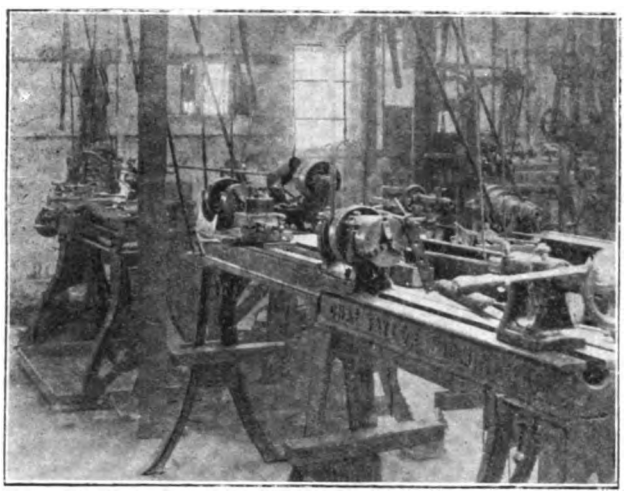

FIG. 1.

Fig. 1 shows the lathes in the machine shop; jig work is the rule, and by having a separate tool room, the machinery of castings, etc., is carried with a minimum of hand work.

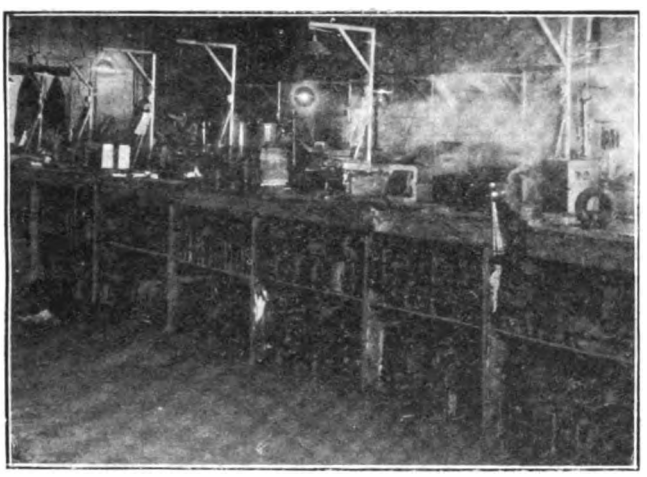

FIG. 2.

Fig. 2 is the transformer assembling shop. Last week in referring to the Foster "Q" type Flamer, we stated that the non-metal cored carbons used were more expensive than ordinary. This was an error, as Messrs. Foster inform us that the carbon cost is about 40% *less than other types*.

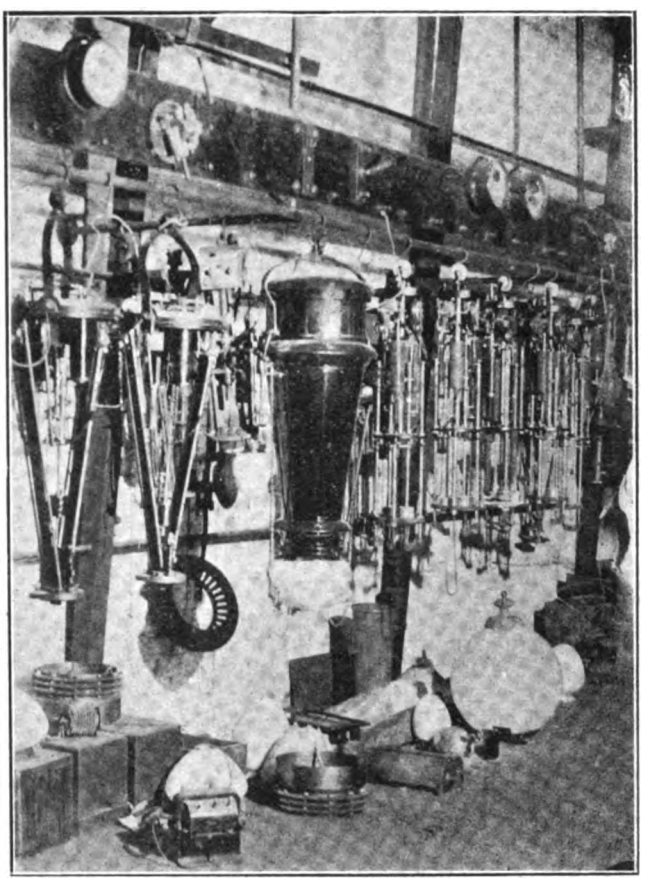

FIG. 3.

Fig. 3 shows a row of arc lamps under test, and we may say that the reputation of the firm has been largely gained through the searching tests which they give the apparatus before dispatching.

MINE ELECTRICAL PUMPS.

At the annual general meeting of Harrison, Ainslie & Co., Ltd., the Chairman, Sir Owen R. Slacke, said that in connection with their mines "10 new electrical pumps have been purchased, seven of which are now working, and three have yet to be delivered. Two of the pumps used in emptying the mines have been sold, as no longer required by the company. We have, therefore, no reason to anticipate any further exceptional trouble or expense in the working of this important plant, and the failure I have explained may be regarded as having been only temporary, and much in the nature of the troubles invariably attached to the installation of a large plant. Experience in other mines has shown that electrical power, when thoroughly established, is by far the best and the most economical. The original installation of a very large pumping plant—and I believe ours is the largest plant, at any rate, in the United Kingdom—is invariably attended with many unforeseen difficulties, and which frequently occasion dispute between the installing company and their contractors. This has occurred in our case, and at the moment there is an arbitration pending between the makers of the electrical plant and the syndicate with whom we contracted for the erection of the plant. The syndicate has, however, agreed that the result of that arbitration shall be binding as between the syndicate and this company, thus preventing the company being involved in any litigation."

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PIONEER WIRING WORK.

THE FIXED PRICE LIGHT CO., LTD.

At the invitation of the Fixed Price Light Co., Ltd., an offshoot of Messrs. Siemens Bros. & Co., Ltd., a number of members of the technical Press gathered together at Cannon-street station on Friday and were there met by Mr. Victor Zingler and Mr. Huddleston, of Siemens Bros., who accompanied the party to Rotherhithe on a visit to the Model Electrically Lighted houses fitted up by the new company.

It was well worth taking the journey, for this conce n has been formed with the essentially up-to-date view of enabling owners or tenants of small property to have their premises wired and electrical energy supplied on the basis of an inclusive fixed rental per lamp. It will be seen that the idea is quite in conformity with the most recent conclusion arrived at by those who are anxious to adjust electrical engineering with modern requirements.

As our readers know in the past various attempts have been made to solve the problem of meeting the needs of small consumers, by the introduction of "Free Wiring" and other systems. Of course, the advent of metal-filament lamps made a solution all the more urgent. A partial solution was arrived at by the very fact of the cheapening of these new lamps, which, under favourable conditions can do more than compete with incandescent gas burners. However, the difficulty with regard to the initial cost of durable forms of wiring still remained. But the aspect of the whole question was changed when Messrs. Siemens Bros. & Co., Ltd., introduced a cheap and effective system of wiring, the "Stannos" wire system, which, it will be recollected, were explained at length in these columns. Following upon this Messrs. Handcock and Dykes read their much discussed paper before the Institution of Electrical Engineers, showing how the problem of serving small consumers could be solved. These gentlemen were the originators of the "Stannos" wire system, and it was only natural that a practical application should be given to the invention and policy advocated in the paper. This has taken the form of the registration of the Fixed Price Light Co., Ltd.,—with Messrs. Handcock and Dykes as the consulting engineers—by Messrs. Siemens.

As Mr. A. H. Dykes, who was met at Rotherhithe, explained, the procedure which the Fixed Price Light Co. will pursue is briefly as follows:—

It is in contemplation to make arrangements with the electrical undertakings operating in various localities and to negotiate with landlords or tenants of small property, tenements, etc., for the lighting of their premises, preferably in blocks of houses or contiguous rooms.

The Fixed Price Light Co. will issue specifications to contractors and call for tenders for the wiring of selected houses, etc. The light will be supplied to the tenants at a fixed rental per lamp per week, including fitting up the houses, the first lamps, and the charges due to the supply authority for the current supplied. When the lamps wear out new lamps will be supplied by the company, either at the usual retail price or on easy terms.

The company is prepared to receive proposals for wiring not less than three rooms in any one house, and suitable fuses, switches, shades, lamps, etc., have been designed and standardised for the purpose. The lamp and shade selected will light adequately one room of ordinary size as generally found on premises of the kind described. The consumer will be expected to use his light reasonably and without waste, and in order to control him in this respect, the company has decided not to include the supply of new lamps in the weekly rental, but to make the consumer pay for these.

The Siemens Companies believe the operations of the Fixed Light Price Co. will promote an increased demand and sale for their specialities, such as "Stannos" wires and "Tantalum" lamps, fittings, accessories, special fuses, etc. Incidentally, however, they think that they have every reason to believe that the business of the Fixed Price Light Co. will promote the sale of electrical energy and assist the electrical supply authorities in a new direction. Further the Fixed Price Light Co. will be in a position to place work with the electrical wiring contractors, which the latter might not otherwise have obtained.

In the first instance the Fixed Price Light Co. have entered into an arrangement with the London Electric Supply Corporation, and have opened branch offices and show-houses at 141, Rotherhithe New-road, and 19, Waterloo-road, S.E. The supply provided by that corporation being an alternating current one, the wiring will be concentric, using single "Stannos" wires, with the sheath as a return conductor, and the light will be supplied to tenants at a rental of 2½d per light per week from April 1 to September 30, and 3½d. per light per week from October 1 to March 31. These prices work out at only about half the cost of gas on the slot meter system, which is almost universally employed in the district in question, and the Fixed Price Light Co. have every hope that as soon as a few installations have been completed and the tenants discover the great convenience, healthiness and relative cheapness of electric light, the demand will increase very rapidly. These rentals refer only to private houses and not to shops, for which special terms will be made.

"VENNER SIGNS" IN POLITICS.

"Venner Signs" surmounting cinematograph displays of the *Daily Chronicle* and *Daily Mail* are to be seen at Croydon, Shepherd's Bush, Upper Street, Islington, Aldwych, Fleet Street, Clapham Road, Hop Poles Hotel, Hammersmith, etc. These signs are also displaying names of candidates in various parts of the country. It must be acknowledged that the *Daily Mail* and the *Daily Chronicle* do not generally see eye to eye on most subjects, but they are in agreement on the value of the "Venner Sign" for publicity purposes, and many of your readers will no doubt have remarked others placed at the top of cinematograph shows, and also up and down the country; and very effective "attractions" they prove to be.

TUNGSTEN LAMP TESTS.

The Westminster Electrical Testing Laboratory announce that they have just completed a series of life tests on 15 of the principal makes of Tungsten-Filament lamps, the results of which will be supplied to subscribers only.

The following are the names of the lamps tested:—Pope; Simplex; Metelite (Bryant); Sunbeam; Auriga (Westinghouse); Welsbach; Leuconium (Stearn); B. T. H.; E. M. F.; Cryselco; Efesca (Falk, Stadelmann); Metfil (Ediswan); Wultun (British Tungsten Lamp Co.); Osram (G. E. C.); Metalik (Beddy).

Four lamps of each make were tested. They were obtained direct from the makers and purported to be for 200 volts, and of either 32 British or 32 Hefner candle-power.

The lamps were run at 200 volts for 1,000 hours and were tested for mean horizontal candle-power, watts and watts per candle-power at start and after 200, 400, 600, 800 and 1,000 hours.

The voltage during the run was maintained constant within ½% by an automatic regulator.

The results of the tests have been printed in full and bound up in one leather covered volume. In addition to giving the results for each lamp individually, they also give the average of all of each make at each period and the average for each make throughout the whole run.

The subscription required to obtain a copy of the complete report is £2 2s. Additional copies may be obtained (for personal use only, but not for re-sale), at £1 1s. each.

The copyright they reserve in their own hands, but they may permit a limited degree of publication on application being made in writing.

No copies of the Report will be sent out on appropal, but they are willing to give all reasonable information concerning the manner of carrying out the tests.

CHANGE OF ADDRESS.

The Tramways and Light Railways Association has removed to Caxton House, Westminster, S.W.

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ELECTRICAL PROGRESS AT HOME & ABROAD

FROM OUR SPECIAL CORRESPONDENTS.

TYNESIDE NOTES.

NEWCASTLE-ON-TYNE.

The development of the system of supply of electricity in bulk upon Tyneside need hardly be dilated upon here. Pandon Dene, Neptune Bank, Carville, and the waste heat power stations mark the successive stages in the enormous system which now covers the Northumberland and Durham industrial areas, and is linked up to the important system operating in the Cleveland and South Durham area. There is, however, evidence that with the return of prosperity to Tyneside there will be further large demands upon the electric supply, and the large generating station at Dunston, which when completed will be equipped with 30,000 h.p. of generating plant, is designed to deal with this increase of load. The station is so situated that it can tap directly on to the high tension supply system, and the work is being pushed forward with all speed. Two sets of turbo generators are being installed, supplied by the Allgemeine Electricitats Gesellschaft, together with a third set of the Parsons-Brown-Boveri type. Babcock boilers are being used, and the switchgear, which is of the remote-control oil-break type, is supplied by the British Thomson-Houston, Ltd. When this generating station is completed the total capacity of the generating plant feeding into the supply system from the various generating stations will be about 115,000 h.p.

Power from Waste Heat.

Another important development in connection with the supply of electricity in this area is in connection with the utilisation of the waste heat of coke ovens, of which there are a large number in Durham. One of the generating stations which has been recently built, is that at Bankfoot, near Crook in the County of Durham. Coke ovens belonging to Messrs. Pease & Partners are situated here, and an electric generating station in conjunction has recently been put into operation, the generators being two Parsons' type turbines supplied by Messrs. Richardsons, Westgarth and Co., Ltd., and driving machines which feed into the main distribution system.

Cable Extensions.

In conformity with the policy of securing customers among the large colliery interests in Northumberland, the Newcastle-upon-Tyne Electric Supply Co., Ltd., has recently decided upon an increased cable service in the direction of Blyth. This seaport for the coal trade is already served by one cable route from Carville *via* Tynemouth, but a second one is to be laid further inland by way of Burradon and Seaton Delaval, thus forming a loop circuit. In this new route there will be approximately nine miles of system operating at 20,000 volts and four miles of 12,000 volts cable. When the circuit is complete it will be in a position to tap at least twelve important collieries in a hitherto outlying district. It can then be said that almost any pit within the area of the supply will be within a mile of the company's cables, while in most cases the distance will not exceed a quarter of a mile. In the county of Durham, also, a large number of extensions are reported, which points to a healthy condition of affairs for the future.

General Progress of Supply.

From enquiries I have made at the head offices of the allied companies above mentioned, there is ample evidence to show that in spite of recent trade depression the work of electrification has been going on very steadily and strongly. Among important power consumers which have recently been given a supply are the following:—The Harton Coal Co., Ltd., whose electric winder I reported upon some time ago, and who are now taking 9,500 h.p.; other collieries, such as the Priestman Colliery Co. (500 h.p. at their Hazard pit), the Lambton Coal Co.'s Sherburn Collieries (1,000 h.p.), Messrs. Pease & Partners, Ltd. (1,800 h.p.), Washington Coal Co. (300 h.p.), Lumley Colliery (700 h.p.), and others; shipyards and cognate industries such as the naval equipment works at Walker, of Messrs. Armstrong, Whitworth & Co., Ltd., the repair yard of the Tyne Commissioners at Howdon, etc., and other industries such as the works of the British Chain Making Co., the cabinet works of Messrs. Robson, mentioned a week or two ago, Messrs. R. S. Bagnall & Sons, of South Hylton, and others. Not only are the indications of work during the past year very encouraging, but present enquiries, as regards extensions to power supply already installed, and the equipment of new works, shows that manufacturers are beginning to lay their plans for the influx of revived trade, which is now very generally anticipated.

MIDLAND NOTES.

BIRMINGHAM.

Scientific exhibits are always a main feature in the Midland Institute Conversazione at Birmingham. This year, as usual, electric specialities occupied a prominent place. Most of these were lent by Messrs. Siemens Bros., and, in particular, there was an apparatus for testing continuously the temperature of the human body. This was in charge of Mr. Hall Edwards, the well-known X-ray expert, who explained its working to visitors. It is arranged on the principle of the balance resistance, and the speciality of the invention is that it records on a table the variations of the temperature of the human body under all conditions. It operates somewhat after the fashion of a recording barometer, and will work for as long a period as a month, so that all the surgeon or doctor has to do is to refer to the table to obtain all the information required. Mr. Edwards considers it would be too expensive for general hospital use, though it is very likely to be extensively adopted where there are medical schools connected with hospitals. But its chief value will be as an adjunct to research, and in this department it is likely to have a very extensive use. In emergencies it would be of the greatest use for testing, for example, the ability of a patient to go through an operation.

Electrical Heating.

While the Birmingham electrical undertaking was being subjected to a keen fire of criticism at the Greater Birmingham enquiry last week, the potent agent was giving a very timely example of its serviceableness in the heating of the room. On the first day of the enquiry the learned counsel and others engaged in the enquiry made frequent complaints of the cold and draughts through the lack of fire, and the great height and extent of the chamber. There was only one fire at one end of the room, and this was insufficient. Mr. Chattrey, the electrical superintendent of the Corporation Department, immediately rose to the occasion, and calling in the firm of Reynolds & Bradwell, engineers, of Edmund-street, they fixed a set of eight Bastin radiators to the air grating at the bottom of the windows, and there was immediately an end of the draught the remaining twenty days of the enquiry, being perfectly comfortable for everybody in the matter of temperature.

The Cost.

The Bastin type of radiator is a new description introduced into the district early in the winter by Messrs. Reynolds & Bradwell, of Edmund-street, Birmingham. Each of the radiators consumed about $\frac{3}{4}$ of a unit per hour, so that the whole eight would not cost more than 9d. per hour, or for the full day of six hours, 4s. 6d. From the point of view of economy, therefore, the heaters were a good investment. A special wire was carried up from the Corporation supply in the basement. The radiators were very small, and, in appearance, not unlike a revolving rat cage. The heating element is a nickel-resistance wire, round which there is a quartz tube for the purpose of protecting the wire. Quartz, it is well-known, is entirely

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transparent to heat, allowing it to pass through. A quartz covering, if it happens to break, can be renewed at the low price of 6d. The installation proved an excellent advertisement for Reynolds & Bradwell.

Questions of Policy.

In his presidential address to the Birmingham and District Electric Club on Saturday Mr. G. O. Donovan, M.I.E.E., dealt with various aspects of the electrical industry, which have caused much concern of late to both capital and skilled labour. Mr. Donovan considers it a mistake, in view of the rapid growth of the popularity of electricity, that all the advantages of every improvement is promptly given to the consumer, leaving the manufacturer and contractor no better off. Attention has been concentrated on reducing costs and increasing efficiency, the fact that electrical work should, first of all, pay those engaged in it being overlooked. The speaker quoted authorities to show that the capital issued by electrical companies in Great Britain and Ireland last year stood at £237,359,440, yet carried an average rate of interest of only 3·59%: while £1,158,445 represented capital liquidated or reduced, or ·48% of capital, so that the net return for capital invested was only 3·47; this, too, in an industry subject to serious depreciation through rapid development. Under the head of manufacturing concerns, the average dividend was only 5·25. Mr. Donovan considered the matter still worse from the labour point of view, as he believes the average wages of electrical workers are lower by ½d. to 1d. per hour than those of gasfitters, plumbers, carpenters, engineers, turners and fitters. Very often trained men are offered salaries insufficient to keep them properly in food. The remuneration of the rank and file bears no proper relation to the time and money spent in training. Mr. Donovan pointed to the enormous influence upon prime movers effected upon various industries, such as printing, coal-mining, and the transport trade, for which instruments of the greatest precision have been designed. He was inclined to think also that too many young men have lately entered the profession. A great many youths have been crowded out of the industry after five or six years' experience, and this has done much mischief, leading to poor pay for staff appointments and, consequently, to poor service. The public, in turn, treats experts badly, because of its ability to fling at the electrical worker whatever price it likes. Electrical workers must take care that the remuneration both of capital and labour ensures the trade that share in the public respect to which their ability and energy entitled them. Mr. Donovan considers it unsatisfactory for a manufacturing house to deal direct with the consumer, instead of through a trade house. On the point of popularity, there is nothing to fear from gas, either for light or fire, and electrical driving is forging ahead in all directions. The great necessity is to arrest the insane home competition, which secures orders regardless of profit, and is really a kind of business murder and suicide. This can only be done by extending the scope of those organisations which are already seeking to maintain quality of work and a reasonable margin of profit. Mr. Donovan welcomed the efforts to deal drastically with certain methods of trading in proprietary articles, where agreement selling terms had been departed from. The public must be made to understand that good service and efficient material, with competent engineers to overcome difficulties, can only be maintained by reasonable returns upon capital and proper remuneration for labour. The address was well received, and a well attended meeting accorded hearty thanks to Mr. Donovan. Mr. J. Fidley (Managing Director of Rugby Lamp Co.) has promised to give a paper next month on "Incandescent Lighting Filament Lamps."

LANCASHIRE NOTES.

MANCHESTER.

The use of electric power increases rapidly, and with it new fields for electrical goods. Despite the efforts of those, whose strange antipathy to the electric drive would have the mills of this country use the less efficient steam drive, electricity is rapidly finding favour with the owners. One of the latest mills to change is that of Connell's, in Manchester. The mills are driven by three large steam engines of which one has now reached the end of its useful life. The company are replacing by a 500 kw. plant. They had previously two or three motors and the results were so satisfactory as to induce the firm to replace their old engine by electric drive. The Brush Co. are carrying out the work. The remaining engines are still some way from the scrapping point and will not be replaced for several years. In the main streets of Eccles, carbon filament lamps have displaced the gas mantles in the old lanterns.

New City Telephone Exchange, Manchester.

This exchange has only recently been opened and is a very good example of the latest design in Common Battery Exchanges. The building (part of which is let off for offices), has been designed to hold two 10,000 line exchanges, when developments require this. At present, however, only one has been equipped, and there are already some 6,600 subscribers connected. All lines leave the building underground, through lead-covered air space dry core cables, run in cast iron pipes. Fibre conduit, however, is now being used instead of piping. Each cable contains 600 pairs of lines, each of 10 lb. copper. At various points in the city the lines in these large cables are divided between a number of smaller district cables, and this sub-division continues until the smaller cables are split up at the derricks for overhead connection to the local subscribers. As the insulation of the lines in the cables consists only of a loose wrapping of paper round each wire, and the enclosed air, it is necessary that this air should be dry. To ensure this, air, dried by passage through cylinders containing calcium chloride is periodically forced through the cables by a compression pump installed at the exchange. Cocks are provided in the lead sheathing of the cables for connecting up to the pump. The air space cable is used, of course, on account of its low capacity. The capacity of these 600 line cables is about 054 microforad per mile. Joints in the line wires are made by simply twisting (without soldering), a paper sleeve being slipped over the joint.

The Exchange.

The cables are run up inside the building to the distributing frames, where they are sorted out in numerical order. This sorting out is necessary, as the cables coming from the districts contain subscribers lines, private line etc., in any order. The cables are split up into sections and run up the frame vertically, each pair of wires (one line) being connected to a numbered terminal board, carrying a carbon arrestor, double-pole fuses, and heat coils (to break the circuit with an excess current too small to blow the fuses). The cables from the frame into the exchange proper are arranged horizontally on the opposite side of the frame, on shelves, and the wires in them are numbered in numerical order. It is by these numbers that the subscribers lines are known. Connection between the two sets of cables is made by cross connection wires which cross and recross one another on the frames in a confused mass. As some lines have more "calls" per day than others, and as it is desired to distribute the work equally among the girls, an intermediate frame is employed by which the operating of any line can be assigned to any desired position in the exchange. This frame is of similar design to that of the distributor. The various relays, registers, are placed in the lines leaving this frame. Every effective call by a subscriber with a limited number of calls, is registered by the operator on the recorder in the subscribers' line. In addition, ineffective calls and calls by subscribers with unlimited calls, are also recorded, so that the number of calls per position in the exchange is known. Between 10 and 11 o'clock in the morning this exchange deals with about 11,000 calls. On the board in the Exchange there are 44 "multiples." Each multiple extends for about 6 ft. along the board, so that all the 10,000 lines are within easy reach of the operator for connecting. Although it is possible for any operator to connect, through her multiple, to any one of the 10,000 subscribers, only some 70 to 80 subscribers call on any one position in the exchange. All the cables are asbestos covered from the distributing frame, and are of square section. Behind the boards they are protected by shields from the relays, etc., so as to minimise the damage which a fire in one portion of the board could do. Steel cords have been used

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instead of the old tinsel cords for local subscribers, and stand the work much better, lasting several months. Tinsel cords have still to be used, however, for trunk lines, as for any but short lines, the steel cords render speaking indistinct.

The Plant.

Two motor-driven generating sets for charging the 24-volt batteries have been installed. They were specially designed for telephone work by the Western Electric Co. In order to reduce the disturbance in the lines, the commutators have an unusually large number of segments. The battery is by the Chloride Co., and the average full load current required is about 300 amperes. Between the battery and the lines a large choking coil has been inserted to choke back any harmonic waves from the machines (which are in parallel with the battery). Two ringing sets with interrupters for various signals have been installed, one of which is driven from the mains, while the other may be run off the battery in the event of a stoppage of supply.

AMERICAN NOTES.

NEW YORK.

The trade journals are full of a new development of the metal filament lamp, which is known as the "Mazda," and one periodical alone (the *Electrical Review*, of Chicago), gives upwards of twenty pages of advertising to this lamp in one issue. "Mazda" licences appear to have been granted to every large electrical firm in the West, and each is advertising the new lamp in whole page and double-page announcements of a very striking character. When the Tungsten lamp achieved its highest development towards the close of the year it seemed almost impossible that efficiency, economy and long life would reach a much higher point. But the "Mazda" lamp is declared by the experts to be as great an advance on the Tungsten lamp as the Tungsten was over the carbon filament. All the published accounts of this new laboratory product agree that the "Mazda" is a very wonderful development, and it is authoritatively declared that it has not been placed on the market until it has successfully emerged from every test which modern electrical science knows how to impose on the metal filament. The secret of its composition or its manufacture is not even hinted at so far, but it is a remarkable fact that the bulk of the great lamp companies of the United States have combined to put it on the market as the very highest achievement in lamp manufacture. The announcements have caused a good deal of sensation in the electrical world.

Electrical Progress in 1909.

The New Year's number of the *Electrical Review and Western Electrician*, of Chicago, contains an admirable review of electrical progress in the country during the past year. The articles deal with every phase of electrical work and each is written by an acknowledged expert in the particular field surveyed. In a brief introductory note it is observed that the promise of a year ago that there would be a continuous development in engineering, in financing and in manufacturing in the electrical field, has been well substantiated. "A year ago we were slowly recovering from a severe depression, but there was a note of optimism evident that has been preserved and increased in richness during the entire year. From every direction come reports that the industry is again on its feet, and the developments have been of a most satisfactory nature. As a matter of fact there has been nothing startling in scientific attainment, or in the manufacturing enterprise, simply a slow and sure improvement of every phase of electrical application." Following this comprehensive review is a symposium on the outlook for the current year in which the views are set forth of the Westinghouse Company, the New York Edison, the Western Electric, the Central Electric, the Edison Illuminating Company of Brooklyn, the Chicago Telephone Company, the National Carbon Company, and other leading incorporations, and all appear to be looking forward to 1910 as likely to be a "banner year" for every branch of the electrical industry.

Survey of Electric Traction.

The *Electric Railway Journal* devotes the bulk of a greatly enlarged New Year's number to a survey of the progress of electric traction in 1909, which is almost encyclopædic in its scope and completeness, and is especially noteworthy from the number and standing of the authorities who have contributed the various phases of the subject. The articles occupy some four and twenty pages and are devoted in the main to an analysis of the problems which have presented themselves during the year. These, it need hardly be said, have an application which is practically world-wide, and electric railway engineers at Home will find in this symposium matter of deep and important interest from nearly every standpoint. Especially noteworthy is an article on electric locomotive design, with particular reference to the use of side rods, in respect of which it is pointed out that for heavy high-speed service the advantages of greater available space for motors, better distribution of equipment, and the reduction of dead weight on the axle which are gained by the use of side-rod connections, more than counterbalance the slightly greater mechanical complications.

The Outlook for 1910.

Among other valuable material there is a well-considered article from the pen of Mr. A. H. Armstrong, of the Railway Department of the General Electric Company, dealing with the progress made during the year, with particular reference to the future. He comes to the conclusion that the industry has made most important advances during the year and is now entering into untrodden fields of great extent. Manufacturing companies are now keener than they were to finish the more powerful machinery required to meet the demand for larger generating and transforming units, operating at greater efficiency and higher potentials. The net result is that electric locomotives are even now able effectively to replace the most powerful steam locomotives that eighty years development has perfected. "The placing on the market of turbo-generator units of 18,000 kw. capacity, rotary converters of 3,000 kw., transformers of 10,000 kw., operating at practically any line potential asked for, and of switchboard apparatus able reliably to control any aggregation of these units, has resulted in effecting economies in generating and distributing systems and increasing their radius of usefulness. The development of electric railway rolling stock has continually opened up new fields until now when the limitations of the steam locomotives are being most acutely felt upon our increasingly congested trunk lines, the electric locomotive is so far perfected and proven successful in the daily operation of the electrified divisions of several well-known steam roads, that the most conservative must admit its fitness for certain classes of service."

Railways and the Telephone.

It is significant of the progress which has been made by the telephone on our railways, that beginning with the first number of the New Year, the *Telephone Engineer* has established a department devoted exclusively to railway telephony, which is rapidly becoming one of the most vital components of the mammoth transportation system of this country. Among the most recent developments the Chicago and Milwaukee Electric Railway Company has decided to instal its own telephone service to be used for the dispatching of trains, and in the near future the stations of the Wisconsin Telephone Company at the various points along the electric line will be taken out to give way to the new service. The Illinois Central Railroad is now putting in telephones throughout Iowa, and the Northwestern has made arrangements to instal a complete telephone dispatching system from Chadron to Long Pine, in Nebraska, a distance of 198 miles.

Large Hydro-Electric Project.

An important hydro-electric is shortly to be put in operation in Oregon by the Portland Railway, Light and Power Company. The scheme involves the construction of three new power plants on the Clackamas River, and one steam power plant in East Portland at an expenditure of $5,000,000 in the next three years. The power sites involved have already been purchased, and orders for the

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machinery to be installed have been placed, while the actual work of building dams, sluicing away earth for buildings and dams and of clearing the power sites has already begun. The three plants on the Clackamas River are to be known as the Clackamas, the Morris and the Upper Clackamas Plants. The latter will have a reservoir seven miles long up the Clackamas River, while the dam will be 155 ft. high and 750 ft. long, and constructed of solid masonry.

Mr. Morgan and the Telephone Deal.

According to a statement issued from Messrs. J. Pierpont Morgan and Company's offices here, "there is no trust, or a contemplation of any telephone trust, as a result of the acquirement by the firm of J. Pierpont Morgan and Company of telephone properties in the Middle West." The firm of J. P. Morgan and Company, it is added, bought these properties in the Middle West for the simple reason that they could be acquired at a reasonable price, and, secondarily, because J. P. Morgan and Company considered them a good investment. While it is true that Mr. Morgan's relations with the American Telephone and Telegraph Company (the Bell concern), are inharmonious, there is no foundation, it is declared, for any statement which would suggest that Mr. Morgan is co-operating with that, or any other corporation, in the formation of a telephone trust.

An Electric Railway Merger.

The combination of all the transportation lines in Chicago, surface and elevated, with a central company furnishing power and the probability of taking in interurban railroads is the plan of the new company which has consolidated the south side street car lines and taken over the J. Pierpont Morgan interests in Chicago traction. Mr. Ira M. Cobe, one of the leaders in the organization of the new Chicago City and Connecting Railways Company, states that the main reason for taking in the Hammond, Whiting and East Chicago Railway was because it formed a natural gateway for the interurban chain of electric roads between Chicago and New York City. Financiers said that it was planned to merge all the local transportation lines. These with the Commonwealth Edison Company represent a total capitalization in stocks and bonds of $36,514,281.

Electricity in the Home.

Mention has already been made in these notes of the marked degree of expert attention which is paid by electrical manufacturers in this country to the development of articles calculated to popularise the domestic use of electricity. One of the latest articles to be put on the market in this connection is a combined heater, cooker and toaster, for which many attractive qualities are claimed, not the least important of which is economy. The heater comprises a small and extremely neat metal frame which embodies not only the heating element but a highly ingenious toaster which takes the form of a drawer with a false bottom of wire. Perforations in the top of the frame provide for the use of a chafing dish, frying pan, kettle or saucepan, or any other ordinary cooking utensil, no special expenditure in this direction being necessary, while the system of arranging the heating element is such as to ensure the minimum of waste. The heating units, composed of special non-oxidizing alloy, are spiral in shape and of such construction that they can be readily renewed with the aid of a pair of pliers. A mica strip running lengthwise of each heating unit serves as a support for every convolution of wire, thus preventing any possibility of short circuits. A three-contact switch is provided which enables low, medium and high heats to be secured, thus insuring a minimum consumption of energy. The device is being introduced by the Central Electric Company of Chicago.

Current Items.

Electric fans have been installed in the vaults in the Nardin building in order to preserve the city records and books of the different departments which are stored there. Their installation follows a suggestion that a free circulation of air would prevent the books and papers from becoming mildewed. Much trouble has been experienced in this regard by the city officials in that building since it has been remodelled.

Application has been made to the Canadian Parliament by a newly organized corporation known as the Niagara Falls, Welland & Dunville Electric Railroad Company, for the right to build an electric road from Niagara Falls, Ont., to Dunnville. The proposed route extends from Niagara Falls, Ont., to Allenburg, along the east side of the Welland Canal to Port Robinson, through Welland and the Air Line Junction, then west by the Forks Road to Dunnville. The total length of the proposed route is about 50 miles.

To prevent light consumers from using old bulbs after they have grown dim, a manufacturer of incandescent lamps is now making what they call a suicide lamp. This is a lamp that will burn only so many hours and then commit suicide, or in other words, "bust," necessitating the consumer getting a new lamp. This might save the electric station manager some abuse, but it is doubtful; other causes for such will surely arise incidental to the introduction of such a lamp.

The Consolidated Reservoir & Power Company, of Los Angeles, will start work shortly on its system by which it will bring the water of the Whitewater River to irrigate lands adjacent to Banning. The intake will be in the San Bernardino mountains at an elevation of 7,000 ft. and five miles below the intake the company will put in its first power house for the development of electrical energy.

GERMAN NOTES.

BERLIN.

Much has been written about the effect of currents of electricity in improving the growth of plants. The year just passed away has supplied some very interesting results, which have been fully reported by Dr. Breslauer. It has been shown that rye and wheat come earlier to maturity and make fuller ears when subjected to the influence of air ionised by currents carried over the field. This result was checked by neighbouring patches of land treated in exactly the same way, except that the air over them was not purposely electrified, although it is extremely probable that ionised air was carried on to these patches by the wind. The electrified plants always gave the better results. In future experiments, precautions will be taken to prevent this transference. The cost of the installation may be put at about 70s. per acre, half of which is for wiring and half for current production. As regards running expenses and labour, the cost is very small. The following data gives a rough estimate of the total cost for 150 days, that being about the time necessary to produce a crop, the area treated being 100 morgen, or say 60 acres. Interest on capital outlay, £30; repairs, £5; cost of current, £7 10s.; labour, £10; making a total of £52 10s. per annum. If we put a fair to middling harvest at half a ton per morgen the gross receipts for wheat can be put at £500 for the area in question. Now it is calculated that the increased yield by electro-culture increases the gross receipts by 30 %, *i.e.*, to £650, an increase which easily bears the 50 guineas expense just detailed. The whole subject is in a very experimental stage just at present, but German farmers and capitalists think highly of the prospects and the matter is attracting much attention in trade circles in Berlin and other large cities.

Statistics of Current Production.

The latest statistics of electrical power stations in Germany show how the generation of current for all its purposes is growing in that empire. In April, 1909, there were 2,050 works in the Fatherland, and they provided in all 4,650 places with light and power. The output of these works is about 1,200,000 kw., 93 having an output of 2,000 kw. and upwards. About two-thirds of the works are in private hands and one-third under the control of the State or of municipalities.

The Rjukanfos.

The utilisation – Ruskin would have called it the desecration – of this famous waterfall is proceeding rapidly. The Brown Boveri Co. is executing an order for five alternating current dynamos of 17,000 kw. each, to be driven by the water of the famous Norwegian cataract. They are coupled direct with 130 kw. and 220-volt exciting machines. This

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is the largest alternating current plant yet established in Europe. Each of these machines, with a speed of 250 r.p.m., can take up 14,450 h.p., so that with an efficiency factor of 0·6 and a tension of from 10,000 to 11,000 volts, they deliver a 17,000 kw. current of 50 periods. The power is used for preparing nitrogen from the atmosphere. Fireproof walls are being erected to prevent fire risks from extending from one machine to another. The total weight of each generator is in round numbers 200 tons, of which the armature and its sale make up about half.

Pola Wireless Telegraphy Station.

At Pola, at the head of the Adriatic, the largest wireless telegraph station on the European continent has recently been fully completed. It possesses a tower 300 ft. high, built on a foundation of glass, from which antennae spread over a ground surface of about eight acres. The station house is in two storeys, the upper serving as a dwelling place, the lower as a working place. The high tension room is isolated by thick walls and doors and windows of treble thickness. During the completion of the installation, the station has been constantly tested over comparatively short distances and has acted faultlessly. Full communication has been established with Berlin with a specially erected temporary station at Vienna and later with the city itself, and with Cattaro. Thus distances of 300 miles have been covered even before the arrangements were complete, and that with perfect success. Wireless messages were sent to the Kaiser on his yacht during his stay in Corfu, and during his voyage thence to Malta, whereby he was kept in regular communication with his Ministers in Berlin. The scope of the station will be largely extended during 1910 and 1911.

Company Notices.

The Grosse Casseler Strassenbahn Aktiengesellschaft is among the larger of the numerous German concerns of this nature which afford instructive figures. The length of the roads is now about 15 miles. The total receipts increased from 1,237,338 marks in 1907–8 to 1,266,411 in 1908–9, say 7d. per car mile, the expenses being about 4¾d. per car mile, a result well worthy of note. The net profit was 255,671 marks, as against 255,813 in 1907–8, so that the same dividend of 4½% could be paid for this year as for last.

Another small concern which shows the enormous advantage acquired by having water power available for generating electricity is the Società Italiana di elettrochimica of Rome. This company, which is in alliance with the Société Franco-Suisse of Geneva, made a net profit of about £20,000 in 1908–9 out of a gross profit of about £27,000 only. The gross profit for the previous year was £23,000. The company is offering £150,000 fresh capital for subscription at 4½% in order to increase its available h.p. by 24,000. Four generator groups each of 8,000 h.p., and giving a current of 80,000 volts, are to be laid down.

A company to be known as the Altmarkische Uberlandzentrale Gardelegen has been formed to supply about 120 places near Gardelegen and Stendal, in Saxony, with electricity for all purposes. Three million marks are to be spent. The initial current will be a high tension alternating current of 15,000 volts.

The Kraftwerke Beznau-Löntzsch made a net profit for 1908–9 of 828,695 francs, as against 669,402. Six hundred thousand francs go to pay a 5% dividend, that of last year having been 4% only. Large additions have been made to the works and are now nearly ready for use.

AMERICAN RETROSPECT.

Reviewing the progress of electric lighting and illuminating engineering in the United States, the *Electrical Review and Western Electrician* of Chicago, says :—

"Although there have been no radical departures in electric lighting and illuminating engineering during the past year, there has been marked and steady progress in improving electric light sources and in electrical illuminating methods. Both of these have resulted in the rapid extension of electric lighting along established lines and in its introduction into the formerly undisputed realm of its competitors.

"A review of the improvements in light sources might very well begin with the flaming arc lamp, which, on account of its great flux of light, has been found to meet very satisfactorily the requirements of a certain field of high-power illumination aside from merely spectacular lighting. On account of the relatively high cost of the carbons, special attention has been directed to methods for decreasing the waste in their consumption and diminishing the cost of trimming by increasing the time between trims. A number of inventors have directed their attention to this problem, with the result that several forms of magazine lamps, holding several sets of carbons that are automatically burned in succession, have been developed. A regenerative flame lamp has been perfected, in which the life of the carbons is materially increased by an arrangement of draughts that compels the complete oxidation of the products of combustion.

"The vertical-carbon type of flame lamp has come into extensive use where a fairly wide distribution is desired. The type of lamp with converging carbons is used in places where a high-power concentrated light is required. By mounting the latter lamps at a considerable distance above the plane of illumination, they also give a good distribution. In iron foundries they are now frequently mounted at a height of about 75 ft., thus giving abundant clearance for travelling cranes. For the lighting of important streets, flame arcs are rapidly coming into extended use in this country, as well as in Europe.

"The magnetite arc lamp has also seen considerable extension of use, particularly for street lighting, for which this lamp is peculiarly adapted. Improvements have been made toward making the lamp operate more steadily. A larger number of sizes is now available, so that they can replace any direct current series arc. The whiteness of the light, the relatively long life of the electrodes, and the satisfactory manner in which these lamps run on constant current has made them very popular for series street lighting.

"The titanium carbide arc lamp, which is an adaptation of the magnetite lamp for alternating circuits so as to eliminate the need of rectifiers, has received some attention, and a number of circuits have been installed. High cost of the electrodes and the comparative unsteadiness of the arc have hindered their general introduction, so that these lamps may be regarded as still in the experimental stage. However, when these difficulties are overcome, it is believed that this type of lamp will be as successful in replacing the alternating current inclosed series arc lamp as the magnetite lamp has been for displacing the old direct current open arc lamp.

"Outside of the development of a direct current enclosed arc employing small carbons and giving a very white light of greatly increased efficiency and frequently spoken of as the intensified arc, there has been no marked change in the direct current or alternating current open or enclosed arc lamps. By many it is regarded that the decline of these types of arc lamps has set in on account of their rapid substitution by flaming arcs, magnetite arcs, and even Tungsten lamps.

"The Westinghouse-Nernst system of lighting has extended its sphere of adaptability during the year by the development of what is called an instantaneous lighting unit. This type of Nernst lamp has a heater in the shape of a silicon filament, which becomes incandescent at the instant that the current is switched on, and, therefore, furnishes some light immediately before the Nernst glower proper has come into full play. This improvement has made the Nernst lamp serviceable for residence lighting, in which it has been unsuccessful heretofore, because the glower required nearly one minute to become fully incandescent. Further improvements in the Nernst efficiency and an increase in the variety of the units have enabled this type of lamp to remain an active competitor in the electric lighting field.

"In the way of tube lighting, both the Moore tube and Cooper Hewitt systems have been further developed. The auxiliary details of the yellow Moore tube, containing nitrogen, and of the white Moore tube and Cooper Hewitt systems have been improved. A compact form of the white tube, called an artificial daylight window, has been brought out for colour-matching purposes.

"The Cooper Hewitt mercury-vapour tubes have been improved as to both the electrical and mechanical features

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of their design. A larger proportion of automatically started lamps are now in service. Partly as the result of these facts, the records of a very large number of installations show a decrease in maintenance for renewal of tubes of about 15% over last year. The cost of maintenance per kilowatt-hour is said to be less than one-half cent. A new type of automatic lamp, having two tubes side by side that can be placed in multiple for 110 volts or in series for 220 volts, has been brought out. The number of Cooper Hewitt installations in industrial plants has been increased very largely during the year. This is mainly due to the growing appreciation of the value of general illumination, and for this the Cooper Hewitt lamps have been found peculiarly suited, because their high efficiency and complete light distribution permits them to be placed as near as possible in the same location and direction as the natural light enters by during day.

"In the line of metallic filament lamps both the tantalum and tungsten lamps have been improved and adapted for still other kinds of service. As to the former, the most marked improvement has been that which has adapted it for street-railway lighting. For direct current traction systems they have been found to give very satisfactory results in both the 16 and 32 c.p. sizes. This lamp can be burned at any angle, and if the filament should become broken, it can be rewelded with a little skill, so as to make the lamp again serviceable. These lamps are rated at 2·3 watts per c.p.

"A number of very important developments in tungsten lamps were made during the year. Among these were the production of a sign lamp taking 5 watts at about 10 volts; further types of miniature and low-voltage lamps; improved and larger varieties of street series lamps; also both larger and smaller sizes of 110 volt multiple lamps. The series tungsten lamps are now made for currents up to 9·6 amperes, so that they can be substituted on any standard series arc circuit. It has been found that they can be used on circuits with frequencies as low as 25 cycles without perceptible flicker. The 110 volt lamps are now available in sizes from the new 16 c.p. type, which is the smallest, to the 200 c.p. type, temporarily the largest. Other types and sizes are being perfected.

"Along with these new types there have been improvements in efficiency, life and toughness of the filament. In certain special miniature lamps the efficiency has been brought to 0·9 watt per c.p. The average useful life has been found to be well above the rated 1,350 hours for street series lamps and over the rated 800 hours for 110 volt multiple lamps. Breakage in shipment has been reduced to very small proportions, and breakage in service has been decidedly decreased as proper care of the lamps has become better known. Several types of shock absorber have contributed to this result also.

"The alarm with which many central station companies regarded the introduction of the tungsten lamp has been almost universally found to be unwarranted. Experience has shown that the diminished current consumption on the part of some consumers, who have availed themselves of the high efficiency lamps to reduce their lighting bills, has been offset by the demand from a large number of new consumers, who have been attracted to electric lighting by its diminished cost as well as inherent advantages. Large numbers of consumers have adopted the tungsten lamp not so much as a means of reducing lighting bills, but rather as a means of securing better illumination both as to quantity and quality. It is unquestionable that the tungsten lamp has come to be generally utilised to extend electric lighting into spheres, where its foothold has hitherto not been very secure.

"As a result of extended study of the subject of heterochromatic photometry, it has been proposed to use a tungsten lamp instead of a carbon incandescent lamp as a secondary standard in comparing light sources of different colour.

"That the study of the scientific and practical aspects of the problems associated with illumination is attracting worldwide interest is indicated by the formation in England of a sister organization to the Illuminating Engineering Society of America.

"While the progress in electric lighting and illuminating engineering during 1909 was not startling, except as to its breadth and steadfast character, the indications are that 1910 will bring some radical developments both in electric light sources and illuminating methods.

"The development of the metal filament lamp has been essentially a matter of laboratory research and technical refinement. Consequently, the announcements made, to become effective January 1, 1910, of the new 'Mazda' lamp, is of great interest and timeliness. Arrangements have been made whereby the technical staff of the research laboratory of the General Electric Co., in collaboration with the technical staff of the National Electric Lamp Association and others, shall regularly follow the work done in the factories and laboratories of the leading foreign and American lamp companies, keeping constantly informed as to the progress and development in methods and processes in each. This information will be available to the lamp manufacturing companies enjoying the benefits of this arrangement. For the purpose of identifying the lamps made in accordance with the information thus secured, the research laboratory has adopted as a trademark the word 'Mazda,' this name on any metal filament lamp to indicate that the expert knowledge and skill of its technical staff entered into the production of that lamp, and that the best materials and processes known to it as fitted for that type of lamp have been employed in its manufacture."

ELECTRICAL PROGRESS IN JAPAN.

A copy of the *Japanese Weekly Chronicle*, just to hand, contains some interesting news concerning electrical enterprise out there.

It appears that a meeting of those engaged in electrical business in the Kwansai district, recently held at Himeji, considered a proposal of the Kyoto Electric Light Co. that the Government should be induced to define its policy on the question of granting a charter to a new company engaged in electrical business in a place where another company is already at work, as the establishment of a new company in these circumstances tends to injure the interests of the existing undertaking. The meeting also considered a proposal made by the Saiga Denki Shokwai, a Japanese firm dealing in electrical instruments, that the proposed increase of Customs duty on electric apparatus be carefully investigated and the result be represented to the Government, as an increase in the duty would hamper the trade in electrical appliances. Finally, a proposal was discussed to ascertain the views of the business men concerned on a proposed new law dealing with electrical business, as the adoption of such a measure may be of serious moment. It was agreed that these matters should be considered in co-operation with the Tokyo Electrical Society, and an endeavour made to fully protect the interests of those concerned.

Our Far East contemporary gives some details of an interview with Mr. J. M. Howell, who was sent out to Japan from England by the British capitalists interested in the Anglo-Japanese Hydro-Electric enterprise. Mr. Howell appears to be of opinion that there is a good field for business enterprise among our allies. He declared that "most Japanese industries at present are conducted in a very uneconomical manner. The harvesting and other processes of rice, for instance, are carried out in a very slow and primitive method, and there is much room for improvement. If more use were made of machinery and motive power than at present it would be of great advantage to the country. At present very little use is made of river water, which, if properly utilised, is capable of producing a large amount of power. In America, cities having an equal population to that of Japanese cities, ten times more use is made of motive power. I have no doubt that Japan will, sooner or later, be induced to avail herself of motive power as liberally as does North America. I have been working for a Japanese and foreign joint enterprise with this end in view, and it is on the threshold of consummation.

"It is not very difficult to ascertain the economical value of a particular hydro-electric enterprise. The most expensive part of the engineering work is tunnelling to make a water way. Tunnelling costs 70 yen* to 100 yen

* The approximate value of a yen is 2d.

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per foot; so that the length of tunnelling required makes a great a great difference in the cost of hydro-electric engineering work, which in turn causes a difference in the price of the power to be supplied. The shorter the length of tunnels the greater will be the prospects of the enterprise. The tunnels to be made by the Anglo-Japanese company are only five or six miles in length, and of a comparatively small diameter. It is evident that, compared with similar schemes which require tunnels of 15 to 20 miles, the difference in the coss of engineering work and the price of power will be great. The cost of electric power is, on the other hand, affected only to a small extent by the distance between the source of generation and the place of consumption, because the cost of connecting wires is a mere bagatelle as compared with that of tunnelling, while the work is easy. Again, the waste of electric power in transmission over a long distance is so insignificant that it does not materially affect its price. Whether the distance between the source of generation and the place of consumption is five or 100 miles, it does not much affect the economic value of an enterprise. As already explained, the prospects of a hydro-electric enterprise should be gauged by the length of tunnels to be constructed."

THE CHOICE OF PRIME MOVERS FOR POWER STATIONS.*

By E. T. DRIVER.

The subject of which is the best and most economical prime mover to employ in modern power stations is one of great importance, especially when the recent development of the internal combustion engine is taken into account. Undoubtedly there is a great future for this type of engine, including those working on the Diesel principle.

Choice of Site.

The ideal site, when the station has to supply a comparatively small area, is at the electrical centre of gravity of the demand, *i.e.*, the point in which there is the greatest demand for energy within unit radius.

The following are important points for consideration:

1. Accessibility, as regards delivery of fuel, removal of ashes, delivery of the plant and stores; also for connection to mains.
2. Plentiful supply of water for steam raising and cooling purposes.
3. Cost of constructing foundations and buildings.
4. Nuisance to adjoining property.
5. Facility for extension.

In practice it is not always possible to obtain a site fulfilling all requirements, so that each site must be separately considered on its own merits.

Available Prime Movers.

The following are suitable types of prime movers:—

1. (*a*) Compound and triple expansion condensing steam engines.
   (*b*) Steam turbines.
2. Gas engines.
3. Oil engines working on the Diesel principle.
4. Water turbines.

Although the steam consumption of triple expansion engines is somewhat less than that of corresponding compound engines, owing to the smaller capital cost and freedom from breakdowns of the latter, the use of them is preferable to the former type.

The use of the steam turbine has greatly increased, owing to its great overload capacity, low steam consumption, freedom from vibration and the ease with which large units can be made. Its small floor space is also in its favour.

Rapid developments have recently been made with large gas engines in conjunction with producer gas plants. Units of 3,000 to 5,000 b.h.p. are now obtainable, while one German firm is now constructing a unit of 8,000 h.p. Although these engines are not in use in this country so much as on the continent, yet even in this country they must be reckoned as a rival of some appreciable importance to the steam turbine. Their high capital cost and somewhat high cost of repairs are disadvantages, yet the high thermal efficiency and low cost of generation per unit are greatly in their favour.

The Diesel oil engine has the greatest thermal efficiency of any engine, being as high as 38%, as against 20 to 25% in the case of a gas engine and 12% in a high-class compound condensing engine. This type of engine, owing to its efficiency, small variation of fuel consumption at varying loads, and total absence of standby losses, is eminently suitable for use in power stations. As a reserve plant or means of coping with peak loads it should prove very useful. A disadvantage is that at present it cannot be made in sizes much larger than about 800 b.h.p., although as there is not a very marked difference between the efficiencies of large and small units, this is of no very great importance. Its overload capacity, similarly to the gas engine, is limited to about 15%.

The use of water turbines has not been much developed in this country, as no special facilities are offered for their adoption, although in America and other countries they have received a large amount of attention, and some excellent results have been obtained. The very high capital cost is their great disadvantage, although the working expenses are practically only those of superintendence. The overall efficiency of such plants often reaches 80%.

The paper concluded with a brief account of the capital and running costs of a moderate size station with a low load factor, when steam, gas, and oil plants, working under similar conditions, were employed. In regard to capital cost, the steam plant was slightly cheaper than the others. The gas plant gave a slightly cheaper cost of generation per unit than the steam plant, while the difference in the case of the steam and oil plants was greatly in favour of the latter.

* Abstract of paper read before the Northampton Institute Engineering Society, Northampton Institute, London, E.C., on Jan. 21, 1910. Mr. C. E. Larard, A.M.I.C.E., M.I.M.E., presiding.

THE NATIONAL ELECTRICAL MANUFACTURERS' ASSOCIATION.

During the past year this Association has dealt with many important subjects, and its activities are briefly summarised below:—

1. Railway and Shipping Rates.
   (*a*) *Metallic Filament Lamps.* The manufacturers of metallic filament lamps have for some time had considerable trouble with the railway companies regarding damage in transit. Delegates from the Association held a conference with the railway company officials, with the result that the railway companies have decided upon a new classification for such lamps, which, in practice, amounts to a reduction of 15% off the former railway rates.
   (*b*) *Recording Ammeters.* The transit of recording ammeters by rail was a matter which was also taken up by the Association, with the Railway Clearing House, and the cost of carriage in this case was also reduced.
   (*c*) *Shipping Rates to South Africa.* The Association obtained a reduction in the freight of electric lamp shades to South Africa.

2. Parliamentary.—The Association has guarded the interests of manufacturers in so far as they were affected by the recent Electric Lighting Acts Amendment Bill. The Association has been successful in influencing the retention of a clause in the Bill relating to hire apparatus, whereby machinery which is now let out on hire by Electric Supply Authorities to users cannot be distrained on.

3. Status Bureau and Collection of Debts.—Early in the year the Association revised its existing arrangements in connection with its Status Bureau. The Association has now entered into an agreement with the British Traders' Association, the results of which have proved to be very satisfactory. Members now receive information very definitely and promptly, and as large numbers of manufacturers are now using the same source for their private information, the value of the replies to such enquiries has materially increased, and probably for the first time constitutes a useful record in the commercial annals of the electrical industry. In addition to this, members now have their debts collected, free of cost, in

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England and Wales, and can consult the solicitor of the British Traders' Association, free of expense.

4. *v.* LAW.—In legal matters the question of trade customs frequently arises.

(*a*) An action was brought against a member of the Association for insufficient notice of dismissal. The judge considered that the case depended on whether it was the trade custom to give an engineer, who was employed in the Sales Department, and paid by a monthly salary and commission, one month or three months' notice. The Association was able to show that one month's notice was the customary notice, and the member was successful in the case.

(*b*) The Association also established a trade custom recording the allowance of cash discount. Many firms were claiming cash discount when making payment after considerable intervals of time, but it was found that this was not the ordinary trade practice; and it was decided that cash discount could only be allowed, subject to the following conditions: "All goods supplied during any calendar month are due for settlement on or before the last day of the following month, unless shorter terms have been arranged."

5. SECTIONAL MEETINGS.—Meetings of different classes of manufacturers have been arranged for various purposes, such as manufacturers of electric light fittings, with a view to overcoming various difficulties regarding the extended loans of fittings on sale or return, also to consider what could be done regarding the wrongful usage of designs; and manufacturers of metallic filament lamps to consider the question of the railway transit, which has been referred to above.

6. EXHIBITIONS.—Various matters relating to exhibitions have been dealt with from time to time, and members have been kept posted with information regarding various foreign and English exhibitions.

7. KINDRED ASSOCIATIONS.—The Association has nominated members of the Engineering Standards Committee and of the Institution of Electrical Engineers Committee for the revision of the "Model Conditions of Contracts."

8. ELECTRICAL TRADES' BENEVOLENT INSTITUTION.—The N.E.M.A. has also forwarded the interests of the Benevolent Trades' Institution, which was founded by it in 1906.

THE POWER PLANT OF THE ONTARIO POWER CO. AT NIAGARA FALLS.*

By Mr. C. W. JORDAN, Assoc.M.I.M.E.

The development of electrical power at Niagara Falls has long attracted widespread attention and interest. Since the first installation upon the American side, descriptions and discussions of its works and methods have been granted a conspicuous place in technical records and the scientific press. Apparently, therefore, a paper such as this is not needed, especially as a few years ago a very complete description of the American installation was given in a Lecture† to the Graduates of this Institution by Professor Unwin; but the fact is apparently less known that there now exist at Niagara four more installations, each larger than the pioneer plant, and one at least differing from it to a very marked degree in the method in which the turbines are employed and coupled to the electrical generators.

The author, having paid a visit to Niagara in December, 1907, when exceptional opportunities were afforded him of inspecting the whole plant of the Ontario Power Co., takes the present opportunity of recording for the members the following notes, which may supplement the knowledge of the subject hitherto available, especially so as after the completion of these notes correspondence took place with the Ontario Power Co., with the object of eliciting further information, and photographs were received illustrating the operations of the company. The suggestion was also made that possibly the Chief Engineer could see his way to contribute a short supplementary paper to the records of this Institution, and so to present an official and up-to-date account of this interesting engineering achievement.

With their customary courtesy, the Ontario Power Co. sent over all the printed information at their disposal, a very complete set of photographs and maps, while Mr. V. G. Converse, their Chief Engineer, hoped to be able to contribute a short paper, but unfortunately business ties have prevented his doing so.

It has therefore been deemed advisable to reprint in this paper many extracts from the information furnished by the company.

SCHEME.

Briefly outlined, this company's development comprises the taking of water from the Upper Niagara River above the Horseshoe Fall, leading it through pipes and penstocks to turbines in a station below the Fall, and there utilizing its energy for the generation of electricity, which is transmitted to a second station on the hill above, and thence distributed. There is a fall in level of 55 ft. in the rapids above the Horseshoe Fall, and to take advantage of this the headgates are placed just above the rapids. From the headgates three great steel and concrete tunnels or conduits, laid below the surface of the Victoria Park, will convey nearly 12,000 cu. ft. of water per sec. to the top of the cliff above the power-house, and just beyond the Fall. Thence it will pass through twenty-two steel penstocks in shafts and tunnels down and out through the cliff to an equal number of horizontal shaft turbines in the power-house below, which is situate on the water edge immediately at the foot of the Horseshoe Fall. From the generators, the electrical cables will pass through tunnels to the twenty-two banks of switches, transformers, and instruments in the distribution station on the hill above, and thence to the transmission lines beyond, the whole installation, when complete, being capable of an output of over 200,000 h.p.

The intake works for the entire 200,000 h.p. are now finished. One of the three main conduits is completed and in use; while the portals and headworks for the second and third tunnel are completed, and a portion of the excavations made. Six of the twenty-two penstocks are completed and with their turbine-sets are at work, and at the time of the author's visit the seventh was practically completed. The distribution-station building is complete for the switchboard of the entire twenty-two units, for the transformers of eight, and the other apparatus of fourteen units, and is well ahead of the developments in the power-house.

The most important engineering features wherein this latest company differs from its predecessors are the arrangement of intake works, the design of main conduit and spillway, the horizontal shaft turbine units, the symmetry of arrangement of the whole, the centralization of control, and the protective isolation of the various apparatus.

PARTICULARS OF NIAGARA RIVER AND THE FALLS.

The total drop in the Niagara River in its course of 36 miles between Lake Erie and Lake Ontario is 326 ft., of which 216 ft. is in the Falls, and the rapids immediately above them.

The American Fall is 167 ft. high, and 1,000 ft. in width, while the Horseshoe Fall is 159 ft. high, and 2,600 ft. in width. The greatest depth of the river immediately below the Falls is about 192 ft. It is estimated that an average of 222,400 cubic ft. of water pass over the Falls each second. This is 25,000,000 tons per hour, or about one cubic mile a week, and represents a kinetic energy of nearly 5,000,000 h.p. At the head works of the Power Co. the river is 3,400 ft. wide, and flowing at an average velocity of about 8 ft. per second.

The height of the water in the Niagara River, and therefore the volume available, is dependent on the surface elevation of Lake Erie the erosion of the river-bed, and such temporary causes as ice gorges, storms, etc. From calculations based on comparative observations extending over a number of years, and upon Government reports of Lake Erie levels for nearly 50 years, the elevations of the intake have been so selected that at extreme low water and most adverse conditions a full supply of water should be secured.

* Paper read before the Institution of Mechanical Engineers, January 7.
† Proceedings 1906, Part 1, page 135.

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Intake.

These works have been placed and designed not only to take advantage of the additional height of the Rapids as mentioned above, but also with special reference to the ice difficulties which have been the limiting factor in the success of Niagara power. Cake ice in enormous quantities floats down for weeks at a time from the Great Lakes, and mush ice is also formed in the rapids, primarily by the freezing of spray and foam, and secondarily, by the disintegration of cake ice. The latter trouble is avoided, since the intake is in the smooth water just above the rapids at a place where the current is very swift. To exclude the former trouble, the following precautions have been taken: a long and tapering forebay, protected at the entrance by the main intake, terminates at its narrow down-stream end in a deep spillway. Upon the river side it is enclosed by a submerged wall, while the other side near the spillway is occupied by the main screen building leading to the inner bay and to the portals and headgates of the three conduits.

The intake, which is nearly 600 ft. long, stretches across the inlet at Dufferin Island almost parallel with the current in the river. Throughout its whole length, a concrete curtain wall extends down 9 ft. into the water, which is 15 ft. deep at this spot, so that the gate openings beneath admit only deep water, and this at right angles to the swift exterior surface flow, which, sweeping the full length of the curtain wall, carries the floating ice past to the rapids beyond.

The intake is divided into 25 bays, through which the water is admitted at a velocity of 5 ft. per second. Provision is made for inserting stop-logs into each of the 25 openings in order to regulate the flow of water.

The outer forebay has an area of 8 acres, and a depth ranging from 15 to 20 ft., and is bounded on its downstream side by a submerged wall or dam 725 ft. long, terminating at the downstream end of the screen-house, which is 320 ft. long, built of reinforced concrete faced with Roman stone. The top view in Plate 1 shows the submerged dam, and the outer forebay with the screen-house in the distance.

The inner forebay is 2 acres in area with a depth of 20 to 30 ft., whilst the gate-house, similar in construction to the screen-house, is 120 ft. long and divided into six bays, two for each of the main conduits. The 18 foot 'Stoney' gates which guard the entrances to the conduits weigh 18 tons each, or 36 tons including the counterbalance. They were built by Ransomes & Rapier, and are operated by electric motors of 5 h.p. capacity.

At the main screen the same precautions for the exclusion of ice are repeated. This structure, which is 320 ft. in length, in 20 ft. depth of water, lies across the entrance to the inner bay, and parallel with the direction of flow in the outer bay. Here again, a curtain wall formed by the front wall of the superstructure admits only deep water to the screens, at right angles to the main current, while it is also excludes ice with the surface currents maintained through the forebay, by a huge spill of surplus water. At the gate structure, where the water is 30 ft. deep, the tapering portals leading to the electrically-operated Stoney headgates are protected with wide-meshed screens, which are also enclosed and safeguarded by a curtain carried by the front wall of the gate-house. There is an ample ice-run from the bay in front of the curtain to the river, and both at the headgates and screens an open canal spills into a gravity ice-run emptying into the river. Both buildings are supplied with steam for heating and thawing from an underground boiler plant, and the author can testify to the entire success of the heating. It was a bitter cold day, snowing and freezing hard, with a nasty wind, but inside these houses it was almost unpleasantly hot, in spite of the large masses of ice-cold water coming in continuously from the river. The water before entering the conduits must pass through three automatically selective steps each excluding ice, and in addition through two screens each behind ice-runs in heated buildings containing live steam for emergencies, and the experience of three winters has proved the above plan of excluding and preventing the formation of ice to be an entire success—"a record which is unprecedented for power plants in a climate like that of Niagara."

An electric overhead travelling-crane runs along the screen-house for removing the screen-frames for cleaning and changing when necessary, and as this building is situate in the Park the roof is flat and finished off as a promenade, access being obtained from the outside by broad steps at either end of the building, and from this point a magnificent view of the upper rapids is obtained.

Main Conduits.

These are of 0·5-in. riveted and reinforced steel imbedded in concrete 18 ft. and 20 ft in diameter and 6,500 ft. long, sunk beneath the surface of the Park. The water flows through them at an approximate velocity of 15 ft. per sec. "The only conduit at present in service has a sectional area of 254 sq. ft., and is capable of supplying sufficient water for the operation of six generators at full load. The second and third conduits have not as yet been installed." Just beneath the top of the cliff, behind the power-house, is a long underground chamber 274 ft. long, 10 ft. high, and 16 ft. wide, with an arched concrete roof to support the conduit above. Riveted to the bottom of the main conduit are seven large tapered steel-castings leading to the 9 ft. valves and penstocks below, each supplying water at 10 ft. per sec. to a single horizontal shaft turbine in the power-house below. Each penstock has two expansion joints, a massive thrust anchorage in the power-house foundations, an automatic relief-valve, and a stone catch which discharges straight into the river. "Six of the valves were made by Ransomes and Rapier, and are intended to withstand pressure from above only. The seventh valve, made by Pratt and Cady, of Hartford, Conn., is built to withstand pressure on either side. Each valve is operated by a 30 h.p. induction motor controlled either locally or from the switchboard in the generating station, and may be fully opened or closed in three minutes," and is so constructed that all working parts may be removed for cleaning, repairs, and renewal while the penstocks are in service.

Spillway and Weir.

The spillway at the end of the conduit, which is intended to prevent water-hammer in the case of sudden loss of load, is little more than the enlarged end of the main conduit, raised and fitted with an enclosed weir and underground discharge. The weir is adjustable as to height, and the discharge tunnel after a steep initial pitch in the taper from the weir follows a uniform grade and symmetrical curve while circling about to reach the river in a helix, thus preserving a water column which is smooth and unbroken, of highest velocity and least expenditure of energy. This has the effect of preventing erosion, restricted flow, and excessive air-suction, the latter on account of the danger of ice forming from the spray under forced circulation of air.

Penstocks.

"The penstocks are 307 ft. long on the centre line and 9 ft. inside diameter, built of steel $\frac{3}{8}$ in. thick at the top, and $\frac{7}{8}$ in. at the bottom. Shafts and tunnels, two penstocks in each, carry them to the generating station. The lower 60 ft. of each shaft is filled in with concrete around the penstock, as the rock here is soft shale." Plate 2 gives a section of the main conduit, showing the penstocks, also the helical spillway.

Location of Power House.

The power house is situated on the river bank nearly at water-level and close under the Horseshoe Fall, and it is an interesting and important point that the full head of water between the upper and lower rivers has been acquired so far as was possible from an economic standpoint, while the huge and costly excavations rendered necessary in the previous schemes have also been dispensed with, resulting in a greatly reduced capital expenditure.

Owing to limited space the generating station is only 76 ft. wide, but, when completed, it will be nearly 1,000 ft. long; the generating units stand side by side in a single row right down the centre of the building, the turbines being on the land side and nearest their source of supply. The space between them and the rear wall is occupied by a gallery, upon which are mounted the oil pressure governors, each almost over the end bearing of the turbine it controls.

"The mean water-level at the generating station is 343 ft. above tide, though it varies from 338 to 365. The walls of the generating station are of concrete, the rear wall being 12 ft. thick at the bottom and the river wall 9 ft."

(To be continued).

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BUSINESS NOTES AND NEWS.

LIGHTING AND GENERAL—Home.

BELFAST.—The City Council have instructed the Electrical Engineer to proceed with the extension of the main in Osborne-park and Lisburn-road. Tenders for the 1,500 kw. dynamo and condensing plant were opened, and referred to the engineer for report.

COVENTRY.—An increased demand for electricity, chiefly for power purposes, necessitates considerable extension of plant. The Electric Light Committee recommend a total outlay of over £54,000 on this department. It is proposed to spend £39,000 on additional machinery and £13,000 on cables and transformers. Electricity and gas are both controlled by the municipal authority, and both are profit earning concerns. A large revenue is derived from the letting of electric motors on hire.

GILLINGHAM.—The Electric Light Committee have under consideration proposals to lay mains in two streets, at a respective outlay of £28 and £180, the estimated revenue from the new connections thus opened up being put at £12 and £300 per annum. Heating by electricity seems to be becoming popular, particulars of radiators on hire being as follows:—Cost of 30 radiators purchased for hire to consumers, £93 16s. 3d.; number on hire at present, 24; number in stock, 6; revenue received from hire to September 30, 1909, £16 10s.; revenue by sale of current to September 30, 1909, £106 15s. Mr. Newitt, Chief Electrical Engineer, H.M. Dockyard, has asked the Council to quote for the heating of the Naval Hospital by means of electrical radiators.

GLOUCESTER.—There has been another gratifying increase in the output of the Electricity Works to the amount of some 7,000 units. This meant an increase in revenue of £97, and at the same time they had been able to turn out this increased quantity with a very considerably less consumption of coal. Their coal bill for the month was £177 12s. 6d., as compared with £210 3s. 8d. in the corresponding month of last year. The total works expenditure showed a decrease of £21, showing a net improvement of £118 in the earnings of the undertaking for last month. During the month they had also made new connections equivalent to 692 8-candle lamps.

KENDAL.—The Town Council having received the Local Government Board sanction to borrow a sum of over £2,000, chiefly for cable extensions, it was decided to call in an expert to advise on the expenditure.

KING'S LYNN.—Six additional electrical street lamps are to be erected. A number of new private connections have been made, bringing its separate consumers up to 723.

LOWESTOFT.—The Town Council have decided to apply to the Local Government Board for a loan of £1,500 for the provision of meters, and £1,000 for public lighting; also £350 for new air pumps for the condensers. The engineer was authorised to distribute a bonus of £5 among the stokers and trimmers at the station as a reward for reduced coal consumption, and also to offer a bonus of £12 to the stokers and trimmers at the station, to be paid, provided coal costs at the end of the year do not exceed ·5 of 1d. per unit. The Town Clerk reported that the Local Government Board has sanctioned a loan of £1,822 for the provision of the new 250 kw. set and mechanical stokers, repayable within 16 years from the date of borrowing.

LYTHAM.—The Urban District Council have sanctioned the Fairhaven Wesleyan Church taking a supply of electricity from the Blackpool, St. Anne's and Lytham Tramway Co.'s works.

NEWPORT (Isle of Wight).—A dispute has arisen between the Town Council and the local Electricity Company with regard to the public lighting of the streets. Complaints are made that the arc lamps are worn out and obsolete, and the company has been called upon to substitute 1,000 c.p. globe lamps. At present there are 30 arc lamps used, and the contract amounts to about £420 per annum.

OLDHAM.—The last fortnightly report shows that the increase in incandescent lamps during the fortnight was 60, making a total of 33,073; in motors three, making 538; and in equivalent lamps of eight candle-power, 508, making 160,818.

REDDITCH.—The Council decided to order one 50 k.v.a. transformer, 110 yards 7/14's concentric cable, two joint boxes, and two meters on capital account. During December additional services have been laid for 108 8 c.p. lamps, and 32 h.p. in motors equivalent to an increase of 1,224 8 c.p. lamps. These figures show an increase during the year 1909 of 4,282 8 c.p. lamps, as against 3,627 for 1908.

WIDNES.—The Town Council have entered into an agreement with the Salt Union for the supply of electricity within the borough. The maximum charge for lighting to small consumers is to be 4d. per unit, to small consumers for power purposes 2d. per unit; large consumers, primarily for power purposes, 1⅛d., consumers not to use less than 300,000 units per annum; maximum price to be charged to the Corporation for traction purposes, 1d. per unit, and for all in excess of 500,000, ¼d.; for purposes of public lighting, 2d. per unit.

WOLVERHAMPTON.—The Local Government Board have sanctioned the Town Council application to borrow £15,000 for the extension of the electricity mains, repayment to be made within 25 years.

WORCESTER.—Mr. Shaw, the City Electrical Engineer, having reported that the breakdown of an alternator at Powick works and that a similar accident occurred a year ago; that as this alternator and one of the other alternators were old and unreliable, the Council adopted his recommendation that they should be sold, and would probably realise £150 or £200, while the Insurance Co. would pay £55 in settlement of their liability; and he recommended the transfer to Powick of the direct-current portion of the No. 1 machine at Hylton-road, and the purchase for Hylton-road works of another of 100 to 120 kw. capacity at a cost of £280, and the looping in of the 15 h.t. feeder, which was out of service, at a further cost of £95, which latter sum, being for a cable along Hylton-road, should be paid out of the existing loan for mains. It has also been decided to establish a showroom for electrical appliances, to be shown by manufacturers and wholesale firms willing to make terms with local contractors.

YORK.—The electric tramway is now in working order, having passed the tests under the supervision of Mr. Hame, the City Electrical Engineer and General Manager of the Tramways, and Messrs. Dick, Kerr & Co., Ltd., the contractors.

LIGHTING AND GENERAL—Overseas.

BELLEVILLE, ONTARIO.—The Corporation have decided to enter into a contract with the Trenton Electric and Water Co., whereby the latter undertakes to supply electricity to not less than 37 2,000 c.p. electric arc lights and 252 incandescent lamps. The price for arc lights is to be $50, and for incandescents $10 a year. The company also agrees to supply citizens on the meter system, at 10 cents per kw. with 20% discount.

BOMBAY.—*Indian Industries* announces that an order amounting to Rs. 8,000 has been received by Messrs. Greaves Cotton & Co., of Bombay, for the electric installation at the Cama and Allbless Hospitals, and news has just been received that the firm's tender has also been accepted for the work at Ganeshkhind, Kirkee. This is by far the most important order which has ever been placed by the Bombay Government and amounts to nearly a lakh of rupees. The generating station will contain three Gardner high speed oil engines direct coupled to 16 kw. compound dynamos, large battery and switchboard.

CHARLTON, VICTORIA, AUSTRALIA.—A company has been formed, called the Charlton Electricity Supply Co., Ltd., and 5s. per share has been called up on 1,500 shares, as a preliminary to having plans and specifications drawn up and inviting tenders for the equipment.

LEEUWARDEN, HOLLAND.—The communal authorities have decided on the erection of an electric generating station, the cost of which is estimated at 260,000 gulden (£21,666); (2) that the burgomasters of Harmelen and Vleuten are endeavouring to arrange for the installation of electric lighting in all the communal districts to the south-west of the Province of Utrecht, the central station to be erected at Harmelen; and (3) that the inhabitants of Idaarderadeel have petitioned the authorities for the erection of a central generating station at that place.

MONTREAL (Ontario).—The contract for increasing the capacity of the generation plant of the Montreal Light, Heat & Power Co., at Lachine, has been awarded to Messrs. Morgan, Smith & Company, of York, Pennsylvania. The improved plant, which entails the expenditure of about $175,000, will increase the capacity of the power-house by 5,000 h.p. Work will be commenced at once, and by early spring the newly-installed machinery will be in operation.

POTCHEFSTROON (South Africa).—A municipal electricity scheme is to be carried out here.

RAMNICU-VALCEA, ROUMANIA.—The communal authorities have obtained powers to contract a loan of 200,000 francs (£8,000), half of which amount is earmarked for the enlargement of the electric generating station.

TRACTION—Home.

BELFAST.—Sixty-nine motormen of the Corporation Tramways have received the annual bonus for careful driving and freedom from accident during the year 1909, and 35 conductors the bonus for accuracy in their cash and daily accounts during the same period.

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TRACTION—Overseas.

CALCUTTA.—The Bengal-Nagpur Railway have ordered from the General Electric Co., Ltd., a steam engine and dynamo, and from Messrs. Armstrong, Whitworth & Co., Ltd., a centering machine.

HOBART, TASMANIA.—A Bill has been introduced into the State Parliament to enable a loan of £5,000 being granted to the Anchor Tasmanian Mining Co. for the construction of an aerial tramway to the Australian Mine. The company will pay the Government 4% for the money, and no profits are to be distributed until the loan is repaid. The Mount Balfour Copper Mines has also introduced a Bill to enable it to construct a railway, operated by steam or electric power, to connect the district with the port of Stanley, on the north-west coast. The company also seeks authority to generate electricity for power and lighting purposes from the waters of the Arthur River.

LEYDEN, NETHERLANDS.—The communal authorities have approved the application submitted by the "Noord-Zuid Hollandsche Tramweg Maatschappij" for powers to construct and work an electric tramway in the interior of the town. The line will be connected with suburban tramways.

MONTEVIDEO.—The Public Works Committee of the Uruguayan Chamber of Deputies have reported favourably on the project of Mr. W. P. Steer for an Electric Railway from Colonia to Montevideo and the Zabala Canal scheme. The State will guarantee 5% for 15 years on a cost of $11,000,000 gold. The energy derived from the canal will serve for motive power for the railway. The speed of the trains to be 90 kilometres an hour. Work to be concluded in four years.

NIAGARA FALLS, CANADA.—An application is to be made to the Parliament of Canada by a company for permission to construct an electric railway, about 50 miles long, from Niagara Falls Town to Dunnville. The company has a capital of $500,000 (about £102,750). The name of one of the directors of the company, to whom enquiries regarding the proposed railway might be addressed, may be obtained by British firms interested on application at the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, London, E.C.

QUITO, ECUADOR.—A Government Bill is before the National Congress providing for the construction of two railways: 1. A branch of the Inter-Andine Railway from a point between Tigsán and Huigra to Cuenca. The work must be completed within three years. 2. An electric railway, 170 kiloms. (about 106 miles) long, between Quito and Ibarra. The maximum cost per kilom. is fixed at 20,000 pesos gold (£2,000), and the maximum total cost of rolling stock, etc., at 1,800,000 pesos gold (£180,000). The line is to be completed within three years.

SANTA FÉ.—Messrs. Colson, Brookhouse and Pyne have applied to the Municipality for a concession for electric tramways.

COMPANIES NOTICES.

The Kraftwerke Beznau-Löntsch made a net profit for 1908-9 of 828,695 francs as against 669,402 for 1907-8. The power sold increased during the period from 66 to 79 million kw. hours. The water power of the concern has been improved for the small amount of 9 kw. hours, which had to be obtained in 1907-8 by means of steam engines has been reduced to 7 millions. Currents of 45,000 volts are now sold. The dividend has been increased from 4 to 5%.

COMPANIES REGISTERED.

CLYDE BRASS FOUNDRY, LTD.—Capital, £1,500, in £1 shares Objects: To carry on in the United Kingdom or elsewhere the business of brass founders and finishers, coppersmiths, mechanical and electrical engineers, metal merchants and refiners, etc. Private company. The first directors (to number not less than two nor more than five) are not named. Registered office, 20, West Scotland-street, Kinning Park, Glasgow.

FIXED PRICE LIGHT CO., LTD.—Capital £10,000, in £1 shares (100 Deferred). Objects: To carry on the business of electricians, mechanical engineers, generators and suppliers of electricity for light, heat, motive power or otherwise, etc. Private company. Registered office, Caxton House, Westminster.

G. WESTON & SONS, FTD.—Capital £5,000, in £1 shares (3,000 Preference). Objects: To adopt an agreement between G. Weston, A. P. Stone and H. Hill, for the acquisition of the business carried on at 153, Fenchurch-street, E.C., Sheen and Finchley by the said G. Weston and A. P. Stone, and to carry on the business of electric light contractors, electrical engineers, gas, light or heating contractors, ventilating engineers, etc. Private company. Registered office, 153, Fenchurch-street, E.C.

LUMINATOR WATER CO., LTD.—Capital £25,000, in £1 shares. Objects: To carry on the business of electricians, engineers, machinists, fitters, machinery makers, etc. Private company.

NEW MOTIVE POWER, LTD.—Capital £20,000, in £1 shares. Objects: To construct, manage or control in England railways, tramways, trolleyways, mills, factories, pumping or other works, manufacturers of and dealers in cycles, flying machines and other vehicles, electricians, electrical and general engineers, etc. Private company.

SHEFFIELD ELECTRIC POWER CO., LTD.—Capital, £2,000, in £1 shares. Objects: To acquire the business relating to the hire of electric motors carried on by W. E. Burnand, and to carry on the same and the business of mechanical, electrical and gas engineers, manufacturers of and dealers in electrical and mechanical appliances and devices, etc. Private company. W. E. Burnand is first managing director. Registered office, Chippinghouse Works, Lowfields, Sheffield.

TRAMWAYS, LIGHT & POWER CO., LTD.—Objects: To carry on the business of electricains, engineers, suppliers of electricity for light, heat, motive power or otherwise, manufacturers of and dealers in plant and apparatus, etc. Table A mainly applies. The company will be dissolved if all the shares are not taken up by February 10, 1910.

CONTRACTS OPEN.

Home.

BRISTOL.—City Docks Committee.—Electric lighting of Royal Edward Dock Passenger station. (Spec., £3, to Secretary Engineer, Cumberland-road). January 31.

HALIFAX.—Borough Council.—Annual supplies for Tramways and Electricity Departments. (Part., General Manager, Shircoat-road.) February 7.

ISLINGTON.—Borough Council.—Annual supplies of electrical and engineer's stores. (Spec., Town Clerk, Upper-street, N.) February 4.

LONDON, S.W.—London County Council.—Construction of conduit tramways (road-work and platelaying) from Brockley-lane Station to Forest-hill. (Part., £5, County Hall, Spring-gardens.) February 1.—London County Council.—No. 1, 3,000 tons steel girder tramway track rails and fastenings; No. 2, 1,500 tons slot rails and conductor tees. (Part., £2 each, County Hall, Spring-gardens, S.W.) February 8.

NEWPORT, MON.—Borough Council.—Stores for Tramways and Electricity Department. (Spec., 5s., Manager.) January 24.

ROCHDALE.—Borough Council.—Rails and fishplates for Whitworth Tramways. (Spec., £1 1s., Engineer, Mellor-street). January 24.

Overseas.

MELBOURNE.—With reference to an invitation by the Australian Postal Authorities for tenders for wireless telegraphy installations, the representative in London of the Commonwealth now notifies that certain alterations have been made in the general conditions governing this contract. Among other changes, tenderers are requested to include in their offers quotations for a range of 1,250 nautical miles, so as to ensure continuous communication with a station in New Zealand. Tenders will be received by the Secretary, Postmaster-General's Department, Melbourne, up to noon on February 22. The alterations, together with copies of the original conditions, etc., may be seen by British firms interested on application at the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, London, E.C.

ROME.—The Italian State Railways invite tenders for the supply of (1) a large lathe, driven by an electric motor, and (2) a milling machine, also electrically driven. Both machines are intended for the Locomotive Depot at Campasso. Tenders should be addressed to the "Direzione Generale delle Ferrovie dello Stato, Via Ludovisi," Rome, where they will be opened at 6 p.m. on January 26. The *Board of Trade Journal* says that, "It is understood that local representation is desirable when tendering for Italian Government contracts, and that, other things being equal, a preference of 5% is given in favour of Italian manufacturers."

WINNIPEG (Manitoba).—Tenders will be received up to Tuesday, February 15th, for the supply and erection of the various portions of the equipment for the terminal station at Winnipeg, and for the turbine governors and gate valves for the generating station. Specifications and plans, etc., may be seen at the office of Messrs. Smith, Kerry & Chace, Confederation Life Building, Toronto, and Carnegie Library Building, Winnipeg. Individual tenders will be received for:—Terminal station; step-down transformers and terminal station switching and accessory apparatus; terminal station, light, heat and power systems; terminal station, light, heat and power systems; testing transformers and apparatus; turbine governors (seven); two five-foot gate valves.—M. Peterson, Secretary, Board of Control.

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TENDERS ACCEPTED.

Home.

REDDITCH.—The Council have accepted the tender of Frederick Mountford, Ltd., for one year's supply of oil, at the following prices, be accepted: Cylinder 1s. 3d. per gallon, gas engine 10¾d., and machinery 10d. per gallon, all subject to a discount of 2½% cash monthly.

Overseas.

LOURENÇO MARQUES.—Messrs. Nagel & Kamp, of Hamburg, have been awarded the contract for the supply of an electric crane to the port. Their tender was not the lowest.

FINANCIAL NOTES.

It is understood that the subscription for the £325,400 sterling 4½% £100 debentures of the City of Calgary, Alberta, Canada, issued at 103½% by the Bank of Montreal in London, was quite a success. The money is required by the city for the purpose of the electric railway now running, extension of electric power system and extension of various public works of the city.

TRADE NOTES.

The Chloride Electric Storage Co., Ltd., have a further large order in hand for the supply of accumulators to the South Indian Railway. The firm are now represented in India by Messrs. Macbeth Bros. & Co., Bombay. Messrs. J. Stone & Co., Ltd., London, had a large order from the same railway for the supply of dynamos; and the Sun Electric Co., Ltd., for the supply of electric light fittings for passenger coaches.

The Western Electric Co. in the United Kingdom has now been registered as a limited Company. Mr. G. E. Pingree has been appointed Managing Director, Mr. J. E. Kingsbury remaining in an advisory capacity until the end of February.

Messrs. Stegmann & Co. have opened a fine showroom at Clapham Junction for the display of electric light fittings, heating apparatus, and other electrical appliances.

The Submarine Signal Co. inform us that their system is attracting much attention in New Zealand, where they have reason to believe a bell will shortly be placed in the neighbourhood of Terawhitti in Cook Strait. The firm have also received an order from Trinity House to provide an electric bell, similar to that placed at the North Stack, which will be installed near the Lizard Lighthouse. They are now also equipping the principal vessels of the Great Central Railway Co.'s fleet with receiving apparatus.

PERSONAL.

A new member of the Hydro-Electric Power Commission of Ontario staff is Mr. S. R. A. Clement, formerly attached to the switchboard department of the General Electric Co., Schenectady, U.S.A.

Mr. T. E. Mott, Chief Clerk and Collector in the Electricity Department, Bridlington, has received the additional appointment of Waterworks Collector at a salary of £125, rising to £150 plus £10 office allowance.

Mr. A. Blackburn, Car Works Superintendent, Belfast Corporation Tramways, has been elected a member of the Tramways and Light Railways Association.

Mr. F. A. Cortez-Leigh has been appointed chief electrical engineer to the London and North-Western Railway Co., his headquarters being at Euston.

Mr. E. J. Russell, Chief Clerk at the Croydon Corporation Electricity Works, has resigned his position. The Town Council have decided to appoint a successor at a commencing salary of £180 per annum, rising by annual increments of £10 to £230.

The Directors of the County of London Electric Supply Co., Ltd., have made the following appointments:—Mr. Bacon, who has been 13 years in the company's service, has been promoted from Resident Engineer at City-road station, to be Superintending Engineer over the company's stations. Mr. W. G. Hardy, promoted from first Assistant Engineer to be Resident Engineer, and Mr. L. Roseveare from Engineer-in-Charge to first Assistant Engineer at City-road station. Mr. H. B. Johnson, promoted from first Assistant Engineer to be Resident Engineer, and Mr. F. C. Sellens from Engineer-in-Charge to first Assistant Engineer at Wandsworth station.

CATALOGUES AND PRICE LISTS.

Bulletin 4002 of the Western Electric Co. relates to the Western Electric Telephone Instruments. It is very fully illustrated not only with pictures of different types of fittings, but with handy diagrams showing systems of connecting for all kinds of installations. A thoroughly practical production.

Last February Messrs. Siemens Bros.' Dynamo Works, Ltd., inaugurated an excellent idea: the preparation of a fine collection of lantern slides of their various manufactures, ranging from small supplies to complete installations. This new move proved very popular, especially among lecturers on technical subjects, as may be easily realised when we find two sets of 12 slides each dealing with loom driving by electricity, a set of 12 slides on mining electric machinery, and quite a large number of sets illustrating the electrification of many types of railways at home and abroad. A fresh list just issued contains particulars of many new sets, which Messrs. Siemens are prepared to lend to lecturers.

Messrs. Jens Orten-Böving & Co. send us an illustrated price list of the Zodel-Voith Patent Flexible Insulating Couplings.

The Maschinenfabrik Oerliken's latest leaflet deals with variable speed three-phase motors applied to the driving of machines for printing textiles.

Messrs. J. P. Hall & Co., Ltd., have produced a revised list of their electrical crane motors, which contains much interesting matter, appealing particularly to those requiring an electric drive where the load is intermittent and the duty severe.

A price list issued by Messrs. Cox-Walkers, Ltd., deals with their patent "Acetylyter" system of lighting motor car and cycle lamps. These are fitted with magneto or coil, and the switch is enclosed.

Messrs. Siemens Bros. & Co., Ltd., have prepared an illustrated booklet describing the Mulligan system of direct motor driving of automatic telegraph apparatus.

The Sun Electrical Co., Ltd.'s latest addition to their catalogue is an illustrated section relating to heating and cooking apparatus. The designs of radiators, both luminous and convector types, are mostly novel, and certainly very handsome. The domestic miscellaneous heating and cooking appliances are also excellent, and the prices moderate.

The Westinghouse Brake Co., Ltd., send us an advance copy of a leaflet illustrating and describing their metallic coupling for steam-heating pipes for railway trains, etc.

A catalogue of the Lamp Department of the Electrical Co., Ltd., contains many new items. Among these are the reflector rosettes with which any kind of letter or decorative sign can be constructed, taken to pieces and reformed. The whole process is very simple and effective. There are other forms of temporary decoration shown, as well as a fine selection of various kinds of lamps. A feature of this catalogue is that the trade terms, together with the name and address of the company, are printed on a perforated fly-leaf, which can be removed by any local contractor. A special circular is devoted to a medical adjustable lamp, specially designed for operative optical, dental and laboratory use.

ELECTRICAL ENGINEERS TERRITORIALS (London Division).—Orders for week ending January 29, 1910: Monday, 24, "A" Company, Technical Drill, 7 to 9.30 p.m.; Tuesday, 25, "B" Company, Technical Drill, 7 to 9.30 p.m.; Wednesday, 26, Gymnasium, 6.30 to 9.30 p.m.; Thursday, 27, "C" Company, Technical Drill, 7 to 9.30 p.m.; Friday, 28, "D" Company, Infantry Drill, 8.45 to 9.45 p.m.; Saturday, 29, "B" Company, week end run at Coalhouse, Parade at Fenchurch-street station, 3 15 p m.—(Signed), P. H. Campbell, Capt. R.E., Adjutant.

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DIARY.

FRIDAY, JANUARY 21.

NORTHAMPTON INSTITUTE ENGINEERING SOCIETY.—Visit to the Board of Trade Laboratory, Whitehall.

NORTHAMPTON INSTITUTE ENGINEERING SOCIETY.—"Choice of Prime Movers for Power Stations," by Mr. C. E. Larard.

NORTHAMPTON INSTITUTE ENGINEERING SOCIETY.—At 8 p.m., at the Institute: Lecture, "The Choice of Prime Movers for Power Stations," by Mr. E. T. Driver.

INSTITUTION OF MECHANICAL ENGINEERS.—At the Institution House, Storey's Gate, St. James's, at 8.p.m : "The Ninth Report to the Alloys Research Committee: On the Properties of Some Alloys of Copper, Aluminium and Manganese"; (With an Appendix on the Corrosion of Alloys of Copper and Aluminium when exposed to the Sea). By Dr. W. Rosenhain and Mr. F. C. A. H. Lantsberry, of the National Physical Laboratory, Teddington.

PHYSICAL SOCIETY OF LONDON.—At 5 p.m., at the Imperial College of Science, South Kensington: "The Polarization of Dielectrics in a Steady Field of Force," by Prof. W. M. Thornton, D.Sc., D.Eng., and "On the Use of Mutual Inductometers," by Mr. A. Campbell, B.A.

ROYAL INSTITUTION OF GREAT BRITAIN.—At 9 p.m., at the Institute: Discourse on "Light Reactions at Low Temperatures," by Prof. Sir James Dewar, D.Sc., F.R.S.

SATURDAY, JANUARY 22.

ASSOCIATION OF ENGINEERS IN CHARGE.—At 8 p.m., at the St. Bride's Institute, London, E.C., Discussion on Mr. Aldwinkle's paper on "Heating and Ventilation."

JUNIOR INSTITUTION OF ENGINEERS.—At 3 p.m.: Visit to the New Generating Station of the Westminster Electric Supply Corporation, Horseferry-road, Westminster.

MONDAY, JANUARY 24.

INSTITUTION OF ELECTRICAL ENGINEERS (Newcastle Section).—At 8 p.m. at the Armstrong College, Newcastle-on-Tyne: "On the Safety Devices in Coal Cutters," by Mr. H. J. Fisher.

INSTITUTION OF ELECTRICAL ENGINEERS (Leeds Local Section).—At Armstrong College, at 8 p.m., "On the Safety Devices in Coal Cutters," by Mr. H. J. Fisher.

TUESDAY, JANUARY 25.

INSTITUTION OF ELECTRICAL ENGINEERS (Manchester Section).—At 7.30 p.m. at the University, Manchester: "Equitable Systems of Charging for Tramways," by Mr. H. E. Yerbury.

INSTITUTION OF ELECTRICAL ENGINEERS (Manchester Section).—At the Physical Laboratory, University of Manchester: "The Generation and Electrical Transmission of Power for Main Marine Propulsion," by W. P. Durtnall, M.I.Mar.E.

WEDNESDAY, JANUARY 26.

INSTITUTION OF ELECTRICAL ENGINEERS (Leeds Local Section).—At 7.15 p.m. At the University, Sheffield, "Equitable Charges for Tramway Supply," by H. E. Yerburg.

INSTITUTION OF ELECTRICAL ENGINEERS (Leeds Section).—At 7.15 p.m., at the University, Sheffield, "Equitable Charges for Tramway Supply," by Mr. H. E. Yerbury.

THURSDAY, JANUARY 27.

INSTITUTION OF ELECTRICAL ENGINEERS.—At 8 p.m. at the Institution of Civil Engineers, Great George-street, Westminster, "Equitable Charges for Tramway Supply," by Mr. H. E. Yerbury.

FRIDAY, JANUARY 28.

INSTITUTION OF ELECTRICAL ENGINEERS (Leeds Section).—At 6.30 p.m., at the Metropole Hotel, Leeds: The Annual Dinner.

PATENTS.

Electric Motor Starting Switches.

2464—1909. SIEMENS BROS., LTD., London. In motor starting switches provided with a single operating lever and a self-contained current overload release arrangement having an armature which operates a main circuit interrupting switch, the armature is mechanically interlocked with the armature of the no voltage coil in such a way that the latter armature interrupts the main circuit by tripping the former armature as soon as a no voltage condition occurs.

Dynamo Electric Machine.

3352—1909. F. W. CARTER, Rugby. The brushes of the machine which is of the commutating type, protrude the side towards the receding commutator segment. The protuberance is such that the contact between the brush and the receding segment is bounded on the side towards the receding segment by an edge having no finite portion sensibly parallel to the edge of the receding segment.

Electricity Meters.

3300—1909. G. NORTH, Urmston. The meter has a rotary element comprising coils composed of thin aluminium. By this construction coils can be made having for a given weight of material an unusually large number of turns, together with a low resistance.

Electrodes.

7338—1909. NYA ACKUMULATOR AKTIEBOLAGET JUNGEN, Fliseryd. An active mass of iron and cadmium in a finely divided state are mixed together in about equal parts by weight in an active state, so that the discharge of the iron takes place according to a single curve of potential, namely, the high potential curve in order to avoid the formation of ferric compounds at the discharge of the low potential of the iron.

Alarm Fuses for Telephone Exchanges.

3573—1909. H. COOPER, Liverpool. The fuse comprises a length of insulating metal having a bracket at each end. A metal tube with part of its surface distinctly coloured, revolves freely on the insulating rod. A coiled spring, connected at one end to the tube and at the other end to the brackets, also revolves freely on the rod. A fuse wire is connected between the end terminal bracket in such a way that the coloured surface is an inconspicuous position when the fuse wire is whole, but when the fuse wire is blown the coloured surface is brought into a conspicuous position for attracting attention.

Electric Lamps.

7073—1909. E. FRENOT, Vincennes. The electric lamp is placed centrally in the interior of a bulb entirely filled with water. The lamp is suspended in position by two conducting wires covered with rubber. It is claimed that the lamp is enabled to stand most violent shocks.

Electric Couplings.

7345—1909. J. H. PARSONS, Kibworth Harcourt. The metal parts of electrical couplings of the snap on type, and the terminal connections of one member are covered with india-rubber. The metal parts of the second member are insulated so that when coupled together the elasticity of the india-rubber insures good electrical and mechanical connection and a high insulation water-tight joint.

Dynamo Electric Machines.

1327—1909. A. BOECKEL, St. Petersburg. In this diagram the armature field rotates not with a double periodicity, but with an ordinary periodicity, the shunts for feeding the magnetic field winding being taken not from definite points of the armature winding but from points which are fixed in space. Fig. 1 is a side elevation, partly in section, and Fig. 2 is a view from the front side. The armature *a* is

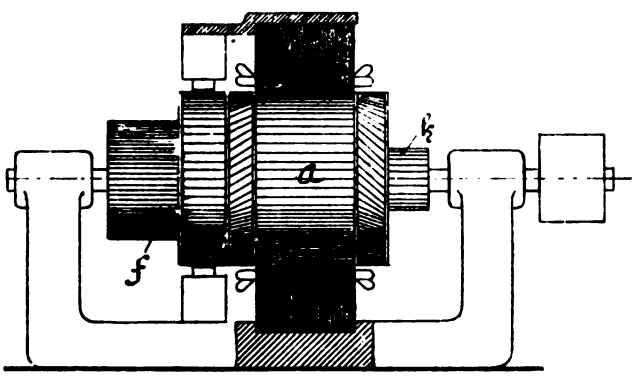

FIG. 1.

provided with two commutators. One commutator *f* has a double number of sections and the other *k* is of usual construction, that is, with a number of sections equal to the number of the armature turns. On the commutator

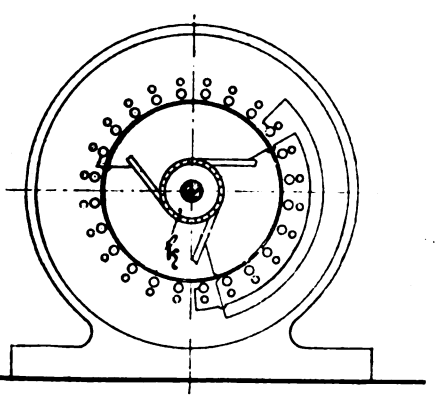

FIG. 2.

f slide non-rotating brushes, which collect continuous current, and on the commutator *k* slide three non-rotating brushes, which collect alternating current. The periodicity of this alternating current corresponds to the number

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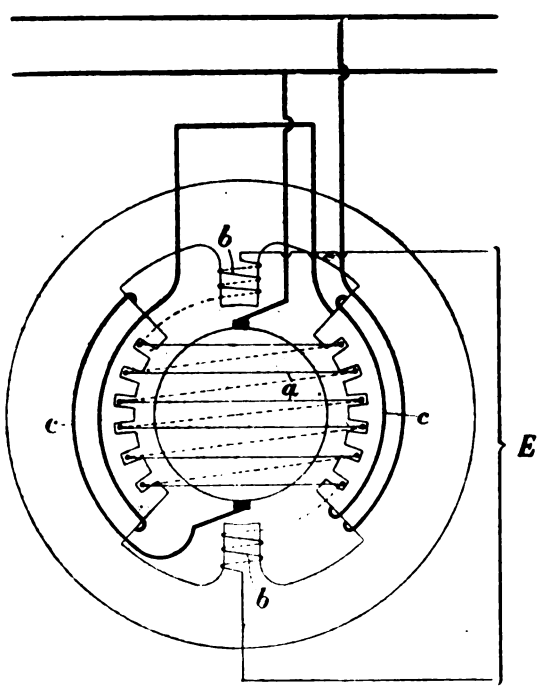
of the armature revolutions, so that by connecting these brushes with the magnetic field winding the latter can be fed from the armature of the machine itself. If it is necessary to change the lag between the phases of the electromotive force and the current a choking coil or a condenser can be interposed between the windings of the armature and of the field according to requirements.

Single Phase Series Wound Electric Motor.

133—1909. F. PUNGA. Liege. This invention consists in a single phase, series wound, electric motor, having compensation winding and auxiliary pole winding in series, wherein by the use of the compensating current for the auxiliary pole winding a complete compensation of the induced voltage can be attained. In the diagram the invention is shown applied to a two-pole motor; *a* is the compensation winding and *b* the auxiliary pole winding, *c* is the exciting winding. The auxiliary pole winding *b* is in series with the compensating winding *a*. These two windings do not take the main current, but the compensating current generated by induction. The small auxiliary voltage, which is put into compensation winding circuit and taken from the main transformer, is denoted by E. It is also possible to utilise the voltage at the armature of the motor for the required phase displacement of the compensating current by using a transformer reduced to the required small tension, or the compensation winding could be made with so many turns, that is for such a low current that the voltage at the brushes of the motor or the terminal voltage may be directly conveyed to the compensation and auxiliary winding. But in every case the volt-amperes, which are in this way furnished to the compensation and auxiliary winding remain small as compared with the output of the motor. The nature of the auxiliary voltage becomes manifest by the fact that when switching off the motor is not absolutely necessary also to disconnect this auxiliary voltage. The main advantage of the present arrangement is a marked superiority as regards commutation. For instance, a voltage applied to the winding of auxiliary poles only, even if well adjusted for full load, would give a certain number of ampere turns and produce a certain flux, which would not follow any change of load; it might be compared to a continuous current machine with shunt winding on the auxiliary poles. It is well known that such a machine will run very well for constant load, but very badly at fluctuating load. If the auxiliary voltage is applied to the compensation winding only, that part of



the circumference of the armature where commutation is going on, cannot be treated in any other way than the remaining parts. This must result either in poor commutation or in a needless distortion of the total armature circumference in order to arrive at a good commutation. Another advantage may easily be combined with this invention, that is, the currents of each armature branch can be separately compensated by simply using as many circuits as there are poles, and thus allowing each armature circuit to produce the most favourable voltage for itself. It would be very difficult to obtain the same result in those methods using the main current for compensation. A further advantage which may be mentioned concerning motors of very large output is one which lessens the cost of the motor. The armature current for large motors is very high, and it is comparatively difficult to obtain an exact compensation with such high currents where the auxiliary pole winding only receives a few turns. In this invention, however, since it is absolutely independent of the armature current, it becomes possible to choose the current, only with respect to a favourable winding arrangement of the compensation winding and the auxiliary pole winding; there is, besides the advantage of a cheaper winding, the possibility of effecting an exact compensation. Should it be desired to also obtain this advantage in the known constructions, it would generally be necessary to use a current transformer in order to reduce the current for the compensation or for the auxiliary pole winding in the same way as it is occasionally done.

Electric Switch Mechanism.

27244—1908. J. F. MARSHALL, London. This is a portable switch into which a lamp fits. The switch can be attached to a permanent switch.

Trolleys for Electric Cars.

7832—1908. T. HOLDSWORTH, Birmingham. A guard arm is jointed to the top of the trolley fitting and so shaped that when the trolley accidentally leaves the wire and the arm is sprung upwardly, the guard arm is turned up and over the trolley. The guard is automatically brought back to its normal position.

Alternating Current Commutators.

27967—1908. H. C. E. Jacoby, London. In repulsion or other motors a V shaped cam may be employed to transmit the motion of the governor to the brush rocker.

Producing Rapid Electric Oscillations.

17349.—1908. F. VON LEPEL, Charlottenberg. In this apparatus the electric discharge takes place between two metallic electrodes of a generator connected in parallel with one or more generators. The working surfaces of the electrodes are parallel to each other and at a comparatively small distance apart.

Dynamo Electric Machines.

16.—1909. J. TAYLOR, Salford. The spindles for carrying the brush holders are made of pieces of metal tube, one end of each of which is placed in a hole in the rocker arm, a sleeve of insulating material being interposed between them and also passed through the hole in the eye at the end of the cross connection cable to the opposite brush holder spindle. The hollow spindles, after being placed in position, are expanded so as to be firmly fixed in the rocker arms and connection eyes. By this method of construction the number of parts are lessened so that the gear is cheapened and simplified.

Supporting Electric Lamps.

875.—1909. J. H. MCLEAN, Harborne. Between the lamps and the rigid support is a joint consisting of a claw socket parts embracing a rubber ball. The claws allow the parts separated by the joints to move away from one another. When the weight is depended from the end, the movement is resisted by the rubber ball.

Alternating Current Dynamo.

786. BRITISH THOMSON-HOUSTON CO., LTD., London. This is an improvement in the method of control of alternating current commutating machines of the type described in British Patent 23288-1902. The improvement consists in short circuiting the rotor working winding of the machine in which excitation of the rotor is effected by direct series or transformer connection with the stator winding up to a pre-determined speed, and then connecting the rotor working winding with a source of external potential adapted for regulation and subsequently reducing the stator working potential when the rotor circuit is transferred to the source of external potential.

Electric Lamp Filaments.

2389.—1909. BRITISH THOMSON-HOUSTON CO., London. The unfinished lamp filaments are mounted in clamps and carried by an endless band through a chamber supplied with the treating gas. The current supplied to the filament, while passing through the chamber, can be regulated so that when a filament is in the portion of the chamber in which the gas is purest more current is supplied to it than when it first enters the chamber.

Lightning Arresters.

2529.—1909. BRITISH THOMSON-HOUSTON CO., London. This electrolytic lightning arrester comprises a plurality of fluid containing trays mounted in a single container. The edges of the trays are insulated by oil. Electrical connections surrounded by oil connect the trays in polyphase relation.

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TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns per week.			Increase or decrease.		Miles of track open.		Accounts for past year.						Cost per car mile.
	Ending	1909-10.	1908-9.	Week.	Current year.	1909.	1908.	Ending	Total receipts.	Passengers carried.	Car miles run.	Receipts per Passenger.	Receipts per Car mile.	Receipts per Mile of track.	
		£	£	£	£				£						
Aberdeen Corporation	Jan. 5	1,642	1,659	— 16	— 845	27½	27½	May 31	71,930	17,517,304	1,566,119	·98	11·02	4,940,	5·93
Ayr Corporation	Sept. 18	671	562	+ 108	—	8	8	—	—	—	—	—	—	—	—
Baker Street and Waterloo Ry.	Nov.	8,141	6,070	+2,071	—	4·25	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	Jan. 9	1,080	1,030	+ 50	— 39	24·003	13·52	—	—	—	—	—	—	—	—
Birmingham Corporation	Jan. 8	6,841	6,460	+ 381	—	56·792	58·52	—	—	—	—	—	—	—	—
Blackburn Corporation	Oct. 6	1,100	1,293	— 173	—1,036	24·53	28·3	—	—	—	—	—	—	—	—
Blackpool Corporation	Aug. 26	2,152	2,050	+ 102	+ 732	—	—	—	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams	„ 8	2,304	2,309	— 24	—	—	—	—	—	—	—	—	—	—	—
Bolton Corporation	Oct. 10	2,416	2,337	+ 79	— 259	42	42	Mar. 31	117,799	25,492,902	2,492,147	1·1	11·34	2,804	6·50
Bournemouth Corporation	July 21	1,681	1,723	— 42	— 23	29½	29½	„ 31	86,225	13,991,328	1,766,068	1·47	11·71	2,912	7·22
Bradford Corporation	Jan. 8	4,691	4,340	+ 351	+ 7,256	98	54·81	„ 31	235,258	47,839,569	5,331,007	1·17	10·59	2,378	—
Brighton Corporation	Jan. 9	780	753	+ 27	+ 1,939	9·5	—	—	—	—	—	—	—	—	—
Bristol Tramway Company	Jan. 14	5,446	4,918	+ 528	—	57	51½	Dec. 31	265,362	46,652,389	5,756,842	—	—	—	—
Burnley Corporation	Jan. 15	1,224	1,095	+ 129	—	19½	19½	Mar. 31	64,261	12,355,958	1,202,330	1·23	12·83	5,971	7·92
Burton Corporation	Jan. 16	245	247	— 2	— 184	6½	6½	„ 31	14,918	3,221,595	430,913	1·04	8·30	1,460	5·85
Cardiff Corporation	April 3	2,000	1,957	+ 43	—	—	—	„ 31	109,979	25,058,146	2,497,169	—	10·57	—	—
Carlisle Tramways Company	June 19	170	175	— 5	— 89	—	—	—	—	—	—	—	—	—	—
Central London Railway	Jan. 8	5,532	5,693	— 161	—	6·32	5·77	Dec. 31	350,150	41,898,373	1,456,781	2·01	5·769	55,404	30·27a
Charing X, Euston, & Hamp. Ry.	Nov.	6,822	6,092	+ 730	—	7·75	—	—	—	—	—	—	—	—	—
City and South London Railway	Jan. 16	3,331	3,299	+ 32	— 61	7·26	7·26	—	—	—	—	—	—	—	—
Colchester Corporation	July 14	200	219	— 39	—	8	—	Mar. 31	10,983	2,308,721	349,539	1·09	7·74	1,477	6·56
Cork E. T. and L. Company	Jan. 13	435	417	+ 18	— 20	9·89	9·89	Dec. 31	24,044	5,737,478	896,945	—	6·43	—	4·43
Croydon Corporation	Dec. 31	1,706	1,155	+ 551	+ 6,290	11½	—	Mar. 31	74,132	16,277,418	1,884,137	1·06	9·56	3,703	7·109
Darwen Corporation	Oct. 1	239	256	— 17	— 201	7·23	7·23	„ 31	13,899	2,557,654	245,584	1·30	13·68	1,922	9·40
Dover Corporation	Sept. 18	230	252	— 22	— 395	7	—	„ 31	11,593	2,697,672	316,754	·98	8·78	—	—
Dublin and Lucan Electric Ry.	Jan. 14	102	100	— 2	— 14	7	7	—	—	—	—	—	—	—	—
Dublin U.T.	Jan. 14	5,014	4,850	+ 164	+ 222	54½	54½	—	—	—	—	—	—	—	—
Dundee City Tramways	Oct. 6	1,332	1,305	— 27	— 569	—	26½	May 15	60,573	16,367,911	1,281,552	·875	1·9	2,371	7·46
East Ham Corporation	Jan. 15	934	896	+ 38	+ 4,940	15	15	Mar. 31	47,430	15,355,703	1,091,586	·73	10·26	—	6·96
Glasgow Corporation	Jan. 8	19,409	17,746	+1,662	— 8,043	189	181	May 31	907,494	226,948,290	20,766,722	·96	10·49	5,080	5·89
Gloucester Corporation	Oct. 6	395	425	— 30	+ 535	15	—	—	—	—	—	—	—	—	—
G.N., Piccadilly and Brompton	Nov.	13,429	9,354	+ 4,075	—	9·25	—	—	—	—	—	—	—	—	—
Halifax Corporation	—	—	—	—	—	52·574	37	Mar. 31	81,872	20,378,672	1,786,390	11·40	11·13	1,528	8·40
Huddersfield Corporation	Dec. 4	1,613	1,357	+ 256	+ 2,663	28	28½	„ 31	84,704	16,200,020	1,960,329	1·29	10·37	2,421	5·10
Hull Corporation	Jan. 15	2,717	2,493	+ 224	+ 5,024	29	26	„ 31	128,722	30,964,254	3,022,844	1·	10·22	—	6·04
Ilford Corporation	Jan. 8	495	431	+ 64	+ 1,656	10	10½	„ 31	25,328	6,385,466	634,446	·87	9·58	2,066	6·42
Ilkeston Corporation	Jan. 12	116	122	— 6	— 246	4	4	„ 31	7,214	1,968,850	198,415	9·1	7·9	1,803	7·04
Kirkcaldy Corporation	Sept. 5	259	266	— 7	—	7½	7½	May 15	14,993	4,874,199	459,066	·711	7·838	1,856	5·26
Lancashire United Tramways	Jan. 12	1,114	1,090	+ 24	+ 102	39	39	Dec. 31	68,904	12,554,593	2,244,344	—	—	—	—
Leeds Corporation	Sept. 18	6,896	6,624	+ 272	+ 3,662	108	96½	Mar. 31	340,368	75,734,083	7,694,989	1·06	10·62	3,527	5·51
Leicester Corporation	Sept. 11	2,162	2,130	+ 32	—	—	—	—	—	—	—	—	—	—	—
Liverpool Corporation	Nov. 6	10,803	10,687	+ 116	— 1,977	109	104	Dec. 31	572,822	124,043,239	12,231,799	1·108	11·24	5,508	7·94
Liverpool Overhead Railway	Jan. 9	1,337	1,378	— 41	— 7	6·65	2·40	June 30	79,004	11,171,515	1,106,386	—	—	—	—
London County Council	Jan. 1	40,923	28,975	+11,948	+84,397	128½	121	Mar. 31	1,274,660	279,166,461	25,591,028	1·08	11·74	—	6·79
Lowestoft Corporation	Dec. 11	155	150	+ 5	+ 30	3½	—	Sept. 30	11,399	2,645,206	370,320	1·03	7·36	2,279	6·12
Maidstone Corporation	Jan. 8	148	138	+ 10	— 341	7·4	—	—	—	—	—	—	—	—	—
Manchester Corporation	Sept. 11	15,631	15,297	+ 334	— 2,871	183	181	—	—	—	—	—	—	—	—
Metropolitan District Railway	Jan. 15	11,017	10,015	+ 1,002	+ 1 789	24	24	—	—	—	—	—	—	—	—
Metropolitan Railway	Jan. 16	17,023	16,418	+ 605	+ 1,118	24½	24½	June 30	680,357	99,846,735	—	1·46	—	—	—
Nelson Corporation	Oct. 16	151	131	+ 20	+ 7	2½	2½	Mar. 31	7,362	2,060,712	204,740	·85	8·63	1,907	—
Newcastle-on-Tyne Corporation	Jan. 1	4,110	3,813	+ 297	— 1,301	60½	59½	„ 31	211,085	46,203,164	4,411,745	1·10	11·48	3,504	6·36
Newport (Mon.) Corporation	Oct. 9	663	638	+ 25	— 311	14½	14½	„ 31	35,531	8,174,003	798,029	1·04	9·89	2,450	7·21
Oldham Corporation	Jan. 24	1,778	1,516	+ 262	— 386	—	—	—	—	—	—	—	—	—	—
Portsmouth Corporation	Oct. 10	2,046	1,809	+ 237	—	28½	28½	Mar. 31	97,741	21,247,048	2,309,439	1·10	10·15	—	—
Reading Corporation	Jan. 13	577	579	— 2	— 63	13½	13½	„ 31	32,769	7,933,572	915,481	—	8·93	—	4·65
Rochdale Corporation	Dec. 26	1,240	1,126	+ 114	+ 746	20·9	20·93	„ 31	56,558	10,196,148	1,252,925	1·32	10·83	2,693	6·47
Rotherham Corporation	Feb. 4	55[b]	587	— 32	—	—	—	—	—	—	—	—	—	—	—
Salford Corporation	Sept. 27	4,096	4,662	— 66	— 3,326	78	74½	Mar. 31	244,065	45,771,611	5,486,150	1·25	10·67	3,185	—
Scarborough Tramways Co.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Sheffield Corporation	Jan. 9	5,853	5 293	+ 560	+ 4,191	39½	37	Mar. 25	289,745	17,568,686	7,065,380	·896	9·842	4,225	5·04
Southampton Corporation	Jan. 15	1,049	1,016	+ 33	— 94	18	18	„ 25	52,647	10,121,887	1,157,451	1·25	11·33	—	7·30
Southend-on-Sea Corporation	Aug 21	995	557	+ 438	+ 1,483	—	—	—	—	—	—	—	—	—	—
Stockport Corporation	—	—	—	—	—	25	25	Mar. 31	52,004	9,155,172	1,335,911	1·34	9·342	1,830	4·75
Sunderland Corporation	Jan. 27	1,310	1,336	— 26	— 7,984	—	—	—	—	—	—	—	—	—	—
Swindon Corporation	Dec. 11	126	114	+ 12	—	—	—	—	—	—	—	—	—	—	—
Torquay Tramways	Aug. 26	630	647	— 30	—	8·41	—	Dec. 31	15,065	2,880,420	353,297	1·40	1·023	—	—
Wallasey U.D.C.	Jan. 15	801	787	+ 13	+ 822	12·68	12·45	Mar. 31	43,823	8,331,038	891,540	1·2	11·79	3,453	7·72
Warrington Corporation	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
West Ham Corporation	Jan. 6	2,361	2,187	+ 174	+ 6,044	27	14·7	Mar. 31	122,881	35,502,836	2,556,854	·789	10·95	4,417	6·79
Wolverhampton Corporation	Nov. 3	841	823	+ 18	— 206	21½	—	„ 31	44,482	9,440,369	975,714	—	10·929	2,190	6·509

a Train Miles. *b* Half-year's figures.

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STANDARD ELECTRICAL WORKS.

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NOTES.

SHOP-WINDOW FIRES.

Undoubtedly some anxiety has been caused by the fires at Messrs. Arding & Hobbs, Clapham Junction, and Messrs. Evans, but as we recently pointed out, though the reckless accusations against electricity are eminently unfair, they may do some good if they induce consumers and the smaller wiring contractors (men often possessing little technical knowledge), to use more common-sense. Last week we published the new rates issued by the Phœnix Fire Office, which are certainly well on the safe side. We note that the Drapers' Chamber of Commerce at a recent meeting discussed the question of precautions to be taken in lighting their shop windows, and this subject is receiving the careful consideration of the London County Council experts, who have been requested to report upon the matter with a view to promote legislation to ensure safety. Another good point is that engineers responsible for the running of electricity supply undertakings are doing their best to educate the public. For instance, Mr. H. H. Couzens, of the West Ham Corporation Electric Supply Works, has issued an "open letter" in which he recommends a few very simple precautions to his existing and possible clients. After saying that when an installation is contemplated competent technical advice should be sought and that any alteration or addition to an existing system should be promptly notified to the supply authority and the fire insurance office, in order to secure reliable testing, he addresses himself to shopkeepers and other people who go in for elaborate decorations. He says: "Above all, regard cotton-wool and celluloid articles as being in the same dangerous category as, say, petrol vapour, and treat them accordingly." Of course, this applies to cotton wool and celluloid in connection with any illuminant, but particularly electricity because its safety engenders carelessness. Mr. Couzens' words might be adopted by every supply authority in the three kingdoms.

CHEMICAL EXTINGUISHERS.

By the way, shop-window fires remind us of a serio-comic, might-have-been-tragedy which demonstrated the immense utility of hand chemical fire-extinguishers. A motor 'bus was careering gaily down Kensington High-street when suddenly the conductor, spying out a big crowd on the pavement, tugged the bell violently, stopped the 'bus and seizing hold of the official extinguisher fastened near the driver's seat, pushed his way through the crowd into a gorgeous shop. It was then seen that smoke was issuing from the doorway, and flames were licking up the woodwork of the window. The conductor got his squirt into action without delay, and at once smoke and flames disappeared like magic. Then he returned to his foot-board and the 'bus proceeded on its erratic career. By the way, the shop window fire had been caused by a gas heated coffee roaster. However, we did not start out to refer to gas but to give an example first of reckless shop-window dressing, and then of the ready wit of a plain conductor and the excellence of first-aid fire extinguishing appliances.

ELECTRICITY IN RUSSIA.

Apart from tramway service, electricity has made very little headway in Russia, but there is evident interest in the subject, and a desire to promote the wider adoption of electricity for lighting and power. This is shown clearly enough by the announcement that an International Exhibition, to demonstrate the application of electricity to railways, is to be held at St. Petersburg between September and November next. The proposal comes from the Imperial Russian Technical Society of St. Petersburg, which might, perhaps, be induced to extend the scope of the exhibition. In any case, it is to be hoped that British manufacturers will not be backward in showing examples of their specialities. The very fact that comparatively so little has hitherto been done makes Russia all the more worth attention from the electrical engineers' point of view.

BELGIANS IN THE FIELD.

Although British capital has done something in connection with Russian tramways, most of the big electrical contracts within the Czar's dominions have fallen to the Belgians. It now appears that they have practically captured the concessions for the electric lighting of Odessa and Kief, concessions involving an expenditure of probably between £350,000 and £500,000. The idea is that the present concessionaires should work the undertakings, but that these should be financed by the Belgian General Electricity Co., who would, no doubt, take good care that Belgian engineers should be employed and Belgian machinery used. This is evidence of one phase of the pioneering activity which the Société Centrale pour l'Industrie Electrique, of Brussels, of which we gave particulars some time ago (*The Electrical Engineer*, Vol. XLIV., page 744), was organised to carry out. It is essentially a bankers and financiers enterprise, bankers and financiers who are interested in and therefore anxious to promote the development of electrical manufactures of many kinds. The Society is a very strong one, and although young in its corporate capacity, already possesses widespread and important ramifications.

FLOUR-MILL ELECTRIFICATION.

Speaking at the twenty-fourth general meeting of the Rio de Janeiro Flour Mills and Granaries, Ltd., the chairman, Mr. E. L. Weigall, made the satisfactory announcement that a change of motive power, from steam to electricity, had taken place at their huge South American mills. Steam is to be kept in reserve, but electricity is to be more and more depended upon, for it has already given good cause to anticipate a considerable reduction in working expenses. This concern does not generate its own power, but takes current from the local light and Power Co., under a special contract. The electric plant has been at work since August, and Mr. J. R. Radford, the Managing Director, declared that "it is a distinct improvement on the old steam plant, both in economy and in ease of manipulation. We now use no steam at the mills—the boilers are empty and silent. All the power and all the light are furnished by electric energy generated by a waterfall in the hills some 100 miles from Rio de Janeiro. This energy is delivered to our sub-station by the Power Co. at a pressure of 6,000 volts, and is there transformed and distributed to the various motor and lighting circuits. Provision has also been made for eventually driving and lighting the cotton mill."

INDIAN LEGISLATION AND ELECTRICITY.

There is considerable disquiet and discontent in India in connection with Government enactments touching upon electricity. To begin with there is the question of diversity of regulations in the different provinces, and there are those who wish to see electricity placed under the control of the Supreme Government. It is, however, probably wise in practice to allow the provincial administrations to make regulations to suit local needs. Competent critics

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complain chiefly of the want of expert advice at headquarters, where lawyers and non-electricians are given too free a hand in drawing up regulations, which, consequently, do not sufficiently distinguish between fundamental principles and matters of detail. Our contemporary *Indian Engineering*, is probably right in saying that commercial interests are not sufficiently considered in some particulars, while given too much power in other directions. It certainly seems that licensees should not possess arbitrary powers permitting them to cut off supplies, practically whenever they see fit, without giving the consumer right to claim damages for unnecessary interference with comfort or business. Such arbitrary powers must, assuredly, militate against industrial progress. Another point made by our contemporary that will call forth sympathy is that it is unjust that State or Municipality should have the power to purchase an electrical undertaking merely for the amount expended on land, structures, and equipment, without any consideration as to goodwill. India presents such a splendid field for electrical development that it seems a pity that any artificial impediments should be put in the way.

RESISTANCE WIRE AND GRIDS.

Most of the resistance wires now used are an alloy of nickel, iron, manganese and copper; nickel predominating. Eureka is one of the best known alloys; it gives a resistance of 225 ohms per square mil foot and it is not affected by a damp atmosphere. A rough test for quality of resistance wires is to make the sample red hot in a lamp and bend it twice at right angles. Any wire the sample of which will not stand that is to be rejected. Wire is used for currents below 50 amperes, but cast iron is usually employed for larger currents. The cast iron is alloyed with two to four per cent. of aluminium to make it run freely and to also add to the resistance. Ordinary commercial cast iron grids have a resistance of about 300 ohms per square mil foot but by the addition of a small amount of ferromanganese they can be made to give as high as 550 ohms per square mil foot.

PREVENTION OF SPARKING IN SINGLE-PHASE SERIES MOTORS.

Sparking at brushes is one of the drawbacks of the single phase series motor. This sparking is principally caused by local currents resulting from the E.M.F. induced in the armature turns, which are temporarily short circuited by the brushes. These turns form at the moment a very low resistance secondary of a static transformer the primary of which is the field winding. Current is being supplied with the brushes located in the neutral position. With respect to the E.M.F. of rotation the short circuited turns are perpendicular to the axis of the field flux and therefore the flux linked with these turns is a maximum. There are two methods of decreasing these local currents; first by reducing the E.M.F. induced in each section, and second by increasing the resistance by the section. The E.M.F. may be decreased by reducing the armature turns per segment by lowering the value of the magnetic flux, and by lowering the frequency of the circuit. Single-phase series motors have, therefore, many more commutator segments than a direct current series motor of equal output and the frequency of supply is made as low as possible. The resistance of the coils can be increased by German silver resistance leads between the armature windings and the commutator segments. Only a few of these leads on in circuit at any instant as the armature rotates. As a further help to commence sparking the brushes are made narrow so as to reduce the short circuit period and of hard carbon.

ILLUMINATION OF OZONE.

Apropos of our recent remarks in these pages on the filamentless vapour electric incandescent lamps, it may be worth remembering that if ozonised oxygen is heated to about 350° C., a phosphorescence, easily visible in the dark ensues. It is doubtless due to the energy liberated on the conversion of the ozone into oxygen by the heat. Dewar has recorded that if ozonised air or oxygen expands suddenly, the same phosphorescence becomes visible. It is probable that the luminosity of phosphorus is due to ozonisation of the surrounding air and to the subsequent expansion of the ozone.

ELECTRICITY IN AUSTRALIAN MATCH FACTORY.

In announcing the fact that the Hon. A. Deakin, Prime Minister of the Australian Commonwealth, was the luncheon marking the opening of Messrs. Bryant & May's match factory at East Richmond, Melbourne's most populous suburb, the *Australian Mining Journal* gives some details of the electrical equipment. The factory has cost £15,000 to build, and the equipment has called for another £30,000, while a further sum of £15,000 will be required later on. The lifts are electric, and were supplied by Messrs. A. & P. Steven, engineers, of Glasgow. It appears that the whole of the machinery for driving the plant in the factory is supplied by the General Electric Co., of Sweden, for whom Messrs. Sutherland & Ashman, of Viaduct-buildings, Flinders-street, Melbourne, are the Victorian agents, and Messrs. H. Gardner & Co., of the same address, are the general agents for Australasia, the current being obtained from the Electric Light & Traction Co.'s works. Twenty-two three-phase motors, from 1½ to 10 h.p., have been set up, and one single-phase motor, 7½ h.p. The system of wiring applied by the General Electric Co., of Sweden, through Messrs. Sutherland & Ashman, has the great advantage of giving all the motors a great starting torque, equal to full load. The motors, of course, have a great deal of work to do at a high speed, some of the machines being run at 1,400 r.p.m., and others, sometimes on the same floor, at from 30 to 200 r.p.m. A worm gear machine made by Richardson & Co., of Footscray (Victoria), reduces the speed as required, Conduit piping for conveying the electric wires has been supplied by the Electro Dynamic Co. A transformer house has been erected at the side of the building, and from a distributing board on the ground floor the power is taken to another distributing board for the second floor. Grinell sprinklers are fitted throughout, and have been supplied by Messrs. Mather & Platt, of Manchester.

THE JAPAN-BRITISH EXHIBITION, SHEPHERDS BUSH.

Count Hirokichi Mutsu, C.V.O., Imperial Japanese Government Commissioner, delivered a most interesting lecture on the Japan-British Exhibition before the Royal Society of Arts last week. The Count explained the great efforts that had been made to secure thorough representation in all the sections. Vast sums of money are being spent on the undertaking. The Count reminded his audience that the trade between the two island countries amounted to 24 millions sterling, of which our share was 14 millions. He went on to say that Great Britain ranks the highest amongst the exporters to Japan, over one-quarter of the entire volume having for a long time been in her hands. We would gladly see her maintain this unique position for many years to come, but the keen competition of other seekers of the market will no doubt keep her more busy in the future than has been the case in the past. The large number of visitors from Japan this year will, doubtless, include amongst them many business and commercial men. Their attention will naturally be more attracted by the display of British goods than by their own. The British exhibitor will, therefore, have a unique opportunity of bringing his wares to the direct notice of the Japanese importer without having to cross the sea to reach him. The number of my countrymen will, however, be but a small group compared with the millions of foreign visitors whom we hope to welcome at the forthcoming Exhibition, and amongst whom the exhibitors may count on a large number of prospective customers.

INCORPORATED MUNICIPAL ELECTRICAL ASSOCIATION.

The Incorporated Municipal Electrical Association will hold their meeting this year at Glasgow, from June 13 to 17 inclusive. It will be remembered that Mr. W. W. Lackie, Glasgow City Electrical Engineer, is President of the Association for 1910.

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RELATION BETWEEN THE STATOR AND ROTOR CIRCUITS OF THE SINGLE-PHASE INDUCTION MOTOR.*

By CHARLES F. SMITH.

The following paper is an attempt to make clear the connection between the current and voltage in the stator of a single-phase induction motor and the current and voltage in the rotor. The author has failed to find a satisfactory statement of these relations in a form suitable for use in practical calculations, and has been led to make the simple measurements and deductions which follow in order to supply this omission from the literature of the subject.

The experiments confirming the theoretically deduced relations were made on several three-phase induction motors. The figures given in the present paper all apply to one motor, although similar measurements were made on other machines for the sake of further confirmation. As representing cases likely to arise in practice, the stator of the motor was sometimes supplied with two of its three phase-windings in series, while sometimes only a single phase-winding was supplied.

The motor was a standard 5 h.p. 220-volt 50-cycle 4-pole machine, made by the Allgemeine Elektricitäts Gesellschaft, of Berlin. The stator had 48 slots, with star-connected winding in three slots; the rotor had 60 slots and a star connected winding in five slots. The stator resistance was 0·25 ohm per phase and the rotor resistance about 0·11 ohm per phase, the latter varying somewhat with the current on account of brush contact resistance.

Voltage of Rotor on Open Circuit.

Assuming the rotor to be revolving in a sinusoidal field produced by a single-phase current in the stator winding, we may calculate the theoretical value of the voltage induced in a coil of the rotor as follows:—

Let $\varphi = \Phi \sin \theta$ be the value of the stator flux and a the angle between the plane of the rotor coil and the axis of the stator flux. Then $\varphi \sin a$ may represent the flux entering the rotor coil.

Let n = frequency of rotation = revs. per second of rotor × number of pairs of stator poles; also—

f = frequency of stator supply in cycles per second.

We may write a in the form—

$$a = \frac{n}{f}\theta + \beta,$$

where β is a constant for any particular coil, and indicates the angular displacement of the coil from the axis of the flux at the moment when $\varphi = 0$.

Thus—

Flux entering coil $= \phi \sin a = \Phi \sin \theta \sin\left(\frac{n}{f}\theta + \beta\right)$.

Voltage induced in coil

$$= t_2 \frac{d}{dt}(\phi \sin a)\, 10^{-8} = \frac{t_2}{2\pi f 10^8}\frac{d}{d\theta}\left[\Phi \sin\theta \sin\left(\frac{n}{f}\theta + \beta\right)\right],$$

t_2 being the number of turns of the coil.

On making the substitution $\theta = 2\pi f t$ and writing for briefness the letter E_2 in place of $\frac{t_2}{4\pi f 10^8}\Phi$, we have the voltage induced in the coil at any instant—

$$v = 2E_2 \frac{d}{d\theta}\left[\sin\theta \sin\left(\frac{n}{f}\theta + \beta\right)\right]$$

$$= 2E_2\left[\frac{n}{f}\sin\theta\cos\left(\frac{n}{f}\theta + \beta\right) + \sin\left(\frac{n}{f}\theta + \beta\right)\cos\theta\right]. \quad (1)$$

This may be expanded into—

$$v = 2E_2\left[\frac{n}{f}\sin\theta\left(\cos\frac{n}{f}\theta\cos\beta - \sin\frac{n}{f}\theta\sin\beta\right) + \cos\theta\left(\sin\frac{n}{f}\theta\cos\beta + \sin\beta\cos\frac{n}{f}\theta\right)\right. \quad (2)$$

When the rotor coil is stationary we shall obtain the induced phase volts by writing $n = 0$, so that—

$$v = 2E_2 \cos \quad \sin$$

* Original communication to the Institution of Electrical Engineers.

This may have any virtual value between zero and $\sqrt{2}\,E_2$ according to the position of the rotor, *i.e.*, according to the value given to β.

At a low speed the voltage will assume a virtual value practically equal to $\frac{1}{\sqrt{2}}$ of its maximum value, so that it may be written—

$$v_{virt.} = \frac{1}{\sqrt{2}} \cdot \sqrt{2}\,E_2 = E_2 \text{ virtual volts.}$$

This voltage we shall subsequently refer to as the "virtual stationary" rotor voltage.

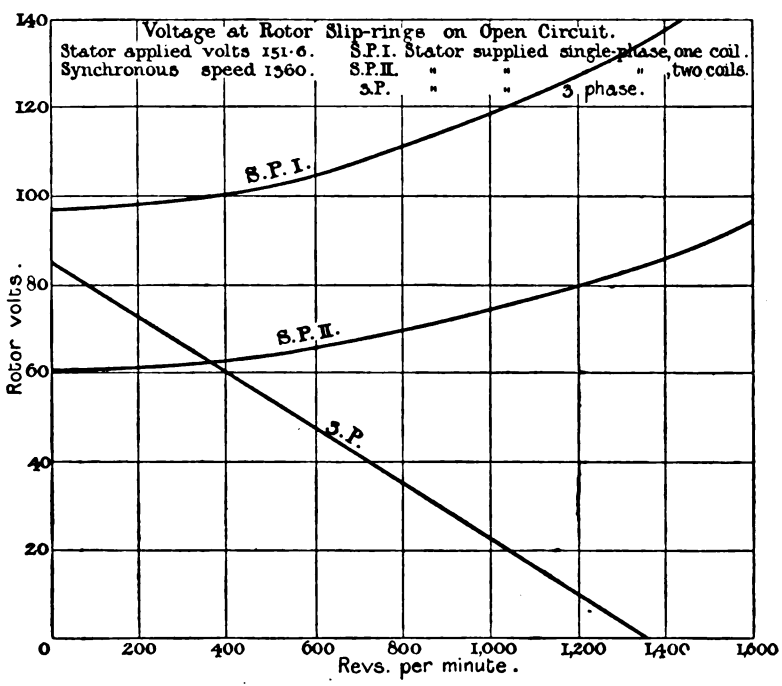

FIG. 1.

In order to obtain the voltage per phase for the rotating rotor in its simplest form, we may put $\beta = 0$ and write equation (1) as follows:—

$$v = E_2\left[\frac{n}{f}\left(\sin\frac{f+n}{f}\theta + \sin\frac{f-n}{f}\theta\right) + \sin\frac{f+n}{f}\theta - \sin\frac{f-n}{f}\theta\right]$$

$$= E_2\left[\left(1+\frac{n}{f}\right)\left(\sin\frac{f+n}{f}\theta - \left(1-\frac{n}{f}\right)\sin\frac{f-n}{f}\theta\right]\right. \quad (3)$$

This expression denotes two voltages of differing frequencies, one having a crest value $\left(1+\frac{n}{f}\right)E_2$, and the other with a crest value of $\left(1-\frac{n}{f}\right)E_2$.

The resultant voltage will have a virtual value—

$$v_{virt.} = \frac{E_2}{\sqrt{2}}\sqrt{\left(1+\frac{n}{f}\right)^2 + \left(1-\frac{n}{f}\right)^2} \quad (4)$$

so long as n is not zero, *i.e.*, so long as the two component waves have unequal frequencies.

If we now imagine the rotor speed to be gradually reduced to a very low value, the voltage given by equation (4) will fall until it approximates to the value obtained by putting $n = 0$ in the expression for the virtual voltage. Thus for very slow rotation the rotor voltage approximates to—

$$v_{virt.} = \frac{E_2}{\sqrt{2}} \cdot \sqrt{2} = E_2,$$

which is the "virtual stationary" value already mentioned.

When n becomes actually equal to zero, the voltage given in equation (3) consists of two waves of *equal* frequency and identical in phase. The crest value of this voltage is $2E_2$, and its virtual value—

$$v_{virt.} = \sqrt{2}\,E_2.$$

This is the "maximum stationary" rotor voltage. When $n = f$ we again find by substitution in (4) that—

$$v_{virt.} = \sqrt{2}\,E_2.$$

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Equation (3) forms the basis for the treatment of the single-phase induction motor as equivalent to two polyphase motors having opposite directions of rotation.

The curves in Fig. 1 show the experimental values of the rotor voltage on open circuit, corresponding to equation (4). The curves indicate the slip-ring voltage of a three-phase motor with the stator supplied under the following conditions and the open-circuited rotor driven by a separate motor at various speeds. They coincide with the theoretical values represented by equation (4).

Curve (3 P.). Three-phase supply at 151·6 volts to the star-connected stator.

Curve (S.P.) II. As above, but with one supply wire interrupted, giving a single-phase supply to two stator coils in series.

Curve (S.P.) I. A voltage of 151·6 supplied to a single coil of the stator (from the star-point to one terminal).

The following table gives the principal results shown by the curves :—

Nature of Supply.	Stator Voltage.	Rotor Voltage at Slip-rings.		
		Maximum Stationary.	Virtual Stationary.	Synchronous.
Three-phase, star-connected ..	151·6	85·3	—	—
Single-phase, 2 coils in series	151·6	85·3	60·3	85·3
Single-phase, 1 coil ..	151·6	137·5	97·2	137·5

The voltage of the single-phase motor given above as "maximum stationary" indicates the voltage with the rotor fixed in the position for maximum mutual induction between stator and rotor windings. The "virtual stationary" voltage is the value to which the voltage of the rotor approximates as its speed falls to zero. When the rotor rotates very slowly, its voltage fluctuates violently between zero and the maximum value given in the third column. At a speed just sufficient to give a steady deflection on a dead-beat voltmeter, the voltmeter indicates approximately the virtual value of a voltage whose maximum is the "maximum stationary" voltage given in the table. The voltages for the single-phase motor given in column four are accordingly seen to be practically $\frac{1}{\sqrt{2}}$ of the values in column three.

At synchronous speed the voltage becomes $\sqrt{2}$ times its virtual stationary value—*i.e.*, it is then equal to the "maximum stationary" value of column three. This condition evidently agrees with the theoretical value given by equation (4).

Ratio of Stator to Rotor Voltage on Open Circuit.

The ratio of stator voltage to the "virtual stationary" rotor voltage may conveniently be regarded as the ratio of voltage transformation for the motor. Its value for the particular motor under consideration may be obtained from the curves in Fig. 1.

In the case of a three-phase motor, the ratio of voltage transformation with stationary rotor is given by—

$$k_3 = \frac{\text{stator volts per phase}}{\text{rotor volts per phase}} = \frac{t_1}{t_2} \text{(approximately)},$$

where t_1 and t_2 are the number of stator and rotor turns per phase. With star-connected stator and rotor this ratio will be the same as that of stator terminal voltage to slip-ring voltage. In Fig. 1 this ratio is—

$$k_3 = \frac{151{\cdot}6}{85{\cdot}3} = 1{\cdot}78.$$

Suppose that, without any other change, one of the supply conductors is now disconnected. The stator will then be supplied single-phase, two phase-windings in series. The voltages between the three slip-rings of the stationary rotor will no longer be equal. The maximum voltage will be produced when two rotor phase-windings are in the position of maximum mutual induction with regard to the two active stator windings. The ratio of stator to rotor voltage will then be the same as when the stator was supplied three-phase. In this case we shall have—

$$\frac{\text{stator volts}}{\text{maximum stationary slip-ring volts}} = \frac{t_1}{t_2} = k_3.$$

From Fig. 1 this ratio is $\frac{151{\cdot}6}{85{\cdot}3} = 1{\cdot}78$ as before. The rotor voltage per phase under these conditions is half the slip-ring voltage. With the rotor in slow rotation the voltages between all the slip-rings become equal and have a "virtual stationary" value $\frac{1}{\sqrt{2}}$ of the maximum value given above.

The rotor phase voltage is now $\frac{1}{\sqrt{3}}$ of the slip-ring voltage for a star-connected rotor. Thus if E_1 = applied stator voltage—

$$\text{Rotor slip-ring voltage} = \frac{1}{\sqrt{2}} \frac{E_1}{k_3} \text{ (} = 60{\cdot}3 \text{ volts in Fig. 1).}$$

Consequently—

$$\text{Rotor phase voltage} = \frac{1}{\sqrt{2}\sqrt{3}} \frac{E_1}{k_3}$$

When the same voltage is applied to a single phase of the three-phase stator, we should find the same ratio of transformation if the flux formed in the single phase-winding of the stator affected only the winding of one phase of the rotor. When the rotor is stationary, but rotated into the position of maximum mutual induction, we shall, however, have the stator flux inducing voltage in two phases of the rotor. The ratio between stator volts and volts between the slip-rings connected to the two active rotor phases will consequently have a value—

$$\frac{\text{stator volts}}{\text{maximum stationary slip-ring voltage}} = \frac{t_1}{t_2 \times m} = \frac{k_3}{m}$$

where m is a constant greater than unity, but less than 2.

In the present case the value of $\frac{k_3}{m}$ is seen to be

$$\frac{151{\cdot}6}{137{\cdot}5} \text{ and } m = \frac{137{\cdot}5}{85{\cdot}3} = 1{\cdot}61$$

With the rotor in slow rotation, the voltages between the rings again become equal and of a value $\frac{1}{\sqrt{2}}$ of the stationary maximum value. The voltage per phase is $\frac{1}{\sqrt{3}}$ of the slip-ring voltage.

We have consequently the values—

$$\text{Rotor slip-ring voltage} = \frac{m}{\sqrt{2}} \frac{E_1}{k_3},$$

$$\text{Rotor phase voltage} = \frac{m}{\sqrt{2}\sqrt{3}} \frac{E_1}{k_3}.$$

At synchronous speed the rotor voltage (virtual value) is in each case $\sqrt{2}$ times its "virtual stationary" value as obtained with slow rotation.

Change in the Rotor Voltage as Rotation Begins.

The voltages in all the coils of the rotor will evidently have the same frequency and phase so long as the rotor is stationary, no matter what the position of the rotor may be.

Immediately the rotor is made to revolve, although the voltage per phase is still given by equation (4), the voltages in the various phases will reach their maximum values successively and not simultaneously. We shall, in fact, obtain a three-phase voltage at the slip-rings, of a character such that the *virtual* values of the phase voltages will reach their maximum values successively. The voltage in any individual phase-winding will be an alternating one, having at slow speeds approximately the frequency of the supply. As the rotor revolves, the amplitude of this voltage will vary, passing through a succession of virtual values with the frequency of the rotation of the rotor. The virtual voltage values measured at the slip-rings will thus fulfil the relations of a three-phase circuit having a frequency equal to the frequency of revolution.

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In the case illustrated by Fig. 1, Curve S.P. II., the virtual stationary rotor voltage *per phase* will be approximately $\frac{1}{\sqrt{3}}$ of the value of 60·3 volts shown on the curve. The virtual voltage per phase with the rotor rotating slowly will consequently be $\frac{1}{\sqrt{3}}$ of 60·3 volts = 34·8 volts approximately.

The following experiment shows that the slip-ring voltage may be regarded as a three-phase voltage (so far as virtual values are concerned) practically as soon as rotation begins.

Three similar voltmeters were connected together in star and to the slip-rings of the single-phase motor. A fourth voltmeter was connected directly from ring to ring. With the rotor stationary, but rotated successively into different positions, the three voltmeters read unequally. The fourth voltmeter always indicated the arithmetic sum of the readings of the two voltmeters connected to the same rings. On rotating the rotor slowly all the voltmeter readings fluctuated violently; with a slightly higher speed (say 80 r.p.m.) they became steady and the three star-connected voltmeters read equally. The fourth voltmeter now read $\sqrt{3}$ times the voltage indicated by any of the others.

The steady readings of the three similarly connected voltmeters were $\frac{1}{\sqrt{2}}$ of the maximum reading indicated with the rotor stationary. The same point may be illustrated by another experiment. Connect the slip-rings of a single-phase motor to a star-connected starting resistance, connecting an ammeter in one phase and a voltmeter across one pair of rings. With stationary rotor, the quotient of the voltmeter reading divided by the ammeter reading will be the resistance of two legs of the starting resistance. If the rotor is now set in rotation the instruments will at first fluctuate violently, but at a fairly low speed will become steady enough to read. It is then found that the quotient $\frac{\text{voltmeter reading}}{\text{ammeter reading}}$ is lower than before in the ratio $\frac{\sqrt{3}}{2}$ and remains constant independently of the rotor speed. This shows that the virtual values of the currents in the limbs of the starting resistance change at a comparatively low speed from coincidence of phase to a relation producing the same virtual effect as that of a true three-phase supply.

The conclusion to be drawn is that the ratios of voltage and current transformation in a single-phase induction motor must be considered to have each two definite values —one value with the rotor stationary and in the position for maximum mutual induction, and one value when the rotor is in rotation. There is no gradual change from one ratio to the other.

Writing k_3 for the ratio of transformation of the motor as a three-phase machine and k_e for the ratio of stator volts to rotor phase volts when operating as a single-phase motor, we have, as already shown—

$$k_e = \frac{\sqrt{2}\ \sqrt{3}}{m} k_3,$$

where m is unity for a stator wound $\frac{2}{3}$ of its circumference, and about 1·6 when wound $\frac{1}{3}$ of its circumference.

Rotor Circuit Closed. Rotor Voltage.

When the rotor circuit is closed, rotation of the rotor in the stator flux produces an E.M.F. along an axis of the rotor perpendicular to that of the main flux. A magnetising current is thus produced in the rotor giving rise to an additional flux, which also induces an E.M.F. on the rotor coils.

On the assumption of zero rotor resistance and zero rotor leakage reactance, we may regard the rotor conductors as moving in two magnetic fields which are perpendicular to one another in both time and space, and which have instantaneous values represented by—

Main flux $= \phi = \Phi \sin \theta$;

Perpendicular flux $= \phi_1 = \frac{n}{f} \Phi \cos \theta$;

Flux entering coil due to $\phi_1 = \phi_1 \cos\left(\frac{n}{f}\theta + \beta\right)$;

$$\text{Voltage due to this} = \frac{d}{dt}\left[\frac{n}{f}\Phi \cos\theta \cos\left(\frac{n}{f}\theta + \beta\right)\right]$$

$$= -2E_2\left[\frac{n}{f}\cos\left(\frac{n}{f}\theta + \beta\right)\sin\theta + \frac{n^2}{f^2}\cos\theta \sin\left(\frac{n}{f}\theta + \beta\right)\right]5$$

The voltage due to flux ϕ has already shown to be (see equation (1)—

$$2E_2\left[\frac{n}{f}\sin\theta\cos\left(\frac{n}{f}\theta + \beta\right) + \sin\left(\frac{n}{f}\theta + \beta\right)\cos\theta\right].$$

Hence, by addition, we obtain the total voltage per phase of the rotor due to both fluxes—

$$2E_2\left(1 - \frac{n^2}{f^2}\right)\sin\left(\frac{n}{f}\theta + \beta\right)\cos\theta \quad \ldots\ldots \quad (6)$$

Since β is without effect on the virtual voltage, we may omit it, and write the volts per phase—

$${}_2E_2\left(1 - \frac{n^2}{2f}\right)\left(\sin\frac{f+n}{f}\theta - \sin\frac{f-n}{f}\theta\right). \quad \ldots\ldots \quad (7)$$

When n has any finite value this will consist of two voltages having different frequencies but equal amplitudes. They will consequently have a resultant virtual value equal to $\sqrt{2}$ times the virtual value of either. Thus the virtual voltage per phase of the rotor will be—

$$v = E_2\left(1 - \frac{n^2}{f^2}\right) \quad \ldots\ldots \quad (8)$$

It will also be evident from the previous consideration of the effect of connecting two phases in star that, in a three-phase star-connected rotor, the slip-ring voltage will have a value—

$$\sqrt{3}\ E_2\left(1 - \frac{n^2}{f^2}\right),$$

which will have a virtual value of $2E_2$ per phase when the motor is at rest, and the rotor is in the most favourable position.

The slip-ring voltage of the stationary star-connected rotor will be double this, or $2\sqrt{2}\,E_2$. The induced rotor phase voltage with short-circuited rotor is thus given for a $\frac{2}{3}$ wound stator by—

$$\frac{E_1}{\sqrt{2}\ \sqrt{3}\ k_3}\left(1 - \frac{n^2}{f^2}\right),$$

while with a winding on only $\frac{1}{3}$ of the stator the corresponding voltage will be—

$$\frac{m E_1}{\sqrt{2}\ \sqrt{3}\ k_3}\left(1 - \frac{n^2}{f^2}\right) \text{ volts per phase.}$$

E_1 represents in each case the applied stator voltage.

The "virtual stationary" voltage of the rotor is evidently the same whether the rotor circuit is open or closed (except for the loss of voltage in stator inpedance).

Equivalence of Stator and Rotor Currents.

With a constant applied voltage at the stator terminals, the stator flux must remain constant (except for drop in the stator winding), and the resultant magneto-motive force of the stator circuit must consequently have the same value, at all speeds and for all values of the rotor currents. Accordingly, any rotor currents which are capable of producing a magneto-motive force along the axis of stator flux will be neutralised by a corresponding current in the stator winding. At any instant this added stator current will produce a number of ampere-turns equal and opposite to that due to the currents in the rotor along this axis.

Any revolving winding of the rotor which carries a current must evidently produce a magneto-motive force in various directions successively, and, unless the frequency of the current coincides with the frequency of rotation, the virtual value of the magneto-motive force due to the current will be the same in whatever direction it is measured. Such a current will consequently produce a magneto-motive force along the stator axis exactly equal to the magneto-motive force along any other axis. The stator winding will, however, receive an increase in current sufficient to neutralise this magneto-motive force along the stator axis. The magneto-motive force due to the rotor currents remains unneutralised along an axis perpendicular

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to this, although "compensation" due to rotation of the rotor occurs to raise the power factor at normal speeds. We thus see that the stator must always carry currents which are the equivalent of all rotor currents, whether regarded as "magnetising" or not, and that, if the rotor has several phase windings, the stator will carry a current equal to the sum of the currents which would be required to balance the magneto-motive force of each phase separately. Each phase winding of the rotor may, in fact, be looked upon as giving rise to a magneto-motive force along the stator axis proportional to the current in it and the number of its turns. The fact that the space and phase displacements between the rotor windings are necessarily identical has the result that the magneto-motive forces due to all the coils have the same phase along any stator axis. In order to obtain the resultant effect along the stator axis, the rotor currents are therefore to be added algebraically and not vectorially.

Suppose, for instance, that one rotor phase-winding of a three-phase rotor carries $c_2 t_2$ ampere-turns. This will exert a magneto-motive force successively along all axes of the stator, the virtual value in any definite direction rising to a maximum of $c_2 t_2$ ampere-turns and falling to zero. When the rotation of the coil is sufficiently rapid to give steady readings of the neutralising stator current, the virtual stator ampere-turns indicated will be $\frac{1}{\sqrt{2}} c_2 t_2$ ampere-turns due to this phase, or $\frac{3}{\sqrt{2}} c_2 t_2$ ampere-turns balancing the three phases together.*

NUMERICAL VALUE OF CURRENT RATIOS.

With stationary short-circuited rotor, the currents in stator and rotor have the same relations as in the static transformer, so that in the position for maximum mutual induction we should obtain current ratios which are the reciprocals of the voltage ratios previously found, if we omit the constant stator magnetising current from our consideration. This position of the rotor will not, however, be the position giving the greatest ratio of rotor to stator current.

When in rotation, a stator wound over $\frac{1}{3}$ of its circumference will carry a current equal to $\frac{3}{\sqrt{2}} \frac{1}{k_3}$ times the current in each rotor phase, because each rotor phase will exert a virtual magnetising force along the stator axis of $\frac{1}{\sqrt{2}} c_2 t_2$ ampere-turns, and the stator has to balance the ampere-turns of three phases. Hence, for this type of stator winding—

$$\frac{\text{rotor phase current}}{\text{stator current}} = \frac{\sqrt{2}\, k_3}{3}.$$

For stationary rotor and single-coil stator we find the current ratio to be the inverse of the ratio of voltages, so that—

$$\frac{\text{rotor phase current}}{\text{stator current}} = \frac{k_3}{m}$$

With a stator winding covering the arc occupied by two rotor phases we have as the stationary current ratio (for maximum mutual induction) the reciprocal of the stationary voltage ratio given on another column, so that (approximately)—

$$\frac{\text{rotor phase current}}{\text{stator current}} = \frac{t_1}{t_2} = k_3 \text{ as for a 3-phase motor.}$$

When in rotation, the stator current has to be the equivalent of $\frac{3}{\sqrt{2}}$ rotor amperes, as already explained. One ampere in the stator is, however, more effective than in the previous case because of the increased windings—in fact, the resultant magneto-motive force of 1 ampere in the $\frac{2}{3}$ winding will be $\sqrt{3}$ times as great along the stator axis as in the $\frac{1}{3}$ winding. We thus find the following ratio for the rotating rotor with a winding covering two-thirds of the stator:—

$$\frac{\text{rotor phase amperes}}{\text{stator amperes}} = \frac{\sqrt{2}\, k_3}{3} \times \sqrt{3} = \frac{\sqrt{2}}{\sqrt{3}} k_3.$$

EXPERIMENTAL VERIFICATION OF CURRENT RATIOS.

The relations given in the previous section may be verified easily by short-circuiting the rotor winding through an ammeter, and supplying the stator with current at a low voltage. The magnetising current in the stator will be small and will tend to increase the ratio of stator to rotor current. The curves obtained in this way are shown in Fig. 2. The values of the currents were varied by driving the motor at different speeds. The actual observations gave the values shown by dots, while the lines show the theoretical ratios as given in the previous section, to which the observed values approximate, and with which they would coincide if it were not for the stator magnetising current. Besides the ratios for the motor when running, the current ratios obtained with the rotor stationary and in the position for maximum mutual induction are plotted. A curve taken with the motor supplied with three-phase current and run at various speeds is also shown.

It is evident from the curves in Fig. 2 that (as in the case of the voltage ratios) there is a definite ratio between

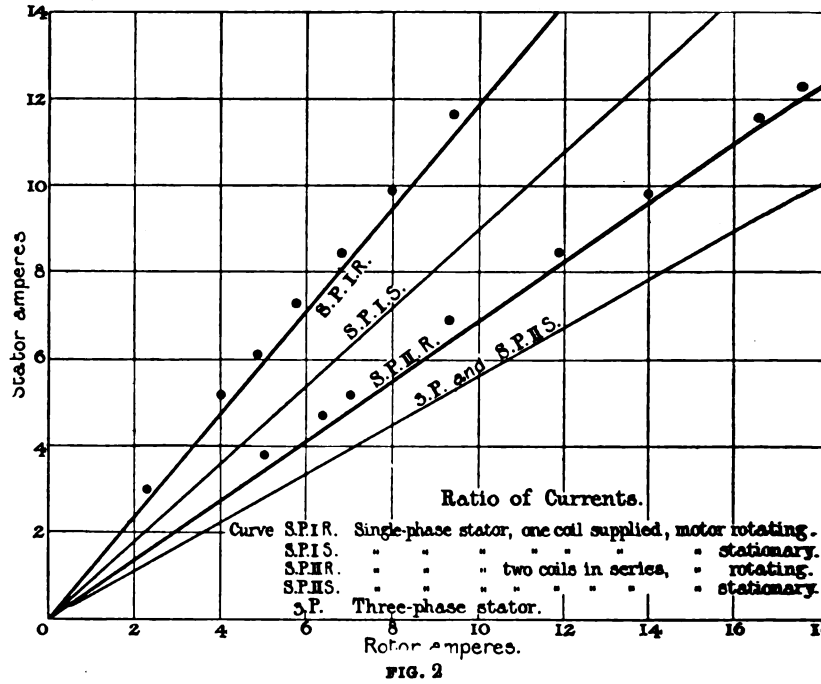

FIG. 2

stator and rotor currents when the motor is running, and another definite ratio when the motor is at rest, and in the position of maximum mutual induction. There is no gradual change of one ratio into the other as the speed changes. This appears to be contrary to the statement of Steinmetz ("Alternating-current Phenomena," 4th ed., p. 329), which suggests a gradual change as the speed of the motor alters from zero to synchronism.

CONNECTION BETWEEN CURRENT AND VOLTAGE IN ROTOR.

In obtaining the expressions for the rotor voltage as given in equations (7) and (8), we have neglected the effect of rotor resistance and leakage reactance in diminishing the perpendicular component of the flux. Assuming this to be permissible for practical purposes, we ought to be able to obtain the magnitude of the rotor current by dividing the theoretical value of the rotor voltage by the impedance of the rotor winding. Since the impedance of the rotor will vary with the speed of the motor, it will be necessary to ascertain the law according to which it varies with the speed.

IMPEDANCE OF ROTOR WINDING.

The impedance will consist of two elements—viz., the resistance, having a constant value, and the leakage reactance, which will vary with the speed.

*As shown on page 12, this statement must be modified by the introduction of the factor $\sqrt{3}$ for a stator with a winding extending over two-thirds of its circumference.

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We have shown that the induced rotor voltage may be looked upon as composed of two component voltages, equal in amplitude, but having frequencies of $f+n$ and $f-n$ respectively (see equation (3)). Because these voltages are of different frequencies, they will act independently on the reactance of the rotor circuit, so far as the production of current is concerned, and the circuit will offer the same resistance but a different reactance to each.

Thus, calling the two component voltages e_1 and e_2, e_1 will give rise to a current—

$$c_1 = \frac{e^1}{\left[r_2^2 + \left(2\frac{f+n}{f}x_2\right)^2\right]^{\frac{1}{2}}}$$

where—

r_2 denotes the resistance of the winding,

and—

x_2 denotes the reactance of the winding at a frequency f.

Similarly e_2 will produce a current—

$$c_2 = \frac{e_2}{\left[r_2^2 + \left(2\frac{f-n}{f}x_2\right)^2\right]^{\frac{1}{2}}}.$$

Since $c_1 + c_2 = c$ will be the total current in the winding, we may consider the rotor circuit as being equivalent to a single resistance connected in series with a reactance

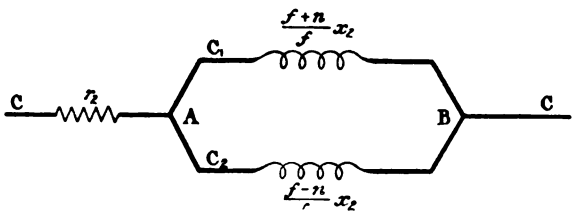

FIG. 3

composed of two parallel unequal parts, as indicated in Fig. 3.

The admittance of the part of the circuit between A and B will have a value—

$$\frac{1}{2x_2}\frac{f}{f+n} + \frac{1}{2x_2}\frac{f}{f-n} = \frac{1}{x_2}\frac{f^2}{f^2-n^2}$$

and the joint impedance of this part of the circuit will be—

$$x_2\frac{(f^2-n^2)}{f^2}.$$

The impedance of the rotor winding is consequently—

$$z = \sqrt{r_2^2 + \left(x_2\frac{f^2-n^2}{f^2}\right)^2},$$

hence we have—

$$c_2 = \frac{v_2}{\sqrt{r_2^2 + x^2\left(\frac{f^2-n^2}{f^2}\right)^2}} \quad \ldots \quad (9)$$

We have already found the value of the induced rotor voltage per phase on the assumpton of no losses in the stator winding to be (see equation (8)—

$$v_2 = E_2\left(1 - \frac{n_2}{f^2}\right),$$

where E_2 is the "virtual stationary" voltage induced.

The relation between the voltage E_2 and the rotor current is consequently given by—

$$c_2 = \frac{E_2\left(1-\frac{n^2}{f^2}\right)}{\sqrt{r_2^2 + x_2^2\left(1-\frac{n^2}{f^2}\right)^2}}$$

$$= \frac{E_2}{\sqrt{r_2^2\left(\frac{f^2}{f^2-n^2}\right)^2 + x_2^2}}$$

If the applied stator voltage is assumed constant, we shall have a loss in the stator winding tending to diminish the value of E_2. Adopting the usual vector notation, we may write the applied voltage—

$$E_1 = k_c E_2 + C_1(r_1 - j\,x_1) \quad \ldots\ldots\ldots \quad (11)$$

where C_1 is the stator current and $(r_1 - j\,x_1)$ represents the primary impedance due to resistance and leakage reactance.

Neglecting the magnetising current—

$$C_1 = \frac{1}{k_c}C_2.$$

Also, the secondary voltage E_2 may be expressed in terms of the rotor current by making use of equation (10) converted into vector form; thus—

$$E_2 = C_2\left(r_2\frac{f^2}{f^2-n^2} - j\,x_2\right).$$

Hence, except for magnetising current—

$$\frac{E_1}{k_c} = C_2\left[r_2\frac{f^2}{f^2-n^2} + \frac{1}{k_c k_c}r_1 - j\left(x_2 + \frac{1}{k_c k_c}x_1\right)\right] \quad \ldots\ldots(12)$$

Now $\frac{E_1}{k_c}$ is the open-circuit "virtual stationary" voltage per phase of the rotor, so that equation (12) gives the relation between this constant voltage and the current of the motor at any speed.*

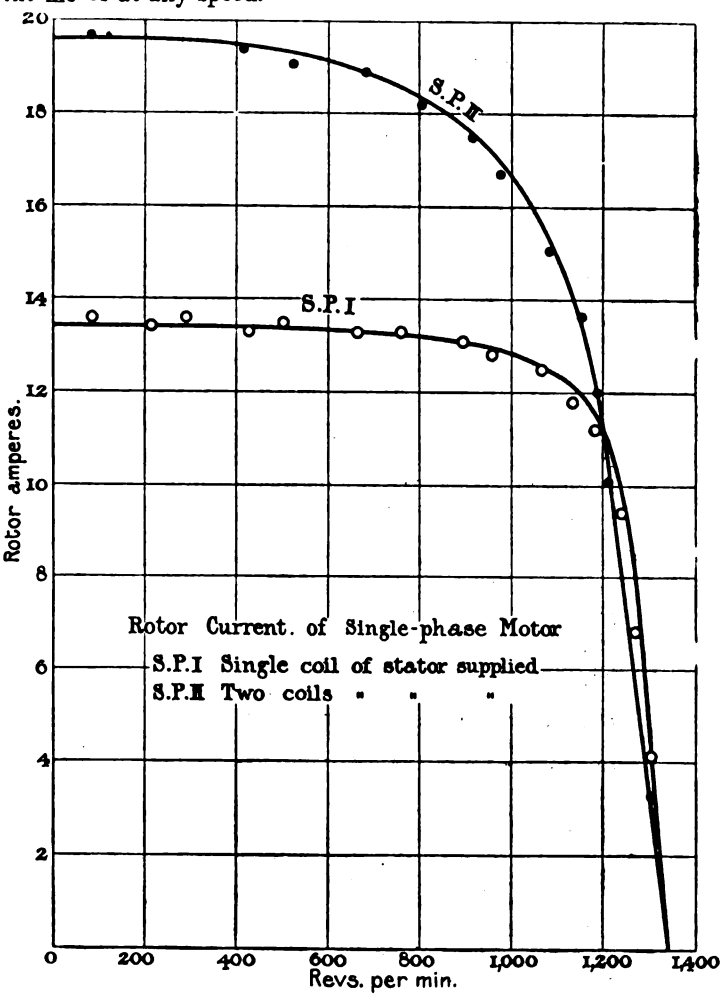

FIG 4.

The numerical form of the relation just given is—

$$c_2 = \frac{E_2}{\sqrt{\left(r_2\frac{f^2}{f^2-n^2} + \frac{1}{k_c k_c}r_1\right)^2 + x}} \quad \ldots\ldots(13)$$

where x is written for the reactance of both windings referred to the rotor circuit.

In order to verify the accuracy of this formula for practical purposes, tests were made on a number of motors by driving them at various speeds with short-circuited rotor, while a constant low alternating voltage was applied to the stator. The rotor current was observed and plotted on a base of speed as shown in Fig. 4. By substituting the measured values of the stator and rotor resistance in equation (13) the reactance of the motor was determined for the condition when $n = 0$, and a calculated curve of current for different speeds (shown by the lines in Fig. 4) was obtained. The agreement between the calculated and observed values (the latter shown by dots and circles) is quite as close as could be expected.

* Compare the vector equations for the single-phase motor given in "Vectors and Vector Diagrams," by Cramp and Smith, published by Longmans & Co.

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The value of E_2 employed in the calculation of the current was obtained directly from the open-circuit curve (see Fig. 1), since the value of E_2 when $n = 0$ will be the same whether the rotor circuit is open or closed.

Let— CALCULATION OF EQUIVALENT RESISTANCE.

k_c = Ratio of rotor phase current to stator current (omitting stator magnetising current).

k_e = Ratio of stator voltage to rotor phase voltage ("virtual stationary value").

r_1 = Resistance of stator winding.

r_2 = Resistance of rotor winding per phase.

The equivalent resistance of the motor windings referred to the rotor circuit will then have the value—

$$R_2 = r_2 + \frac{1}{k_c k_e} r_1 ;$$

similarly the equivalent resistance of both windings referred to the stator would be—

$$R_1 = r_1 + k_c k_e r_2.$$

Applying this to the case of our motor, we have—

$r_1 = 0{\cdot}25$ ohm for single coil supplied,

or— $0{\cdot}5$ ohm for two coils supplied in series.

$r_2 = 0{\cdot}11$ ohm.

With two-coil stator—

$$k_c = \frac{\sqrt{2}}{\sqrt{3}} k_3 = 1{\cdot}45,$$

$$k_e = \sqrt{3} \cdot \sqrt{2} \cdot k_3 = 4{\cdot}36.$$

Hence for this case—

$$R_2 = 0{\cdot}11 + \frac{0{\cdot}5}{1{\cdot}45 \times 4{\cdot}36} = 0{\cdot}19 \text{ ohm.}$$

With single-coil stator—

$$k_c = \frac{\sqrt{2}}{3} k_3 = 0{\cdot}84,$$

$$k_e = \frac{\sqrt{2}\ \sqrt{3}\ k_3}{m} = 2{\cdot}74 ;$$

consequently—

$$R_2 = 0{\cdot}11 + \frac{0{\cdot}25}{0{\cdot}84 \times 2{\cdot}74} = 0{\cdot}219,$$

we may call the factor $k_c k_e$ the "impedance ratio" of the single-phase motor, corresponding to k_3^2 for the three-phase motor.

The value of m appears to be about 1·6 for the usual distribution of winding covering one-third of the stator circumference.

The author has to thank his colleague, Mr. W. Grant, for assistance in connection with the experiments made for this paper. The experimental work was carried out in the Electrical Engineering Laboratories of the Municipal School of Technology, Manchester, and the motors employed belong to the equipment of the Electrical Engineering Department of the School.

LIST OF SYMBOLS EMPLOYED.

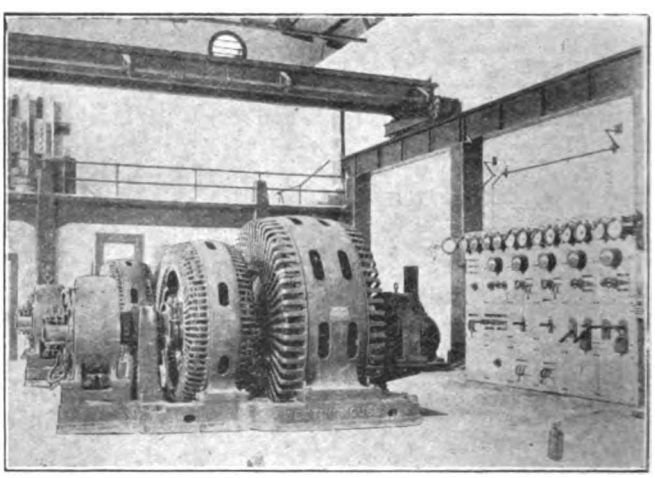
c_1 Stator current in amperes.
c_2 Rotor current in amperes.
E_1 Stator applied voltage.
E_2 "Virtual stationary" rotor voltage per phase.
f Frequency in cycles per second.
k_3 Ratio of stator phase voltage to rotor phase voltage of stationary three-phase motor $\left(=\frac{t_1}{t_2}\right)$.
k_c Ratio of rotor phase current to stator current (omitting stator magnetising current).
k_e Ratio of stator voltage to rotor phase voltage of single-phase motor.
m A constant giving the relation between k_3 and k_e $\left(k_e = \frac{k_3}{m}\right)$ employed in the case of stator wound over one-third of circumference.
n Frequency of rotation = revs. per second of rotor × number of pole-pairs of stator.
r_1, r_2 Resistance of stator and rotor phase winding.
t_1, t_2 Number of turns in stator and rotor phase.
v Instantaneous value of voltage induced in rotor coil.
x_1, x_2 Leakage reactance of stator and rotor phase winding.
a Angle between plane of rotor coil and axis of stator flux.
β A constant angle.
ϕ Instantaneous value of stator flux.
Φ Maximum value of stator flux.

A FIFTEEN CYCLE SINGLE-PHASE RAILWAY.

The first, and at the present time the only, 15 cycle, single-phase, alternating current railway in the United States is the Visalia Electric Railroad, running from Visalia to Lemon Cove, California. After two years of successful operation, this pioneer 15 cycle development has fully justified the confidence and courage of its builders in selecting, untried, a system of electrification without the restrictions for heavy main line service shown by the other systems investigated. Although the present length of electrical operation is only 22 miles, the location of the Visalia road is such that it will undoubtedly become an important link in the large electric railway system, which seems destined to cover that section of the San Joaquin Valley at a date not far distant.

For a distance of 10 miles, between Visalia and Exeter, the electric railway traverses the main track of the Southern Pacific Railroad, which has been electrified over this section by the addition of rail bonds and the 3,300 volt trolley. Twelve miles farther, from Exeter to Lemon Cove, a new road bed has been constructed, making the total length of the Visalia-Lemon Cove electrified route 22 miles. The road is single tracked, with the exception of the switching and freight yards at Visalia, Exeter and Lemon Cove. The trolley construction is of the single catenary type, suspended from brackets on poles spaced 120 ft. apart.

Ground was broken for the Exeter and Lemon Cove extension in March, 1905, and the road was operated by steam locomotives in December, 1905. In March, 1908, the steam service was discontinued, and since that the road has been operated by electricity.



INTERIOR OF EXETER FREQUENCY-CHANGING SUB-STATION.

From Visalia to Exeter the country is practically level. Between Exeter and Lemon Cove the land is of a rolling nature, but the maximum gradient on the road has been kept down to 0·9%, and the curves are of long radius. The worst conditions are met on a combined 10° curve on a 0·9% grade.

For this electrification, three-phase, 60 cycle power is purchased at 35,000 volts, from the Mount Whitney Power Co., which operates a hydro-electric generating plant on the Keweah River. At the Exeter sub-station, located nearly at the centre of the present railway line, the 60 cycle power is stepped down to 2,200 volts, and then converted to 15 cycle, 11,000 volt, single-phase current by a Westinghouse synchronous motor generator set. From the main frequency changing sub-station at Exeter, the 15 cycle, 11,000 volt feeder lines, made up of a pair of No. 4 bare copper conductors, transmit 8 miles in each direction to the sub-stations on the Lemon Cove and Visalia divisions. Transformers in these stations reduce the 15 cycle, 11,000 volt, single-phase supply to the trolley pressure, 3,300 volts.

The frequency changer sub-station contains six 150 kw. oil insulated, water-cooled, 35,000 to 2,200 volts, 60 cycle Westinghouse transformers, and 2 two-bearing motor generator sets, each composed of a 540 h.p. Westinghouse synchronous motor wound for 2,200 volts, 60 cycles, with induction motor for starting, direct connected to a 375 kw. rotating field, single-phase Westinghouse alternator, delivering 11,000 volts, 60 cycle current. The 60 cycle incoming

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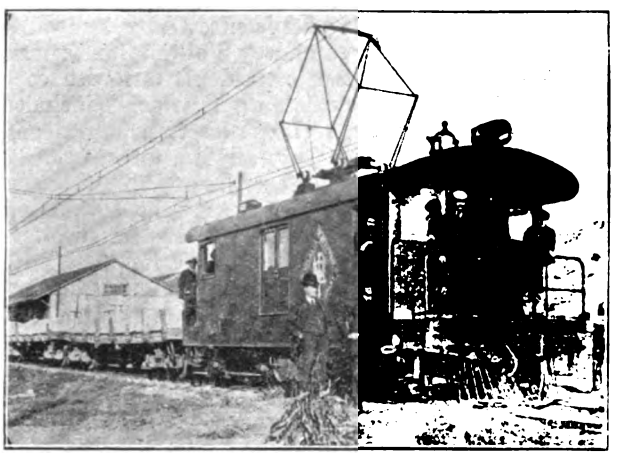
transmission line is protected by low equivalent lightning arresters, complete with oil insulated choke coils and disconnecting switches.

Three 15 kw., 2,200 to 200 volts, 60 cycle transformers are supplied for lighting service and for operating the motor generator exciter set. On the extended shafts of each motor generator set are mounted 125 volt direct current generators, which furnish excitation current, in addition to a similar direct current exciter driven by a three-phase 60 cycle induction motor supplied from the incoming transmission lines. The outgoing 11,000 volt, 15 cycle feeder circuits are protected against lightning discharges by complete arrester apparatus, and are controlled by oil switches. The Exeter sub-station also feeds the trolley wire through two 300 kw. oil insulated, self-cooling, 15 cycle, single-phase transformers, reducing from 11,000 to 3,300 volts.

The two 15 cycle transforming sub-stations, each located about 8 miles from Exeter in the direction of Lemon Cove and Visalia respectively, contain a Westinghouse 300 kw. oil insulated water-cooled, 15 cycle, single-phase transformer, reducing from 11,000 volts to the trolley pressure. Lightning protective apparatus, choke coils, and high tension circuit breakers are included in the 11,000 volt apparatus, while the 3,300 volt trolley feeders are controlled by oil circuit breakers.

The 15 cycle 3,300 volt, single-phase trolley construction is of the single catenary bracket type, comprising $\frac{7}{16}$ in. steel messenger suspended from poles 120 ft. apart, and supporting No. 000 trolley wire. The redwood poles, 36 ft. long, are set 6 ft. in concrete.

The rolling stock comprises :—



WESTINGHOUSE FIFTEEN-CYCLE SINGLE-PHASE ELECTRIC LOCOMOTIVE ON VISALIA ELECTRIC RAILWAY.

A 47 ton Baldwin-Westinghouse electric locomotive, equipped with four 125 h.p. Westinghouse series, compensated, single-phase motors driving 36 in. wheels through a gear reduction of 17 to 66.

Four 40 ton passenger cars, each equipped with four 75 h.p. motors.

Two 28 ton trailer cars of construction similar to the above motor cars.

Cars and locomotives are all supplied with unit switch control and automatic air brake equipment. The trailer cars, as well as the motor cars, are fitted with brake valves and master controllers, so that three-car trains can be operated from a trailer car at the head of the train, if desired.

The motor cars and locomotives are supplied with power through pantagraph trolleys, and carry auto-transformers arranged with taps for reducing the trolley pressure to voltages suitable for supplying the motors, car lighting, and air compressors. The motor cars have oil insulated, self-cooled auto-transformers, while that on the locomotive is air cooled from the motor driven blower equipment furnished for the forced ventilation of the motors.

The 45 ton electric locomotive is of the double swivel truck class, provided with car type of cab, and has the following general over-all dimensions :—

Length over bumpers, 29 ft.
Extreme width, 9 ft. 6 in.
Height, rail to top of cab, 11 ft. 7 in.
Rigid wheel base, 7 ft. 4 in.

With its four 125 h.p. motor connected to 36 in. wheels through a gear reduction of 66 to 17, this locomotive is capable of developing a continuous draw-bar pull of 4,500 lbs. at 20 miles per hour on level track, The full load draw-bar pull is 9,000 lbs. at 17 miles per hour on the level. The maximum draw-bar pull is 17,000 lbs.

The capacity of each sub-station was designed to take care of the electric locomotive fully loaded, or one train of two motor cars and one trailer. In general service, only single motor cars are operated, without trailers, but when crowds are to be handled or the traffic conditions warrant, three-car trains are run. As an operating test, a six car train has been successfully operated over the entire system.

The maximum regular operating speed is 45 miles per hour, although a single motor car has developed 62 miles per hour. The fast cars of the system run from Visalia to Exeter in 23 min., and from Exeter to Lemon Cove in 21 min., calling for a schedule speed of 31 miles per hour.

A recent incident provides evidence of the ample tractive power of the locomotive. While doing some switching around the yard at Exeter, in order to get hold of a certain car, it was necessary for the electric locomotive to move a string of 40 standard refrigerator cars standing in the way. Twenty-eight of these were loaded, making the total weight of the train 1,044 tons, which was handled and switched around the yards by the electric locomotive without special effort.

The following figures will afford the reader some idea of the economy with which this single phase, 15 cycle road is operating :—

During a period of 40 days over which readings were taken, the average power consumption of the locomotive was 72·4 watts per ton mile.

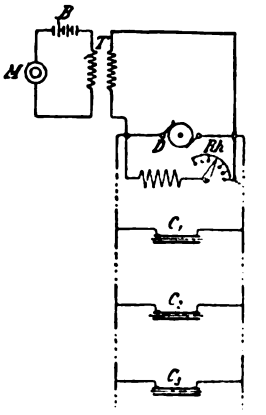
During 60 days, the average output of the frequency changer sub-station was 70·25 watts per ton mile, although during another period of 30 days, when operating conditions were better, the average station output was 66·6 watts per ton mile.

During 60 days of operation of the motor cars, the actual power consumption at the car was found to be 55·9 watts per ton mile.

The electrical equipment of the Visalia 15 cycle, single-phase electric railway, including locomotive, cars, and sub-station apparatus, was furnished by the Westinghouse Electric and Manufacturing Co., Pittsburg, Pennsylvania.

CONDENSING TELEPHONE.

Experiments with the Duddell system have led Ort and Rieger to an improvement in wireless telephony, enabling distinct speech to be reproduced with less battery current than has hitherto been necessary. Their plan is to substitute a micro-transformer for the Duddell arc lamp with its primary connected to a battery and a micro-



phone. The secondary throttles almost completely the indulations of the current of the condensers in the circuit. The distinctness of the speech is further improved by using shellac instead of paper as the dielectric in the condensers. The necessary current of from 4 to 20 volts is provided by a 15-cell dry battery. The arrangement is shown diagrammatically in the Figure.

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BOOK REVIEWS.

"The Dynamo: Its Theory, Design and Manufacture," by C. C. Hawkins, M.A., and F. Wallis, B.A. (London: Whittaker & Co. Price 21s. net.)

This is the fifth edition of a very well written book, which is very much unlike other books on the same subject. Dynamos are divided into *Heteropolar* and *Homopolar* types, the first being those in which each active wire in each revolution cuts the same lines twice over, in opposite directions—once as they issue from an N and once as they enter an S pole—and by reason of its so cutting the lines, has an *alternating E.M.F.* induced in it. The second, or Homopolar, are defined as those in which each active wire, when cutting lines, is always cutting them in the same direction and therefore the E.M.F. induced in it is always in the same direction along its length. In other words, the authors being out prominently the generally overlooked fact that the ordinary type of dynamo is really an alternator with a commutating device attached to it; whilst the neglected Homopolary is really the only true direct current machine, yet they also carefully point out that there re m chines which answer to the description of Homopolar alternators. Being informed of the above, the reader will not be surprised that a large part of Vol. II. really treats of the machines which are usually called alternators. They are, of course, logically right in this, for an alternator has just as much right to be called a dynamo as any machine has. In the section dealing with magnetic properties of iron the authors give much useful information, not to be found in other books on *Hyster sis loss in a rotating field.* This has always been a doubtful quantity with dynamo designers, and there is more yet to be learnt about it; but at any rate, it is now clear that Professor Ewing's molecular theory fits the case and as a result of his and Professor Baily's investigations the hysteresis loss in a rotating armature can be arrived at with fair accuracy. In the Homopolar machine the hysteresis is known to be less than in the Heteropolar and regarding this the authors say: "Since the E.M.F. of the Homopolar alternator is itself dependent upon the difference in the values of $B_{max.}$ and $B_{m\,n.}$, and $B_{max.}$ must be higher than in the Heteropolar machine to give the same E.M.F. the hysteresis loss on the homopolar, although still remaining less than in a heteropolar becomes appreciable and can by no means be neglected." Armature reaction, commutation and sparking at the brushes are treated most thoroughly and the clearness of the reasoning is worthy of all praise. Designs of 80 k.w. four pole, 165 k.w. four pole dynamos, and 500 k.w. with commutating poles are worked out in detail. There are no worked out designs of alternators, but the theory of the machine is given in great detail and at the end of the volume there are some typical examples of alternators made by the G. E. Co., New York, 7,500 k.w.; A. E. Co., of Berlin, 3,000 k.w.; Westinghouse, 5,000 k.w.; Siemens-Schukert, 5,000 k.w.; A complete list of symbols is given and the diagrams are excellent.—E K.S.

"Arithmetic of Electrical Measurements," by W. R. P. Hobbs, R.N. (London: Thos. Murby & Co.)

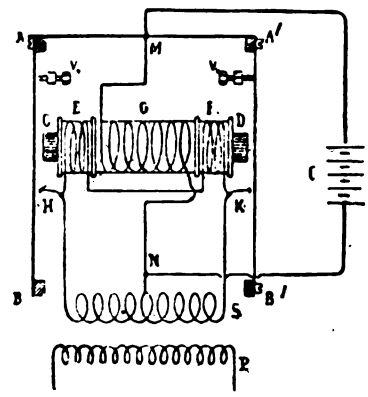
Mr. Hobbs is head-master of the Naval Torpedo School at Portsmouth, so by personal contact with students he knows just what they want in a book of this kind. The fact that it has gone through twelve editions shows that it is appreciated. Most of the pages are full of sample questions, but there is a fair number of worked-out examples. The steps in working out seem to be unnecessarily long in some cases. Thus the following question has six steps. A student who can tackle a question of this kind should be taught to do it in one step as below, and in these days of slide rules 92 amperes is near enough. To worry it out as 92·38 is waste of time. It is required to raise water out of a m ne, 800 ft. deep, at the rate of 8,000 gallons per hour. If the combined efficiency of the pump and motor b: 58% and 10% is lost in pipe friction, what current w uld be required with 500 volts at the motor terminals?

$$\frac{8{,}000 \times 10 \times 800 \times 746}{\cdot 9 \times 60 \times 33{,}000 \times \cdot 58 \times 500} = 92 \text{ amps.}$$

E. K. S.

TRANSFORMER FOR ALTERNATE CURRENTS WITH SWINGING PLATES.

A. Soulier has invented an arrangement shown below for converting alternating into direct currents, for charging firing batteries, working searchlights or small motors, etc. It depends on the action of two telephone membranes. Two metal plates, A B and A^1B^1, swing between two fixed points and touch in turn each after half a period the contacts H and K, the duration of contact being regulated by the screws V_1V_2. A core C D of soft iron, magnetised by a direct current in the solenoid G (this current may be provided by the transformer itself), carries two other solenoids, E_1F_1, one at each end. These two are



supplied with the alternating current through the transformer P S. Hence the electro-magnet causes the membranes to vibrate in unison with the main period. The conversion of the two half waves is effected by connecting the contacts H K with the secondary S of the transformer, so that each membrane is connected in turn with each pole, so that the battery U to be charged, which is included between the neutral points N of the transformer and the plate ends A A^1 through M, receives a direct current. To prevent sparking at the contacts the membranes must be touched exactly at the null point of the alternating current. The co-efficient of efficiency is 94% for an alternating current of 15 amperes and 110 volts, and the energy required is 100 watts.—*L'Industrie electrique.*

ELECTRO DEPOSITION OF METALS.

A paper by Dr. F. Mollwo Perkin and Mr. W. E. Hughes, entitled, "Studies in the Electro-deposition of Metals," was read in abstract before the Farady Society by Dr. Perkin. Therein the authors describes a rotating cathode employed for rapid electro-deposition of metals. It consists of sheet platinum spun up so as to form a narrow thimble, the upper end being open and having a stout iridium wire fused to it. This electrode, which has an active surface of 16·3 cm., is rapidly rotated within a cylindrical platinum gauze anode. In other cases, particularly when graded potential methods are employed, a spiral anode of platinum is rotated within the gauze cylinder, which then functions as cathode. In the potential measurements a cylindrical glass funnel with a glass tube sealed in the side is employed for holding the electrode.

Upon this paper Dr. Henry J. S. Sand sent in a communication, in which he pointed out that the form of electrode ultimately found most suitable by the authors very nearly approached the one used by him, and if the investigation had been extended to this a further improvement would have been found. He considered the authors electrodes were inferior in smallness of resistance to the electrolyte, stirring efficiency, and ease of manipulation. His electrodes, again, could be used with ordinary beakers and far less wash water was required. He had discarded the use of NH_4NO_3 solution as a connecting liquid, as on one occasion the auxiliary electrode gave completely wrong results.

Dr. F. M. Perkin, in reply, said the electrodes described in the paper were simpler and less costly than Dr. Sand's. He preferred the tap-funnels to beakers, and found no difficulty in raising the temperature of the electrolyte before pouring it into the funnel.

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CHARGES FOR TRAMWAY SUPPLY.

We hear so much about the inter-departmental friction existing between Corporation electricity generating stations and municipal tramways over the question of charges for current, that Mr. H. E. Yerbury's paper on "Equitable Charges for Tramway Supply," read before the Institution of Electrical Engineers, will prove very welcome. All the more so because, while the author shows himself to be a keen critic (and his fourteen years' experience entitles him to assume that attitude), yet he does not set out as an advocate of separate generating stations. Indeed, much of what he says goes to demonstrate the wisdom of adopting a combined system. But his figures can leave no doubt as to the fact that in the majority of cases overcharging the tramways is the rule, and it is in order to find out how these overcharges occur and how they may be avoided that Mr. Yerbury has placed his views before his colleagues both on the central station and the tramway side. Certain students of municipal affairs curiously ask why such a fuss should be made over what is regarded solely as a matter of detail, because both departments belong to the community, and the essential point is that a profit should be made, or at the worst a loss avoided, on the whole "trading" concerns. But such a line of argument is untenable. It is not, as a matter of fact, merely a question of one or other department showing a profit out of a feeling of pride or even for self-interested motives. It is a problem that affects the whole policy of management. We see this clearly enough if we consider the question, which, however, Mr. Yerbury did not himself directly raise, as one of separate *versus* combined generating stations. For the sake of argument it is, of course, necessary to consider what a low-tension station equipped solely for a tramway system costs both as regards capital outlay and working expenses, for it is in this way that we can arrive at some idea of what equitable charges should be. In a separate station the capital outlay both as regards building and equipment is lower than

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it is for a combined station. Nevertheless the author takes the sensible view that combination has the greater advantages, and should conduce to economy in the benefits of which all customers, as well as the supplying authority should participate. Mr. Yerbury's plaint practically amounts to this, that those responsible for generating current are apt to be overcautious. Spare plant, for instance, he considers, is made far too much of in a combined station, for after all the peak load of a tramway is very small, even taking fine Bank Holidays into account. He, therefore, holds that in a station equipped with suitable plant for general power supply purposes, a 25% spare plant would be ample to provide for the most exceptional peak loads. On the other hand, a question of breakdown is rather more serious with a tramway system and lighting system combined than if these are taken separately, and it is probable that most electrical engineers would wish for a slightly higher margin. The plea that the tramway department should be responsible for the selection of the diameter of main cables and feeders and for their maintenance seems reasonable enough, and this change would probably result in an appreciable saving. At all events, under such an arrangement no central station profit would have to be taken into consideration. As regards this question of profit, Mr. Yerbury quite agrees that the generating station should be allowed to make a profit on the current sold to the tramways, but he is anxious that not more than 3 to 5% should be calculated on the "running costs" only. This is a contention that most men responsible for the management of generating stations would decline to accept, and it certainly does not agree with sound business principles. Some profit ought surely to be allowed both on management and capital charges. This would not be serious if, as the reader of the paper desires, the capital charges were calculated on that portion of the undertaking which is essential to the actual generation and distribution of power to a tramway department, while the management charges were to be made up of salaries, insurance rates and taxes based on the kilowatt capacity of plant employed for tramways. It is certainly somewhat anomalous that in the majority of cases tramways are charged more per unit than trading users of power,or private users of current for heating purposes. Mr. Yerbury is inclined to think that too great concessions are made to users of current for power and heating, declaring that these charges are often below cost, but the returns of municipal electrical undertakings, with their tale of diminishing demand for current on the lighting side and growing consumption for power and heating, and yet coinciding with a maintenance and increase of profits, seems to disprove this, and, on the other hand, to strengthen the plea that a revision of the methods of charging tramway undertakings is needed without delay.

DETERMINATION OF THE MOMENT OF INERTIA OF A CONTINUOUS CURRENT ARMATURE.—With reference to the paper by Dr. Kapp under the above title, appearing in our last issue, we are notified of a supplementary correction. The first of the two equations numbered (2) to read :—

$$P = 9{\cdot}81 \times 4\pi^2 \, u \, I. \frac{du}{dt}$$

CORRESPONDENCE.

TO CORRESPONDENTS.

All communications intended for the Editor should be addressed "THE EDITOR, 149, Fleet Street, London, E.C." Anonymous communications will not be noticed. Letters should reach the Editor not later than Tuesday afternoon to be included in that week's issue of the Journal.

The Editor is not responsible for, nor does he necessarily endorse opinions advanced by correspondents.

QUESTION 1212.

Sir,—W. J. J. will find that in the formula he quotes D = distance *in a straight line* from the lamp to the point A, and NOT along the ground.

His formula is then identical with mine, which is, obviously, the more convenient.

With regard to the minimum illumination, I intended the minimum illumination *due to each lamp* to be 0·03 candle foot, so that the actual minimum illumination = 0·06 candle ft. (= 0·7 lux), a suitable value.

I still maintain that 30 ft. is a more suitable height of suspension than 20 ft. for arc lamps; the opinion of most illuminating engineers supports this view. Owing, however, to the opposing effects of the $\sin^3\alpha$ and $\frac{1}{h^2}$ terms in the I. equation, W. J. J. will find that the height of suspension does not greatly affect the financial aspect of the problem.

It is contrary to my experience that double carbon lamps are *generally* used: they may be used, and with somewhat the effects indicated by W. J. J. In my opinion they are distinctly unusual in 600 c.p. (6 amp.) arcs.

I quoted 14·9 mm. carbons for a 600 c.p. arc which should not require more than 6–7 amps. This is standard practice.

The price, £5 5s. per 1,000 ft. of positive and negative is based on several quotations I have received during the past year. I believe the figures to be fairly representative. Possibly W. J. J. will cite his own experience.

Yours, etc.,

"L. C."

TECHNICAL PROBLEMS, WITH SOLUTIONS BY PRACTICAL MEN.

Owing to our steadily increasing circulation and the ever widening interest taken in these Technical Problems, it has been found necessary to revise the old regulations.

The new Rules have been framed in order to encourage fresh talent to enter the field; at the same time it is hoped that the progressive lines adopted will meet with the cordial approval and support of our old and valued correspondents.

It is to be noted that these Rules only apply to Questions 1213 and onward. The first replies under the new conditions will appear in our issue of January 7, 1910.

RULES.

Under the above heading we insert questions of a practical character relating to power stations, electrical railways and tramways, mining installations, electric power in workshops, electro-metallurgical plant, and electrical engineering work generally.

QUESTIONS.—For each suitable question we offer one shilling. Questions of a practical character stand a better chance of acceptance than those of a theoretical nature. Questions may be sent in at any time.

WEEKLY PRIZES FOR SOLUTIONS.—For the best solution of any question we offer a cash prize of *seven shillings and sixpence.*

For the second best solution (if published) we offer a prize of *five shillings.*

For the third best solution (if published) we offer a prize of *two shillings and sixpence.*

QUARTERLY PRIZES.—No competitor will be awarded more than three third prizes, two second prizes, or one first prize during any one quarter. But, in adjudicating upon the merits of the various solutions, marks will be allotted to the four best solutions to each question, and at the end of each quarter extra prizes will be awarded to those competitors receiving the highest aggregate number of marks.

These prizes will be awarded in kind, the winners being at liberty to choose any book advertised or reviewed in our columns, or any instrument or appliance manufactured by any advertiser in our pages. These quarterly prizes will be of the value of *one guinea, half-a-guinea* and *five shillings.* Winners may, if they should so desire, order through us books or appliances of a higher value than their prizes, by forwarding to us the difference in price.

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MSS. AND SKETCHES.—All answers to problems must be sent in within fourteen days of the question appearing in our columns. Replies should be concise and ought not to exceed one thousand words in length.

Quarto paper (10 in. by 8 in.) should be used, only one side being used, a margin 1½ in. wide being provided on the left side of each sheet. The number *only* of each question should be written legibly at the top left-hand corner of each solution. The solution should be signed with initials or pseudonym, and the name and full address of the contributor must be appended. Any formula should be set out on a line by itself; all letters and symbols in the text should be clearly written, to make them conspicuous.

Loose sketches should bear the *number* of the question and the author's name and pseudonym, and should be pinned to the MS.

Sketches must be drawn in ink, with good solid lines. Squared paper may be used, but as the faint blue lines are not reproduced by the photographic process, all horizontal or vertical lines to appear must be inked in with heavy, full dotted or chain dotted lines as required. Column width blocks are preferred, so it is well to draw sketches 6½ in. wide, for reduction to one-half.

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QUESTIONS.

Question No. 1213.—A large D.C. generating station (440 v.) Bellis & Morcom condensing engines, using superheat steam, is supplied with a Masson & Scott oil treatment and water-purifying plant. The discharge from the air-pumps (each set having its own condenser and auxiliaries) on its way to the hot-well flows through a cistern, the outlet being proportional to the supply, by means of a vertical slot at one side. A greater or lesser flow of water through the common discharge pipe raises or lowers a float in this cistern, which by means of a cord attached and passing over a pulley fixed on an horizontal shaft, just above, opens or closes the outlet needle valves (by rack and pinion) of two other cisterns; these cisterns are connected by means of pipes—one to a tank containing alumina-ferric solution, and the other to a tank containing caustic soda solution, the supply in each case being governed by a float operated valve. The air-pump discharge and chemical solutions mix as they pass into the hot-well. It is desired to find out what strength the solutions shall be—the best way of testing them, seeing their densities may be extremely weak—and how best to find the adjustment of the valves to automatically keep pure clear water, suitable for boiler use, under varying loads also, if possible, taking into account the varying quantities of oil coming through with the condensed steam? The water is pumped from hot-well to feed tank, passing through sand filter (automatically flushed) *en route*.

REPLIES.

Answer to Question No. 1213 (*awarded 7s. 6d.*).—With regard to "W. B.'s" query, I can only state that after a long and thorough experience in the handling of similar plants to that to which he refers (up to 7,500 k.w. capacity), he will find that the only practical way to ensure the tanks of solutions being of the correct strength is to arrange the plant so that a certain measured amount of water is always mixed with a certain quantity of chemical. This is best done by having two tanks, one of which can be used, whilst the other is being filled with solution. I have had similar trouble with the varying strength of the solutions and have overcome this in two instances by installing a stirring arrangement operated by a water-wheel, worked by the inflowing water. (A similar gear is used in the lime and soda tanks of the water softening plant supplied by Messrs. Doulton & Co., and this I can say from practical experience works extremely well).

The exact setting of the taper or needle valves regulating the supply of chemicals, can only be arrived at by experiment under the ordinary conditions of the running of the plant. Care must, however, be taken (and this is where a large amount of difficulty is caused), that all the pipes and valves are kept quite clean and clear of incrustation and sediment.

A rough test for the strength of the solutions is to so arrange the chemical tanks (which need *not* be of the same capacity) so that equal bulks of each solution exactly neutralise one another as regards acidity or alkalinity. If this is done a test can be taken in a moment at any time by taking, say, a test-tube full of each solution, mixing them, and testing with litmus or other suitable agent. This need in no way interfere with the relative proportion of the chemicals. It only affects the bulk of the stock solutions.

There is at present no arrangement which will vary the quantity of chemicals according to the quantity of oil in the steam. The better plan is to instal oil separators to take out the bulk of the oil, and treat the remainder with the chemical plant. There is more than one oil separator which will deal with oil from exhaust of an engine using highly superheated steam—still as this is an electrical paper I will refrain from going into the details of the mechanical side of the question—this is doubtless well understood by the querist.—"B. J. S. R."

WESTMINSTER'S NEW GENERATING STATION.

THE JUNIOR INSTITUTION OF ENGINEERS.

With the permission of the Chief Engineer to the Westminster Electric Supply Corporation, Sir A. B. W. Kennedy, F.R.S., a large number of members recently visited the Corporation's new Millbank Station. They were shown over by Messrs. S. B. Donkin, C. L. Grimshaw, and G. Horley, to whom the thanks of the visitors were conveyed at the conclusion by Mr. F. Disney Napier, Vice-Chairman. The station has been built to replace the old Millbank-street station, which must be pulled down in consequence of the County Council's scheme for making an enbankment roadway from the House of Commons towards Chelsea. The County Council have provided the Company with a new site in Horseferry-road, and are bearing the expense of re-building the station and filling it with plant to an extent equivalent to the present capacity of the old Millbank-street station. The actual size of the Horseferry station and the amount of plant being put in is greater than at Millbank-street, and this additional size and amount of plant is, of course, being paid for by the Company. The buildings as at present completed can ultimately hold 6,600 kw. of steam turbine-driven plant generating direct current at 440 volts. It can also ultimately contain about 14,000 kw. of motor generator plant, the motors working with three-phase current at 6,600 volts, supplied from the joint station belonging to the Westminster Electric Supply Corporation and the St. James' Co. at Grove-road, transforming this to direct current at about 440 volts for supplying the Westminster district. The plant at present erected, or being erected, is as follows: Four water-tube boilers, each with its own economiser and superheater, capable of producing 25,000 lbs. of steam per hour at 200 lbs. pressure with 150° superheat; two 300 kw. turbines, each driving two 150 kw. generators placed tandem, these being the balancer sets; three 1,000 kw. turbines, each driving two 500 kw. generators placed tandem; separate surface condensers with air pumps for each turbine, and a special arrangement of circulating water pumps, including strainer boxes and rotary strainers for sucking water from the Thames, forcing it through the condensers and back to the river; direct current switchboards for controlling the turbine-driven generators, and for controlling the direct current feeders; a 2,000 ampere-hour battery with 200 cells in all, 100 being a positive battery and the other 100 being a negative battery, arranged across the three-wire system; two battery boosters for enabling these batteries to be charged and discharged, the boosters being regulated by hand; one 500 kw. generator arranged with two 250 kw. generators for balancing, and two 1,000 kw. motor generators, each with single 1,000 kw. direct current machines (the three-phase motors of these motor generators are all of the asynchronous type with slip rings and resistances for starting up); complete high and low tension switchboard for controlling the motor generator plant; electrically-driven travelling cranes in turbine house and motor generator room; coal conveying machinery, ash hoist and gear, and coal measuring boxes between the bunkers and the boilers.

CHANGE OF ADDRESS.

Mr. T. A. Nunwick has removed from Deansgate to 32, Prince's-chambers, John Dalton-street, Manchester, where he will continue to represent Messrs. Dorman & Smith, switch-gear, water-tight fittings and electrical accessories; Messrs. C. J. Thursfield & Co., Cecil Works, Birmingham, electroliers, brackets, and fittings; Messrs. Oliver Arc Lamp, Ltd., Woolwich, magazine flame arc lamps; and Messrs. The Standard Cable Co., Ltd., London, E.C., cables and wires.

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INCANDESCENT AND ARC LIGHT IN MEDICINE.*

By DR. A. D. ROCKWELL, Neurologist and Electrotherapeutist to the Flushing Hospital, New York City.

There is no more important and efficient method in its relation to therapeutics than the application of light, and although much has been written about it, and much use has been made of it, yet, from the standpoint of those who from personal experience fully appreciate its value, it seems surprising that there is not a more universal recognition of its varied therapeutic properties.

In the few remarks that follow on light therapy it is not my thought to include the whole of phototherapy. I do not propose to discuss the Finsen light which is a very important part of phototherapy, but for the information of those who have a confused idea of what constitutes the Finsen light, and imagine that it is a very simple and easy thing to get, a word may fitly be said. The Finsen light, whether derived from sunlight or the electric arc light, exerts only actinic or chemical effects. In Finsen's original installation, an arc light of 20,000 c.p. was used, and the intense heat thus developed had to be absorbed by an elaborate cooling process, before the ultraviolet rays were available for practical and efficient use. The original Finsen lamp required 80 amperes of current and 60 min. of exposnre, but with simplified apparatus good work can be done with 5 amperes, and less exposure. Strictly speaking, the essence of the Finsen light is not light at all, for the ultraviolet ray having frequencies of almost infinite rapidity, are no more visible than the still higher frequencies of the X-ray, or the far lower frequencies that we appreciate as sound or heat. The effect of the so-called Finsen light then is local and superficial, of remarkable value in the treatment of skin affections, but of little worth in deep-seated morbid conditions.

The ultraviolet ray has no power of penetration. It is immediately absorbed by the blood, and even when the parts are rendered anæmic by pressure or by adrenalin and cataphoric action, its penetration is still comparatively superficial. Used alone and uncombined, it exerts no general constitutional effect, and acts only on the periphery, but, as Finsen demonstrated, is invaluable in dermatological cases and especially in the treatment of lupus.

It cannot be too often repeated that the difference in forms of physical energy is one of degree rather than of kind. The three things that go to make up a complete light treatment, or phototherapy, are the heat, light, and chemical rays which are simply different rates of vibration. Sound, which is a lower rate of vibration, we do not regard of therapeutic value, but as vibrations increase in frequency and decrease in length we get the heat rays, then light (the visible spectrum) until finally we enter the region of the invisible (the ultraviolet), and beyond this the X-ray. Light, heat, and chemical energy constitute the trinity of phototherapy. These combined effects are undoubtedly represented best by the rays of the sun—which when concentrated act more powerfully than those from any artificial source, but for obvious reasons their general and successful utilisation is impracticable.

The two available artificial sources of this method of treatment are the incandescent lamp and the arc light, either of which are superior both in physiological and therapeutic effect to the ordinary hot air bath, for the reason that the latter is more depressing and far less penetrating than radiant heat, and is without chemical activity. In the administration of light energy, a principle as striking on its moral and intellectual side as on its physical. Electricity, for example, is of value therapeutically only as it meets with resistance, and in the same way, light cures disease, only as it meets the resistance of the human body, and is transformed into radiant energy. The rays from a powerful incandescent or arc lamp readily penetrate the skin, but in overcoming the deeper and denser structures are converted into heat. Heat, therefore, is one of the principal therapeutic factors in the use of the electric light.

It may be observed further, that radiated heat, as developed by the incandescent, and especially by the arc light, results in a more rapid and powerful dilation of the superficial vessels than the action of simple hot air, and this relaxation of vessels, because of no appreciable heating of the surrounding air, can be continued indefinitely. These light rays exert a remarkable stimulating effect upon the peripheral nerve endings, and may be utilised to excite perspiration more quickly than any other method. The superior efficiency of this form of radiant energy in increasing oxidation and tissue changes is evidenced in the elimination of carbon dioxide. As indicated by this elimination, oxidation goes on far more rapidly under the influence of radiant light than of simple hot air. Another well recognised and important factor in the light tratement, more especially with the arc light, is its action on the blood. The hemoglobin carrying power of the red corpuscles is demonstrably increased, and through the influence of its invisible rays upon micro-organisms we get pronounced bactericidal effects.

My first experiences along this line were with the incandescent lamp, not the ordinary incandescent light bath, made up of many small electric bulbs enclosing the body of the patient, but of a single lamp of 500 c.p.

Placed within a cylindrical metal hood and suspended by a convenient mechanism, the light can be easily applied to any and all parts of the body. For the relief of pain and especially in the treatment of neuritis it is invaluable. I even have gone so far as to say that in the relief of local painful conditions and in its general constitutional influence it was superior to the arc light. In this I believe I was mistaken. After a more extended experience in its use I do not hesitate to assert, that while the arc is quite as valuable as the incandescent light for the relief of pain, its influence upon defective blood and skin conditions is far superior. From what has already been said as to the composition of these two manifestations of light, it is not difficult to understand why this may be so. Both are forms of radiant energy, but in the incandescent or leucodescent lamp, the glass globe effectually intercepts the chemical rays, while the arc light with no intercepting barrier gives the full value of the concentrated solar ray. While, therefore, theoretically it is no difficult matter to decide upon the relative value of these two forms of light and to rule as to some differential indications for their use, practically it has not been quite so easy Many cases had to be treated, some by one method, some by the other, with results on the whole seeming to indicate the greater efficiency of the arc light, but it was not until the two methods were successively used in the treatment of the same patients that the superiority of the one method to the other became strikingly manifest.

Briefly stated, then, the superiority of the arc light to the incandescent in the treatment of certain local surface conditions, and conditions constitutional and general is due to the fact that with light and heat are combined the subtle chemical reactions which are wanting in the other. The arc light represents all the rays of the spectrum as does the sun itself, and practically it is nothing but sunlight. Fortunately, however, for our therapeutic purposes, it is far more controllable than sunlight, and can instantly be made intense or mild, concentrated or diffused, and even the different light rays selected or excluded at will.

* Abstract from the American *Medical Record* of December 18, 1909.

PUBLICATIONS.

Parts I. and II. of Vol. XXX. of the *Proceedings of the Royal Society of Edinburgh*, have been received.

Journal of the Institution of Electrical Engineers, Part 195, Vol. 43, contains an excellent portrait of Mr. W. M. Mordey, Past President, reports of papers read during the Session, with discussions, several original contributions, and the usual reports of business meetings.

Proceedings of the Rugby Engineering Society, Vol. VI. In addition to official information this volume contains reports of papers read before the society, and discussions thereon, on "Incandescent Electric Lamps," by Mr. James Findlay; "The Utilisation of Exhaust Steam," by R. F. Halliwell; "The Electrification of Railways," by F. W. Carter; and "The Propulsion of Ships," by G. M. Brown.

The West Ham Electrical Bulletin for the January quarter contains, among other things, an illustrated article on "Whence Comes the Power?" in which Mr. G. Lloyd-Jones, the resident engineer, describes the power station, and a description of the huge electrically fitted chemical manufacturing works of Messrs. Burt, Boulton & Haywood, Ltd.

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PUBLICITY.

In this Section of "The Electrical Engineer" we give Publicity to New Inventions and Specialities.

Gas Engine Low-Tension Ignition Gear.

In the low-tension ignition gear for gas engines of large dimensions, more particularly those intended for use in electric power stations, which we illustrate herewith, one of the chief points has been to ensure against the possibility of pre-ignition. Figs. 1 and 2, represent the distributing arrangement, consisting of a commutator with brush gear

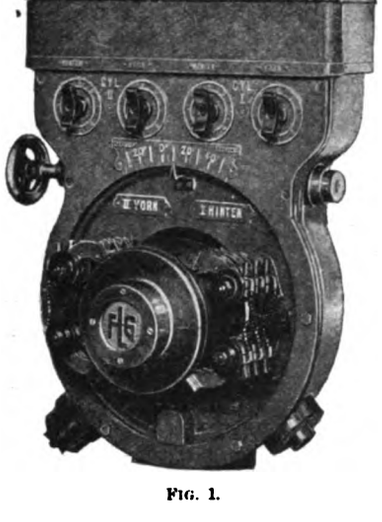

FIG. 1.

carried on a ring-frame, which may be mounted on the end of the engine shaft. It is shown in this position in Fig. 1, while in Fig. 2 the commutator is removed to show the brushes and frame. The commutator receives current from the mains, distributing it to strikers, consisting of cast-iron boxes, each containing two coils, controlling the position of armatures inside the boxes. These armatures have spindles protruding from the boxes and carrying weighted striking levers, moving in unison with the internal armatures. When the strikers are supplied with current by the distributing commutator, they descend and the weighted levers hit the levers fixed to the ends of the movable spindles of the igniters. As they rotate together they cause a separation of the sparking-points inside the cylinder, an arc is formed and the change is fired. A view of one of the strikers is shown in Fig. 3, while Fig. 4 gives a cross-section of one of the igniters.

It will be seen that the construction of these appliances is novel, and well calculated to afford protection to the electrical apparatus from outside injury, and also to ensure accuracy and dependability in action. In an appliance of this kind it is always interesting to show the electrical connections and these are given as applied to a double-acting, twin-cylinder, tandem gas-engine (see Fig. 5). We see the strikers and igniters with their spark-contacts at the top of the figure, eight sets being fitted. This duplication (for there are two to each cylinder end), is for greater certainty of operation and the minimising of ignition

FIG. 2.

trouble. Each striker-circuit is protected by a double-pole fuse, while each duplicate pair is controlled by a commutating switch, enabling the two strikers forming a pair to be used together or singly. The fuses are carried at the top of the ring-frame, protected by a cover, the switches being mounted below them.

The distributing commutator is at the bottom left-hand corner of Fig. 5. Each set of brushes bears alternately

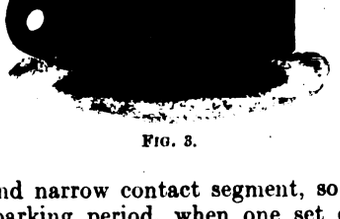

FIG. 3.

on a broad and narrow contact segment, so that, except during the sparking period, when one set of brushes is on the narrow segment, the striker circuits are short-circuited and a commutator breakdown will blow the main fuses. These fuses, together with their switch, are placed on the lower part of either side of the ring-frame.

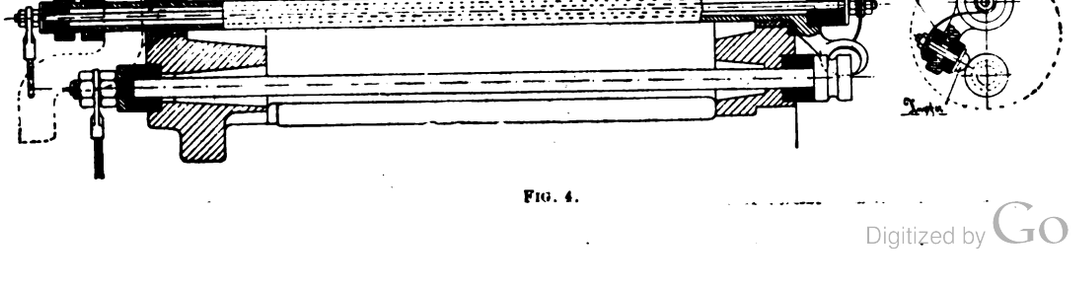

FIG. 4.

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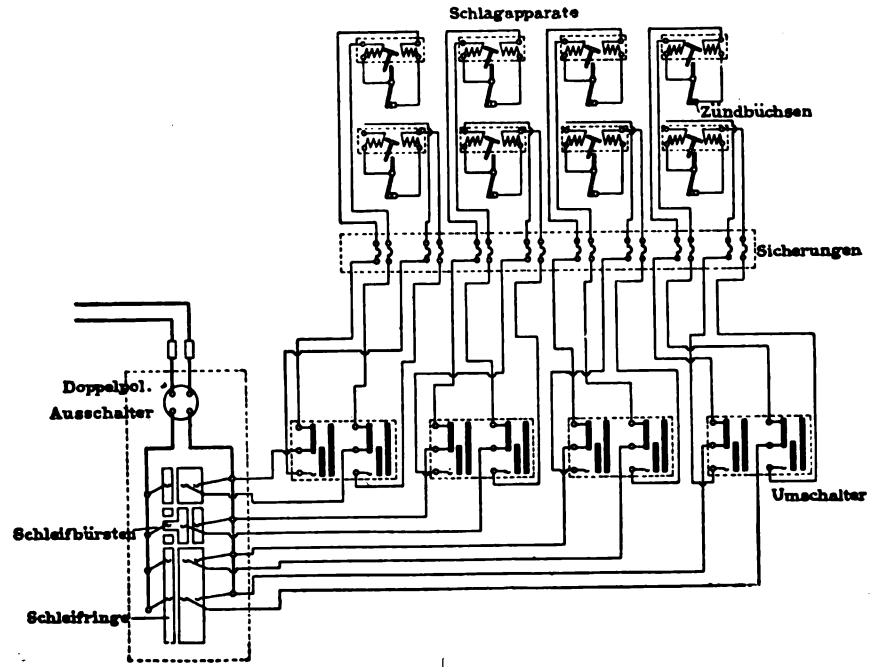
The commutator-brushes are provided with a rocking gear controlled from a hand-wheel, placed at the side of the frame, and which may also be placed on either side to suit the arrangements of the gas-engine. The brushes have a possible rotation of 50°, while each set may also be individually adjusted through about 10°, this arrangement being made as it is sometimes desirable that the time of ignition of the forward and back ends of a cylinder may be differentiated by a fixed angle.

The apparatus is built for pressures of from 65 to 220 volts, and in a continuous-current station may be connected to the lighting mains, or in an alternating-current one to the exciter circuits. But a battery is necessary to supply current when starting up, in case all the machines are shut down. This ignition gear is manufactured by the Felten and Guilleaumé-Lameyerwerke A.G., of Frankfort-on-Main.



PERSONAL.

There is a possibility of Mr. A. A. Voysey, Electrical Engineer to the Corporation of the City of London, retiring shortly. He has written to the Common Council relative to the need for reviewing the duties and responsibilities of the electrical department, and suggesting that it would be advantageous for the Corporation, in the event of its deciding to increase the responsibilities of the position, to take the opportunity of putting a more robust man in charge of the department. The communication was referred to the Streets Committee.

Mr. T. E. Mott, who has held the position of chief clerk to the Bridlington Corporation Electricity Department for over five years, is shortly leaving the service of the department, having been unanimously appointed by the Council to a superior position in the Waterworks Department. Mr. Mott was selected out of 158 applicants for his new appointment.

Mr. Alfred G. Collis, A.M.I.E.E., has resigned his position with Messrs. Ferranti, Ltd., and has joined Messrs. Cowans, Ltd., Salford, Manchester, the well-known high and low tension switchgear experts.

MORE LIGHT.

We mention in another column that the British Westinghouse Electric and Manufacturing Co., Ltd., have adopted the trade name of "Auriga" for their well-known tungsten metal filament lamps. In this connection they have been issuing a very clever post card, which we illustrate herewith. It will be seen that it shows Mr. Asquith demonstrating to Mr. Balfour the advantages of having light on any subject. It is a point of view which the public generally appreciate.

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THE POWER PLANT OF THE ONTARIO POWER CO. AT NIAGARA FALLS.

By Mr. C. W. JORDAN, Assoc. M.I.M.E.

Continued from page 81.

Generating Units.

Each generating unit consists of a horizontal double turbine direct coupled to a generator. The completion of the station and its equipment will be but an extension of the present form until, according to present plans, there will be an installation under the one roof, capable of continuously delivering 200,000 h.p. of electrical energy. Three of the generators, which are all of the conventional horizontal shaft pattern and exactly alike in appearance, have a capacity of 10,000 h.p. each, while the others have each a capacity of 12,000 h.p. These machines are wound for three-phase current at 12,000 volts and 25 cycles, and have revolving fields, the revolutions being 187·5 per min. The total weight of each generator is 231 tons, and each was entirely assembled on the spot, including the building up of the laminated iron rotor, and the winding and insulating of the armature.

"The generators were built by the Westinghouse Electric and Manufacturing Co., Pittsburg, Pennsylvania. The revolving element weighs 95 tons. Six generators are at present in operation. The exciters are 375 kw. Westinghouse direct current generators, 300 r.p.m., 250 volts direct coupled to Stillwell-Bierce & Smith Vaile "Victor" turbines, located on the gallery overlooking the turbine floor, and supplied with water through 30-inch penstocks that connect with the main conduit through the cable tunnel. Each of the two exciters has capacity to supply the fields of six generators."

Turbines.

"The turbines were made by J. M. Voith, Heidenheim, a. d. Brenz, Germany," and are of the Francis or inward-flow type, double, central discharge or balanced twin turbines, and are designed to deliver 12,000 h.p. at 175 ft. head. Their shafts are 24 in. maximum diameter, and each carries two 78-in. cast-steel runners of "normal" reaction. The housings are of reinforced steel plates, 16 ft. in diameter, spiral in elevation, and rectangular in plan. Gates are of the wicket or paddle type, and the rotating guides forming them are carried by shafts, which project through stuffing-boxes to an external controlling mechanism worked by the governors, thus freeing the casings from the objectionable internal-gate rigging, and leaving the approaches to the guides uniform and open. Whilst the velocities in housings and draught tubes are high, corresponding losses are avoided by easy changes of velocity and direction, and large curves free from acute angles or obstructing projections."

"Three of the governors were made by the Lombard Governor Co., of Ashland, Mass., and three by J. M. Voith. All operate by means of oil under pressure."

Of the 175-foot head, 20 ft. is in the 10-foot diameter draught tubes, since the floor of the power house has been raised 26 ft. above mean water level to provide for the excessive variation of water level in the gorge below the Falls. All the bearings are self-oiling, but, in addition, are all equipped with a water-cooling system, and also a piping system, for the changing of the oil has been so fitted as to be instantly available for forced lubrication in emergency. Each bearing is also fitted with an automatic recording thermometer, providing a daily record not only of the temperature of the bearing, but, of equal importance, the temperament of the attendant as well.

Reasons for Adoption of Horizontal Shaft Turbines.

The main reasons for adopting the horizontal shaft turbine in place of the vertical type, in addition to the saving of capital expenditure in excavations, were the freedom from step bearings, and their higher efficiency and greater accessibility. While step or thrust-bearings are perfectly reliable in numerous adaptations, still they always require special care and frequent adjustment. To reduce load on the step-bearing the vertical unit is usually of the heighest permissible speed, and whilst this is in favour of efficiency at the electrical end, the effect on the turbine is the reverse, and usually to a greater degree, because highest efficiency and durability seem to require "normal" reaction, a radial relative direction of bucket entry and a narrowly limited relative dimensions of runner. At such a reaction, peripheral velocity of runner (the components of which—diameter and rotation—are inversely proportional) is fixed by the available head. With such relative dimensions, power is proportional to the square of the diameter; hence it is inversely proportional to the square of rotation. Increase of rotation, therefore, means disproportionately decrease of power, or abandonment of ideal re-action and relative dimensions. When carried to the extremes common in vertical units, it results in inefficiently high reaction, and reduced area of discharge, unfavourably abrupt changes of direction in buckets and a wasteful, distorted, and overworked wheel. It is rare to find a vertical unit possessing anything like the efficiency or durability possible if correctly proportioned. In the present case the speed selected allows of almost exact "normal" reaction, and ideal proportions without sacrifice at the generator, and is best proved by the increase in output of the last units put in, without increasing the size of the turbines.

Every part of the combined set being above the main floor of the station, with plenty of light and room, and served by a powerful overhead crane, repairs and adjustments are easily effected, and the whole plant is in the full view of the operator on the switchboard gallery. As mentioned before, the, entire gate rigging is external therefore it is accessible for lubrication, adjustment or repair. Excepting runners and gates, every moving part is in full view, and by removing a single ring, even the guides themselves are accessible for cleaning or replacing. This arrangement is in strong contrast with that of the vertical type, with its many floors, intervening stairs, and dark corners, and its advantages are obvious.

Position of Main Generator Switches.

Where the cable tunnels commence, the power house is widened towards the cliff and the gallery carried in. Immediately above the tunnel entrance are mounted the main generator switches, and on one side the two turbine-driven exciters and their governors, and on the other the motor-actuated main field rheostats. In front of the switches are a few panels carrying exciter rheostats and switches controls for actuating penstock valves, and the necessary circuits and apparatus for a limited local distribution. Relief valves and small drainage pumps are the only operating machinery below the main floor, while upon it, in addition to the generator units, are only duplicate electrically-driven pumps supplying the storage tank, and transformer cooling water for the distribution station. To avoid dampness from spray from the adjacent fall, and to ensure the generators keeping cool in hot weather, a cold air supply is led to each generator from a sub-floor chamber, communicating with external shafts, and the heated air is released through large roof ventilators.

Leads.

The leads from the generators are single conductors, insulated with treated cambric. These leads, each in a separate compartment, are mounted on porcelain insulators, ample clearance to earth being allowed everywhere; the compartments are built up of thin shelves of reinforced concrete, fastened to the concrete substructure of the power house, and are closed by asbestos doors readily removable for inspection. At no place are the leads of more than three generators brought near one another, and the leads of each set of three generators, where they approach their respective oil switches on the gallery, are so protected and isolated from each other that earths or short circuits are impossible. Field circuits, exciter leads, and control wires are carried in iron conduits, and are either in separate passages, or at a proper distance from the main wires.

Control of Switch-Gear.

The switch-gear already outlined is controlled from the distribution-station on the hill above the power-house and ordinarilythe engineer in the power-house has merely, to attend to the supply of exciting current, but in case of a destructive short circuit on a generator, or other serious trouble, the control of the first generator oil-switch, and of the field-switch is at his command. All communications

and orders from the distribution-station to the power-house, and *vice versa*, are effected by means of a "telautograph," thus ensuring a written confirmation of every order given.

Path of Generator Leads and Cables.

The outgoing generator leads from the oil-switches go to cable heads supported and insulated in a substantial manner, directly under the gallery. Here they branch into three-core cables, two being required for each generator. These are paper insulated and lead covered, having on the outside of the lead a spiral steel armour imbedded in and covered with jute. These cables are taken to the distribution-house through a tunnel approximately 9 ft. square with arched roofc ut through the solid rock. This tunnel starts on a level with the main floor of the power-house, extends through the rear wall, and rises at an angle of 30° until it has passed under the main water-conduits. For this portion of the distance it accommodates the two 30 in. diameter penstocks for the exciter turbines. After passing under the main conduits it rises at an angle of 60°, and opens in a manhole half-way up the hill at the distributing station. The chief difficulty was to support the three-core power cables, and yet to insulate them, and provide for their easy drawing both in and out of the ducts. After the tunnel was driven through the rock it was lined with brick, a set-off being left in each side-wall of sufficient height to accommodate ten vertical courses of tile ducts, secured in place by steel ties and a facing of concrete. At frequent intervals in each duct a tile was left out. In the openings so formed, iron clamps with wooden bushes for gripping the cables were secured by bolts to the rock wall. The requirements for such support will be best understood when it is realised that each cable weighs 13 lb. per foot, and for the length of the tunnel exerts a downward force of over a ton.

The control cables for the operation of the governors, field-switches and penstock valves are carried in iron conduits secured to the roof of the tunnel by hangers. At intervals a space is left in the conduit, and a wooden clamp holds the cable, aud bears against the end of the conduit. The exciter penstocks are laid on the floor of the tunnel, and support a staircase giving easy access. The present tunnel will accommodate the necessary cable for 6 units, and extra cable for 2 units to be used in cases of emergency. Two similar tunnels will be required in addition for the completed plant. On Plate 7 is a section through the Generating Station and Distribution Station, showing their relative positions to the main conduits, penstocks, and also the cable tunnel.

After leaving the manhole at the end of the cable tunnel, the cables are carried in three groups of tile ducts buried in the ground, the two outers being power cables, and the inner one control cable. Thence they are taken to a distributing manhole in front of the distribution station. Both this manhole and the one at the end of the tunnel have separate chambers for the control and power circuits. The manholes allow of a straight passage of the cable through them, and reinforced-concrete shelves furnish both support and isolation for the cables and splices. From the distribution-manhole, any generator cable can be drawn through a manhole and duct system along the front wall of the distribution-station, and connected to any unit in the station. In the general arrangement of the works, symmetry and centralisation of control are predominant features.

Distributing Stations.

The generating and distribution stations are parallel, and nearly 600 ft. apart with a difference of 260 ft. in elevation. The distributing-station is wider and shorter than the power-station, and is divided into three longitudinal bays or five main sections. The narrow front bay contains the switches, bus-bars, etc., at generator pressure; the wider rear bay contains those at transmission pressure. Between these bays is the main middle bay, divided transversely by a three-floor switchboard section into two long transformer-rooms. The projecting central bay is utilised as offices. The transformers stand along the centre of the two rooms in groups of three, corresponding in position and capacity to their respective generators. Similar apparatus is arranged in rows parallel with each other, and with the generating units. Unit values corresponding to the generators in capacity and position are maintained throughout. Thus, each generating unit has its individual cables, switches, and switchboard, section of bus-bars, transformers, interrupters, and high-pressure switches complete to the transmission lines, enabling independent operation as an independent power plant, or through the selector switches, and duplicate sectional bus-bars, the operation of all units in any combination of groups, as readily and perfectly as their operation in parallel.

Transformers.

The low-pressure bay contains on the main floor the 12,000 volt automatic oil circuit breakers in double column, and in the chamber beneath only the sectional duplicate bus-bars and their immediate connections. In the transformer-rooms, the transformers stand in pits 6 ft. below floor-level, and parallel with them, adjacent to the high-pressure bay, are corresponding pits for choke-coils or other protective apparatus. Beneath, and between the foundations, are laid the various systems of piping for water, oil, and drainage, and the main cableways to the transformer above. Each transformer is fitted with a recording thermometer, and is of the oil-insulated, water-cooled type, three to a unit, connected in delta on the low voltage, and in star with centre grounded on the high-voltage side. The secondary potential of each transformer is 36,000 volts, and as connected the resultant line voltage is approximately 62,000 volts. Each transformer has a normal capacity of 3,000 k.v.a., and weighs, complete with oil and case, approximately 50 tons. They are cylindrical in form and the three constituting a unit are arranged in a triangular group in the pit. Strong barrier walls, rising several feet above the tops of the transformer cases, isolate each group of transformers and choke-coils from adjacent similar groups. A lower wall separates each group of transformers from its bank of choke-coils. Besides the protection given thus by the barrier walls, each transformer case is so strongly constructed that, should short circuits or combustion occur within it, the expanding oil and gases would find access and relief to the sewer through an 8 in. outlet pipe, before any undue rise of pressure could occur. Whilst there is but little chance of continued combustion within a closed case of this type, cold oil may be admitted from the supply-pipe at the bottom to flood the transformer if required. An electric travelling-crane spans the room, and will handle any choke-coil or transformer without interference with the operation of any other units. The high-voltage wiring from the transformers is insulated with treated cambric. and further protected by a braided fireproof covering of asbestos. It is supported on large porcelain insulators in the upper part of the transformer pits, the proper connections to the transformers being made through terminals issuing from the top of their cases.

The three outgoing leads, after connecting with the choke-coils, pass into the high-voltage room through insulating bushes set in the centres of circular wall panels. These panels are composed of two half-inch thick sheets of a fire-resisting insulating composition. In the high-voltage room, the switch and series transformers are on the floor, and the bus-bars overhead. The latter are composed of copper pipe wrapped with treated cambric and asbestos braid, and are supported mainly by their tie-switches, which are mounted on the tops of high masonry walls separating the units. The wiring is done in the same manner as in the transformer room, there being a clearance of several feet between wires, but no other protection than distance and the insulation on the wires. Both low and high voltage switches are of the plunger type, actuated by direct current magnets, but, of course, the high-voltage switches are considerably larger because of the longer break required and the greater insulating distances.

The oil is contained in large steel tanks, approximately 500 gallons being required for each switch. Oil piping for the switches, and control wires for their actuation, are carried beneath the floor. Each wire of an outgoing feeder passes out of the building through an insulating bushing, which is supported in the centre of a double glass panel set in an opening in the outside wall, and is protected from the weather by an overhanging hood.

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Horn gap lightning arresters of ample proportions, and with graded gaps and resistances, are placed at the rear of the station for the protection of the high voltage feeders.

Bus-bar Protection.

With regard to the distribution station, two points require special comment—the use of reinforced concrete for the bus-bar protection, and the method of control. The use of concrete for the almost entire construction of a bus-bar outfit is unique, but the success obtained assures the continuation of its employment. It is not only strong, easily erected, and economical of space, but also furnishes one of the best fire-resisting mediums, and is comparatively inexpensive, whilst it also makes a particularly neat-looking job.

Method of Control.

The control room is situated on the top floor of the switchboard section at the best position for the observation of the apparatus in the distributing station. Control pedestals corresponding in number to the generator units, containing operating switches and pilot lamps, with indicating instrument stands directly behind them, are arranged in a semicircle round the room. The line is broken at the centre, to permit of the feeder-control panels placed at the back of the room being in sight of the operator. Each instrument stand has mounted upon it a voltmeter, ammeter, wattmeter, power-factor indicator, frequency indicator, and synchroscope; also three ammeters connected in the leads to the transformers. Each control pedestal contains, besides the small switches for the control of oil-circuit breakers, push-buttons for opening and closing the generator field switch, a controller for the rheostat face-plate, and a controller for varying the speed of the turbine through the medium of the governor. A diagram of circuits on the face of each pedestal in which are placed pilot lamps from oil-switches, enables the operator to verify his connections, bearing in mind that the apparatus being controlled is all situated in the power-house far beneath his feet. Each feeder-control panel carries the switches and pilot lamps necessary for the control of the oil-circuit breakers in the duplicate feeders and three ammeters for each feeder circuit.

Opposite the semicircle of generator and feeder-control boards are two service-boards, one on each side of the entrance to the room. One of the boards contains the switches and instruments required for the distribution of alternating current at 220 volts for light and power purposes in the buildings, also the control for the oil-circuit breakers located in the low-voltage bus-bar. The other board contains the switches and instruments requisite for the distribution of 250 volt direct current (derived at present from one of the exciters) for lighting and control purposes. There is also a panel on this board for the control of a storage battery, which serves as a relay for the 250 volt exciter control circuits.

On the three floors beneath the control room, arranged in the same semi-circular manner, there are in order, the recording instrument boards, terminal and relay panels, and assembly racks for control and instrument wires. The room containing the latter is in the basement, and besides housing the wires contains a compartment for a 240-ampere hour storage battery, and also serves as a distributing point for all oil, water, and steam piping. The control and instrument wires, grouped into cables according to the character of service, come into the assembly room on different shelves for each unit from ducts, which are entirely isolated from the power apparatus. Here they rise to the terminal boards, where there is a terminal and fuse for every wire. These terminal boards and the similar ones in the generating station furnish definite points for the detection of trouble in the control or instrument circuits. From the terminals the wires go to the switch relays or recording instruments in the control room.

Recording Instruments.

The graphic recording instruments are of a new type, and comprise voltmeters, ammeters, wattmeters, and frequency and power-factor indicators. They are so connected in the low-voltage circuits that there is a continuous record of each generator as well as of the demands of any set of feeders. In the control room, the chief operator's position is the centre, where at his desk he may observe by means of his instruments, every electrical occurrence, and direct his assistants as required. He has his own private telephone system running to all the rooms in the building, and also has direct connection with telephones along the transmission wires. The telautograph is invariably used for communicating with the generating station because of its unmistakeable records. He is thus able without moving from his chair to control every electrical circuit and situation of the system, and to stop, start, regulate or synchronze each unit. He can throw the output of each unit through its transformer to the transmission, as if from a single isolated plant, or he can throw the current upon either bus-bar while supplying its transformers from the same or another bus-bar. The experience obtained up to the present in the practical working of the plant has been so successful that it is to be anticipated that other large plants in the future will adopt the same system.

ELECTRICAL EQUIPMENT OF ROLLING MILLS.

The electrically operated 28 in. cogging mill equipment recently installed by Messrs. Dorman, Long & Co., Britannia Works, Middlesbrough, to which we referred in a recent issue, has fully justified their courage and enterprise in being one of the first to realise the advantages of the electrical operation of this class of machinery. On November 26 last during a night shift of 12 hours it cogged 92 ingots 14 in. by 12 in. down to both 6 in. and 5 in. billets as required in 4 hrs. 41 min. actual cogging time, the total weight cogged being 105 tons. The mill, which was built by Taylor & Farley, of West Bromwich, and the electrical equipment, which was designed and built by the British Thomson-Houston Co., Ltd., of Rugby, gave no indication that they were then at their limits.

The output for which the mill and equipment was originally designed was 15 tons per hour, with a possibility of dealing with 22½ tons per hour for two hours continuously it required. It will be noted that during the shift referred to the output of the mill was 22 tons per hour for 4¾ hours continuously. In this mill an ingot of from 22 to 25 cwt. 14 in. by 12 in. can be cogged down to a 5 in. billet in 2¼ min. It is claimed that this is the fastest cogging plant in the North. It reflects great credit, not only on the users for the manner in which the mill is operated to obtain these results, but on the designers and builders of the mill and its equipment.

A General Engineering and Allied Trades Exhibition is to be held at Manchester in the Spring of 1911. It will be managed by a committee of exhibitors and organised by the International Trade Exhibitions, Ltd., of London.

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TYNESIDE NOTES.

NEWCASTLE-ON-TYNE.

There has been an almost complete paralysis of business activity throughout this district during the past week owing to the attention which has been attracted by the General Election. The issues before the county have been fought with intense earnestness on Tyne and Wearside, and in view of the peculiar results which have been obtained at the poll it may be worth noting briefly the impressions of the campaign as affecting industrial questions in which electrical engineers are interested. The preponderating issue was the alternatives of Free Trade and Tariff Reform. Many electrical manufacturers and contractors with whom I have discussed the situation appear to be in favour of a revised tariff, while on the other hand the shipping (not the ship building) interests seem to be in favour of Free Trade. The artizan class, however, seem to have plumped heavily in favour of Free Trade. As an instance, it has been more than once stated to me that the districts of Heaton, Byker, and Elswick, in which an overwhelming proportion of the industrial vote is found, went almost solidly for the Liberal candidate.

Tyne Industries.

There is now no doubt that there is a "good time coming" on the Tyne, as among the big shipbuilding yards activity is commencing which will develop more and more strongly during the next two years. It is rumoured that in connection with their new yards at Walker, upon which I recently reported. Messrs. Armstrong, Whitworth & Co., Ltd., are preparing to make two large berths capable of accommodating first-class war vessels. Their ordnance department is also very busy at present. Messrs. Swan, Hunter & Wigam Richardson have received an order for a new Cunarder, which will be about 620 ft. long from stem to stern and will have a displacement of about 24,500 tons. It is designed partly for emigrant transport, although considerable provision is made for first and second class traffic, and will be driven by reciprocating engines. A large amount of electrical work will be included in her equipment. Other shipbuilding firms are also receiving definite orders for new vessels, so that prospects are considerably brighter.

Electrical Standards on Board Ship.

In connection with the shipbuilding industry it may be interesting to recall the fact that Professor Kapp at the last dinner of the local section of the Institution of Electrical Engineers referred briefly to the fact that electrical engineering in connection with marine work suffered owing to the absence of standardisation of voltages on board ship. I have been given to understand that opinions have been taken upon Tyneside as to the possibility of reducing the voltages on ship-lighting and power specifications to a uniform value so as to allow electrical contractors and manufacturers to adhere to a definite line of stock, and although the whole matter is at present in a somewhat nebulous condition, hopes are entertained that it will be possible to bring about something like uniformity in this connection.

Electricity in Mines.

Electrical mining matters in this area are still somewhat at a standstill owing to the difficulties encountered between colliery owners and the pit men in the practical working out of the Eight Hours Act. Although in many pits, principally in Durham, amicable working arrangements have been arrived at and the men have returned to work, these arrangements are in many cases purely tentative, while in Northumberland the position is still unfavourable. In the meantime the general public, and with them the electrical engineers, are suffering. Considerable prominence is being given at present to mining matters in this area. On Monday, the 24th inst., a paper was read by Mr. J. H. Fisher before the Local Section of the Institution of Electrical Engineers on the "Safety Devices in Coal Cutters," while on Wednesday, January 26, the Newcastle branch of the newly-formed Institution of Mining Electrical Engineers is to discuss a paper on "Electric Shock."

Electric Train Service in Newcastle.

The North-Eastern Railway Co. have recently been increasing the local railway facilities on their electrified section by linking up the newly developed junction station at Manors North with the Central Station. Mr. C. A. Harrison, the North-Eastern Railway civil engineer, before the Institution of Civil Engineers, mentioned that the electric service effected a saving of time without increasing the maximum speed. The time taken in running a round trip between the Central Station and Manors North, *via* Whitley Bay and Benton was in the case of steam trains 68 min., while the electric trains stopping at all the stations, do the round in 58 min. The less platform accommodation and the higher duty per platform at terminals due to the abolition of attaching and detaching locomotives is also a good feature. According to the local press three electric parcel vans are now used for dealing with the fish traffic between Tynemouth and Newcastle. The total length of electrified lines is now 75 miles, and trains are made up as required to a length of 550 ft. It is also stated that the electrified lines as a whole are now carrying more passengers than they have ever done since the date of their opening.

MIDLAND NOTES.

BIRMINGHAM.

A number of firms in the Midlands took advantage of the Christmas holidays to complete the installations of electrical plant with which they are replacing their other motive power. Among these are eight or nine important Birmingham firms, whose connections represent a considerable addition to the total horse-power on the Birmingham Corporation mains. It is anticipated that at the end of the financial year, which comes on March 31, the total will be not far short of 20,000 h.p. On December 31 last the motors connected with the Corporation works represented 18,550 h.p., as compared with 12,900 h.p. on December 31, 1908, and 8,200 h.p. at the end of 1907.

Lighting Progress.

The lighting sales also show a progressive increase, though not in the same ratio. At the end of 1907 there were 143,000 lamps in circuit; at the end of 1908 the number was 168,000, and on December 31 last it was 182,214. The sales of current for public supply last year were 15½ million units, as compared with 11¾ millions in 1908. These figures, it should be noted, include nothing for street lighting, which is entirely by gas. Adding 11¾ millions in 1908, and 12 millions in 1909 for tramways, the sales show an increase last year of 4 millions, or 19%, or without the tramways, of 3¾ millions, or 31 %. The metallic filament lamp, of course, has to be taken into account as a factor materially qualifying these figures. Probably about two-thirds of the lamps in use in Birmingham are now of this type. Taking the 60-watt lamp, the standard used in the above statistics, the candle-power of the metallic filament may be put at 50, as compared with 15 for the carbon, and the current for the light, supplied last year, would, under the old conditions, have been 60% more. No fear is entertained in Birmingham however, as to any permanent retardation in the rate of increase, as it is evident that the superior results from the metallic filament lamp are rapidly increasing the popularity of electric lighting, so that new connections may be expected soon to compensate for the diminution in sale of current per lamp. This movement will be favoured by the introduction of metallic filament lamps of low candle-power, and in Birmingham one of 15 c.p. is already being largely fitted. The efficiency of this lamp is 1·7 watts as compared with 1·2 for 32 and 50 c.p. lamps, but there is an important set-off in the longer life of the smaller lamp.

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"Fair-Fare" Doubts.

Fuller experience of the "fair-fare" method of charging tram fares does not appear to suggest that it will prove in the Midlands so advantageous to the undertaking as was at first believed. The public seems to have come to the conclusion that the change works out more favourably for the company than for the passenger, as it enables the average distance traversed for a penny to be reduced. The penny ride on the Black Country network of tramways is being contrasted with the longer rides given where the lines are under municipal management; and in some cases formal protests are being made against the introduction, of the new system. A resolution of this character has been passed by the Labour Representation Council on behalf of the Trade Unionists of Smethwick, and the Town Council of Smethwick, which has already taken the question up, is being urged to act more vigorously. It does not appear that the Council has any power in the matter, but advantage is being taken of the present dissatisfaction to renew the agitation in favour of an application to Parliament for compulsory purchasing powers. As the company's present concession has 27 years to run, it is likely that the Council will think twice before going in for a Parliamentary struggle with the B.E.T. with this object, and will probably content itself for the present with remonstrance.

Quinton and Tramways.

The question of tramway communication through Quinton, a district recently incorporated with Birmingham, has been raised by the notice given of a renewed application by the Halesowen Light Railway Co. for authority to construct certain light railways in parishes wholly outside the city, and one passing through Quinton, the object being to form a link with the existing tramway of the Birmingham and Midland Tramway Co. The application with regard to the latter part of the scheme was opposed by the Corporation in 1903, and refused by the Light Railway Commissioners, and it will be again opposed on the ground that by the incorporation of Quinton with the city it has become more urgent that the Corporation should retain control of the portion of the road over which the company are now seeking powers, and which forms the boundary between Smethwick and Oldbury on the north-east side, and the city on the south-west. The City Council has been recommended by the Tramways Committee to take the necessary steps for applying to Parliament for power to construct a tramway along Beach-lanes between the King's Head and Balden-road so soon as the demand for such tramway will, in their opinion, justify the application.

"Vitrite" Incandescent Lamp Cap Factory.

Much interest is being taken in Wolverhampton in a new electrical venture, which looks like eventually being a most important addition to the industries of the district. The initiative has been taken by a local committee known as the Wolverhampton Development Committee, formed some time ago to introduce new industries into the locality. The requisite capital has been raised to acquire the patent rights of an incandescent lamp cap made on what is known as the "vitrite" process. The substance is of a very hard glassy nature, which answers the purpose extremely well. The cap is capable of being fitted to a variety of lamps now in use. The device is of American origin, and has hitherto been worked chiefly in Belgium. It is hoped to concentrate the manufacture eventually in Great Britain. Up to the present about £5,000 has been subscribed, chiefly by local financiers; but, probably, this amount will be increased to £20,000 or £30,000 as the scheme develops. About 40 hands are being employed as a commencement; but a big business employing some hundreds of hands is expected to develop. Among those who are taking a leading part in the venture are the late Mayor of Wolverhampton, Alderman Bantock, and Mr. Charles Mander, with a number of well-known manufacturers. A factory has been rented which is likely to be extended and adapted for the new manufacture.

SCOTTISH NOTES

GLASGOW.

At a meeting held the other day the Glasgow Corporation decided that "all standing committees be instructed, in making contracts, to provide in all schedules and specification, for preference being given to goods of British manufacture." The first practical application of this resolution came up last week (Thursday, 20th), when after a lengthy and heated discussion the Glasgow Town Council agreed to place an order for tramway cable with the British Insulated and Helsby Cables, Ltd., in preference to the Standard Cable Co., a continental firm, although the offer from the latter was £77 lower than the other. Another motion, very much less practicable, was that preference should be given to local ratepayers in connection with corporation contracts involving employment in the city. It is clearly inconsistent in one clause of a contract to demand first-class workmanship, and then in another clause to limit the contractor in his choice of men to do the work.

Ship Lighting.

Glasgow has the honour of including among its wiring contractors a number of firms occupying the foremost rank in ship lighting. Messrs. W. C. Martin & Co., of West Campbell-street, Glasgow, for example, who wired the Cunard R.M.S. *Mauretania*, carried out some important contracts during the past year on a number of first-class steamships. In three new steamers built for the Orient Steam Navigation Co.'s Royal Mail Service, they put in over 1,500 lights in each ship, with fittings to suit the decorations of the various rooms. For the navigation of the Suez Canal a Sautter Harlé projector was erected on the bow. Over 300 electric fans were fitted for ventilating. Electric heaters are fitted in the principal rooms. Forced draught fans, pumps, domestic machinery, hoists, winches, cranes, etc., are now all being electrically operated on board ship. Other installations fitted by Messrs. Martin during the past year have been a train ferry steamer for the Swedish State railways with 800 lights, T.S.S. *Hollandia*, with 900 lights, and a number of smaller boats. The firm's new work includes Cunard R.M.S. *Tranconia*, now being built at Wallsend, which will have 3,000 lights, with a corresponding amount of various electrical lighting and power appliances.

Electric Heating.

The growth of the application of electricity for heating purposes is being kept up in Glasgow. Additional radiators and convectors continue to be installed in the City Chambers, and an order has just been placed with the Prometheus Co. (Messrs. H. G. Barrett & Co.) for three convectors, and with Henderson Green & Co., of Glasgow, for three radiators for the heating of the offices of the Corporation Sewage Department's new station at Shield-hall. These six heating units will take current to the extent of 36 amps, equivalent to 9 B.O.T. units per hour.

Publicity in the Electrical Industry.

A typewriter traveller thinks most highly of the typewriter which he regards as the greatest opponent to the machine he is selling. Similarly, the increasing amount of attention which electricity receives from gas people is the best tribute that electricity could get. But it is more than time that those responsible for the electrical industry should fight the advocates of gas with their own weapons. It is true that a little has been done in this way already, but nothing in the proportion to what is being done for gas. In Glasgow, for instance, the Corporation Gas Department have a large shop in one of the main thoroughfares in the centre of the city where all kinds of gas apparatus are not only on view but on sale. The Corporation Electricity Department are now organising a small showroom at their head offices in Waterloo-street, but when it is finished it will be meagre and unpretentious when compared with the Gas Department's large premises in Union Street. Not only so, but the Gas Department Committee of the Corporation recommended the other day that £150 be spent on a series of lectures with demonstrations for the purpose of instructing the public as to the best manner of utilising gas for lighting, heating and cooking purposes. In the absence of a similar recommendation being forthcoming from the Electricity Committee, it is suggested that those interested in extending the application of electrical energy should have a series of lantern lectures prepared and a selection of electrical devices collected for demonstration. These lectures could be put into a neat syllabus which could be sent, say, early in September to

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the secretaries of literary and other similar societies with a view to getting one or more lectures on the application of electricity included in the programme of subjects to be considered by such bodies. It may be worth noting that the suggestion now made, if carried out, would not be an untried experiment: a certain society in Glasgow in propagating their ideas have used this method for years, and their members deliver in Glasgow and neighbourhood from 120 to 150 lectures each winter.

Development of Private Telephones in Scotland.

To those who have closely followed the development and vicissitudes of privately owned telephones in our industrial and commercial organizations in Scotland, it is most evident that a drastic revolution in telephone practice is taking place. The development referred to is one worthy of the most serious consideration by Electrical engineers and users alike. The system is such that it tends to set up a universal standard of telephone practice similar to that obtained in the electric lighting and power worlds. We recollect the vagaries of the early point-to-point battery call and magneto call telephone systems, with their complicated arrangements of switches, extension bells, and code ringing, and also the introduction of the earlier forms of peg boards. We have passed through the improved arrangements of the elementary types of annunciator plug boards, and we have also been severely bitten with the craze for the putting up of the cheap and nasty 7s. 6d. 'phones which have done so much to retard the development of the private telephone system. We come to the boom of inter-communication telephones, automatic and otherwise, in their hundred and one forms, and which, within very restricted limits serve a distinctly useful purpose. We are at the present on the top of that boom. The inter-communication systems have, however, been pushed far beyond their natural scope, which should never exceed 10 lines. Authorities are unanimous in agreeing that at and above the 10-line limit the only satisfactory system from all points of view is the exchange system. Telephone experts are further in agreement beyond all question that the *beau ideal* exchange system is the central battery or common energy system. Until within the last two years or so the utility of the central battery system has been confined to public exchange service. Throughout the world the central battery system is rapidly ousting all other exchange systems and is becoming firmly established as the international standard system on account of the efficiency and economies effected. The General Electric Co., Ltd., have clearly foreseen the immense and unlimited feature before the central battery system for private telephone users, and have produced C.B. exchange apparatus for private exchange systems of 10 lines and upwards to any capacity according to requirements. This company has done excellent work in Scotland by introducing the system to the notice of the public with most satisfactory results. It should be pointed out that this system can be installed at a cost which compares most favourably with that of a magneto call exchange installation, and comes out decidedly cheaper than a reliable inter-communication system—automatic or otherwise. The pioneer firm in Scotland to adopt the General Electric Co.'s C.B. exchange system was Messrs. A. F. Craig, Ltd., the well-known Paisley engineers, who, acting on the advice of Messrs. Sayers & Caldwell, the consulting engineers, of Glasgow, installed a 20-line switchboard which is of the automatic eyeball shutter type. The eyeball shutters fulfil the function of both line and supervisory signals, being exposed when the conversation is in progress and disappearing automatically from view when the conversation is finished and the receivers are hung up. The entire energy for both speaking and signalling purposes is supplied by a 12-volt central battery made up of two 6-volt 60 ampere-hour ignition accumulators coupled up in series. The battery is maintained in duplicate, one battery being always in reserve whilst the other is being charged. The installation has been heavily worked for considerably over 20 months, and the cost of maintenance during this period has been a negligible quantity. Messrs. A. F. Craig's lead have been well followed, and many enterprising Scottish firms are now the happy possessors of a private telephone installation that does not show an ever-occuring tendency to take a rest. Notable amongst the orders executed by the General Electric Co. is the complete model C.B. exchange installation equipped for the North British Locomotive Co., Glasgow. This company possesses two works and central administrative office situated in Springburn, on the northern side of the city, and other works at Polmadie, three miles due south of Springburn.

A main exchange is installed in the administrative buildings at Springburn, and consists of a 200-line lamp signalling relay type C.B. switchboard with double lamp supervisory signals, constructed on a most up-to-date modern practice and arranged in two operators' positions. A ringing dyna-motor supplies alternating current for ringing out to "wanted" subscribers, and a power hand magneto generator is provided on each operator's position as a standby against breakdown. There is a fully equipped test room containing the main frame on which all the external and switchboard connections terminate on arrester strips and terminal blocks respectively, which arrangement makes provision for full-line protection and necessary cross connections. A modern test panel is provided equipped with dead beat central zero voltmeter and sufficient keys and associated apparatus to permit of various forms of tests being applied to any line which can be immediately selected by means of a special test clip which is plugged on to the required pair of arresters. The battery room contains two sets of batteries, each consisting of 11 cells of chloride accumulator of 90 ampere-hours capacity at a 9-hour rate. The battery charging is controlled from a special power board of a marble slate mounted with appropriate meters, switches, fuses, and automatic circuit breaker and rheostat. The telephone connections from the two works are brought into the exchange by means of underground lead-covered dry-cored paper insulated cable with 10 lbs. conductors, and the lines distributed in the works by means of centrally situated steel distributing standards.

The exchange at Polmadie consists of a 30-line lamp signalling relay type switchboard with similar associated apparatus and plant to that at Springburn. The two switchboards are directly connected by two pairs of junction circuits so arranged that the action of inserting a plug in a junction jack of one switchboard immediately lights the corresponding line lamp on the other switchboard. The arrangement of the double supervisory clearing lamps entirely eliminates the necessity of the operator "listening on the line."

Among other places where this system has been installed are Messrs. Beatties Dennistoun Bakery, Glasgow—two switchboards; Messrs. Craigpark Electric Cable Co., Glasgow, and the Kirklandside Infectious Hospital, Kilmarnock. A large number of important enquiries are in hand, and several installations shortly going in.

FRENCH NOTES.

PARIS.

Disastrous floods are causing enormous inconvenience and damage not only in Paris, but in a large area of France. Electrical undertakings have suffered heavily. It is not only that floods have disorganised, and in some cases injured, hydro-electric generating stations, but steam operated plants, usually placed near rivers for the sake of water for cooling purposes, have been flooded. For this reason the electric light has failed in many places, and both trams and electric railways have been brought to a standstill. In the Paris underground railway the loss has been very serious, and, indeed, it is difficult at the moment of writing to estimate the real amount of damage. A considerable mileage of the underground tunnelling is built over the long disused quarries, which honeycomb a vast area of the capital on both sides of the river. The danger lies in water making its way into the lime, gypsum, and sandstone quarries and undermining the elaborate system of underpinning there carried out. Electrical engineering in most of its phases has received a severe blow, the effects of which will be long felt, for the loss will re-act on the money market, and so impede expansion.

The Institute Prize.

The Institute of France has been called upon to take part in the management of an international triennial prize, to be called the "Montefiore-Levi Foundation," to be

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awarded to the author "of the best original work on the scientific advance and applied technical progress of electricity in all its branches." The prize will be the interest on a capital sum of 150,000 francs, and will amount to about 13,500 francs, £540. The first award is to be made in 1911. The jury will consist of ten electrical engineers, five of whom must be Belgians. The Institute and other learned bodies will have a general supervision of the administration.

The Use of Aluminium.

Aluminium is not only being produced in ever-increasing quantities in France, thanks largely to the rich deposits of bauxite in the Var, the Bouches-du-Rhone and the Hérault, and also to the big hydro-electric stations, but is also coming into extensive use among electrical engineers. A number of the more important power supply stations are making use of aluminium cables, either aerial or underground, for the transmission of electricity, and with the most excellent results, both as regards economy of first cost and upkeep.

The Microphone as a Divining Rod.

M. Dienert, a Paris engineer, calls attention to the use of the microphone in searching for subterranean water. One end of a pipe, open at both ends, is thrust a little way into the ground, and the microphone is then used to magnify any sound that may come up the tube. Running water is said to cause a sound like that of the wind in a forest, and dropping water one resembling a bell. In a branch valley of the Marne, where there is a scarcity of water, the microphone has led to the discovery of two valuable springs 50 ft. below the surface.

The International Electric-Technical Commission.

The International Electro-technical Commission, which was the outcome of the Conference held last year at Marseilles, is getting to work. The Belgian Committee has now been formed, with M. Léon Gerard, delegate of the Société Belge d'Electriciens, as vice-president.

River Lock Electrical Equipment.

M. Imbs, engineer of the Ponts et Chaussées, has given a description of the electrical equipment at the barrage-lock on the Seine, at Port-à-l'Anglais. The lock is a new one, with a single gate, and all the mechanism is set in motion by electricity, which is also used for signalling and lighting purposes. For the actual working of the lock gate, power generated by the fall of the water itself, passing through a turbine, is utilised; but as this only amounts to 10 h.p., electricity supplied from the great generating station of the Compagnie Est-Lumière at Alfortville, is taken. The capstans are electrically controlled, and this proves of immense service in saving both time and labour. The passage of the usual squadron of eight boats has been reduced from 40 to 27 min.

GERMAN NOTES.

BERLIN.

The Berlin police are now in possession of a teleprinting apparatus whereby police notices can be printed simultaneously at nearly 200 police stations in Berlin and the suburbs. The communications from the central office are delivered from a tape machine at each of the receiving stations. This is a great step in advance in police methods, but it may be permitted to us to suggest that the escape of criminals could be still more guarded against if every receiving station was also a transmitting station. If some outlying police office could cause news of a burglary, for instance, occurring in its district to be printed simultaneously in all the other police stations the whole available force could be on the look out at once.

Winter Sport and Electricity.

Our German and Swiss mountain districts afford healthful recreation all the year round. In the summer there is peak climbing, and in the winter the tourists crowd to the well-known resorts for tobogganning, ski-ing, and other snow-favoured pastimes. Are not all the European and American journals, and the railway companies' posters full of advertisements illustrated in many cases of these delights? The necessary consequence of the popularity of these frost-bound amusements has been the erection of palatial hotels in situations so far above the valleys that water power is not to be thought of, even in summer. These places have to be lighted and heated, and electricity is usually resorted to for supplying the necessary energy, expensive as it must evidently be in such localities. Power stations at a lower level are generally at a great distance, so that the cost of getting current from them is really prohibitive, and it becomes necessary to generate power on the spot. Gas engines have proved too costly, for they require gas which must either be brought from a distance or made on the premises, when there is, of course, the additional expense of a gas-making plant. The only possible solution was, therefore, to use a liquid explosion-motor to drive the dynamos, but benzole has been substituted for petrol for fiscal reasons. The benzole engine is coupled direct to the dynamo, and it has been found advisable to use the current to charge an accumulator instead of sending it direct to the lamps, The reason is that if the load on the dynamo is not steady the efficiency factor falls off, and the consumption of fuel is too great.

The Albula station, which supplies the important town of Zurich with current, is the first large undertaking of the kind to commence operations during the present year. The execution of the works has been an interesting piece of engineering, as difficulties were encountered which necessitated the invention of new methods in several cases. The flow of water is 3,300 gallons per second.

Magnets as Lifters.

The use of magnets for lifting heavy weights has now become a regular part of what the Germans sometimes call crane-practice. The magnets used have movable poles so as to secure the greatest possible amount of contact between them and the iron to be lifted. Magnets are, however, especially adapted for lifting iron in small pieces, such as turnings, borings, etc. That the electromagnets can be made to carry a heavy load is shown by the following figures given in *Dingler's Journal*:

A magnet lifting	250 kg	of pigs of iron	weighed	650 kg.
Do.	150 do.	cast iron turnings		625 kg.
Do.	200 do.	do.	do.	780 kg.
Do.	300 do.	do.	do.	1,000 kg.
Do.	735 do.	do.	do.	9,310 kg.

Lifting the monkey in pile driving is another branch of weight-lifting in which magnets render great service, and electro-magnet pile drivers have been constructed with eight-ton monkeys, the magnet weighing about two tons.

Hungarian Notes.

My Budapest correspondent informs me that the city of Budapest intends to have a municipal electrical station worked by the water power of the Danube. M. Fischer, the director of the Ungarische Allgemeine Elektrizitatsgesellschaft, considers, however, that it would be cheaper to work it by steam, and that for several reasons. In the first place the electricity could then be generated on the spot, and the place contemplated at present is at such a distance that a great length of conductors for high voltages would be required to bring the current to the city. Another is that he thinks that the estimate of 2,000 hours as the time during which the current would be used for industrial motors is far too high, for at the largest power station on the continent, that of Berlin, the actual time is 680 hours only. He estimates the cost of the present scheme at roughly a million sterling, and says it would pay 2½% only, while his own steam system would cost less than half a million and pay 6·3%.

An important undertaking to utilise the power of the Poprad river in Hungary for current production has just been started. The capital to be expended is nearly half a million sterling. Ten thousand horse-power can be obtained from the river. The available head of water is about 100 yards, and a canal about 2½ miles long and 4 ft. wide will be constructed to bring the water to the turbines at the power station.

Current Notes.

The Rheinisch-Westfalische Elektrizitatswerk A.G., at Essen, has had another good year, and is actively extending its operations and its numerous branches. The gross profit

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rose from 3,513,886 marks in 1907–8 to 3,677,575 in 1908–9. The dividend will again be 8% on the capital of 30 million marks.

Some further particulars are to hand of the trial of the Eichel mono-rail at the Berlin Zoological Gardens in November of last year. The current used was a continuous one of 110 volts. The carriage weighed three tons, and the wheels were 16 in. in diameter. The gyroscopes which keep the carriage in its proper position run in cases from which the air has been pumped out, and each of them weighs one cwt. The speed attained at the trial was about 6 m.p.h. only.

Berlin now possesses four electrically driven fire engines. They have so far worked without accident, and the working expenses are less than those of horsed engines.

AMERICAN NOTES.

NEW YORK.

What is probably the largest single order ever given in this or any other country for electrical machinery has this week been passed to the Westinghouse Electric and Manufacturing Company by the Pennsylvania Railway. Eminently satisfactory reports having been made on the tests recently undergone by the two new electric locomotives made by the Westinghouse for service in the New York terminal division of the Pennsylvania, the Westinghouse has been instructed to proceed with the construction of fifty of these, the most powerful electric machines ever built for railroad service. The Company has until July 1, 1910, to complete and deliver the entire order. The new machines are built in the form of double locomotives or two in one; each machine will have a motor with 2,000 h.p. capacity, or a total in the double machine of 4,000 h.p. The new machines will be equal to three of the steam locomotives of the largest freight type, and are constructed in such a manner as to be operated with the utmost simplicity and economy.

The Chimneyless Age.

The current week's instalment of a series of articles on "Central Station Advertising," which Mr. C. A. Parker is writing in the Chicago *Electrical Review*, gives some piquant hints on increasing current consumption without increasing "kicks" on the part of the consumer. The writer deals in detail with the art of pushing various domestic electrical appliances, and concludes with the observation that "when the chimneyless age arrives, every home will be wired for electricity, just as every home is now piped for water. The wiring will be much more elaborate than at present. There will be an electrical heating service and electrical cooking service, and an electrical domestic convenience service that will comprehend every human need. Outlets and plugs will be multiplied to the "nth" power. Electrical devices and utensils will be omnipresent. Living room, kitchen, bed chamber, toilet, and den will be so equipped that the genie of the wire may ever be at the summons of its human master. A race of men will be developed fully capable in mind and body of realising their complete potentialities. And not the least important element in this scheme of things will be the central stations of the "Chimneyless Age"—the source of nine-tenths of the well-being and comforts of the entire community. There will be perfect understanding and mutual good-will between the people who pay the bills and the man who receipts them. Current will cost less to all parties concerned. The central station man's profits will be larger in volume than ever before. Electricity and electrical devices have merit enough to justify the prediction that, at some time in the course of human events, they will play an all-important part in the daily round of human life—a *role* even more important and more nearly universal than at present. And the rapidity with which that happy state of affairs is attained depends very largely upon the thoroughness with which the central station advertiser comprehends his problem and learns and applies the lessons that experience has to teach." It is obvious that the Chimneyless Age will also be the Golden Age.

The Westinghouse in 1909.

The most important electrical development of the past year from the standpoint of the Westinghouse Company has been the practical operation of the first circuit breaker or switching apparatus for controlling 110,000 volt circuits, which was recently described in detail in these Notes. A number of these Westinghouse type "GA" oil breakers have been installed on the lines of the Southern Power Company, and are giving excellent service. The switch elements of these breakers are immersed in oil, in separate, lined tanks, and are connected only by pull-rods. The breakers tend automatically to open by gravity, and are released by a tripping mechanism energised from series relays or series transformers. Another important Westinghouse development was the electrolytic lightning arrester, which is now offered for the protection of lines up to 110,000 volts. These represent recent advances of the pioneer research work which developed the first aluminium-cell arrester in 1907, while mechanically the present types include great advantages in the superior ease of installing and filling, and in discharging the cells to reform the film, over any arrester yet devised. A third development of note was the giant self-cooling transformer, of which twelve 1,000 k.v.a. units of the 100,000 volt type were furnished to the Southern Power Company.

The Turbo-Alternator.

According to the Allis-Chalmers Company's review of the business of the past year, possibly the largest increase in demand along any one line has been the call for turbo-alternators. The sales of this type of apparatus have increased practically four-fold over those of the year previous. These have varied in size from 300 kw. to 5,000 kw., the 500 kw. units having the largest sale of any one size. Most of the turbines have been intended to run condensing, but there have been many calls for non-condensing turbines. The year has also seen the satisfactory commercial development of the low-pressure and mixed-pressure turbine. The report also shows that there has been an increasing use of electrical drive in all sorts of manufacturing establishments. Practically every textile mill that is now designed is arranged for the electrical operation of the machines, either singly or in groups. Not one of the larger cement mills built during the past year but has been equipped throughout with electric drive. By the elimination of shafting and belting, the total power requirements are reduced nearly one-half. The use of the dustproof motor has also been of assistance in developing this field. Among saw mills, several of those built during the past year have been entirely equipped with motor drive. Motor-generator sets of large capacity are also coming more generally into use as designers are perfecting them, and users are discovering their adaptability to various conditions.

The Production of Tungsten.

According to a return compiled by the United States Geological Survey Department, the production in this country during the past year of tungsten concentrates, reckoned at 60% of tungstic trioxide, was 1,958 short tons, valued at $746,130. Of this amount, Boulder County, Colorado, produced 1,401 tons, valued at $550,280. In 1908 the total production was 671 short tons, valued at $229,955, and there was, therefore, an increase in 1909 of 1,287 tons in output and of $516,175 in value, or about 200%. The tonnage of 1909 was the largest yet recorded, and the value of the product was exceeded only by that of 1907, which was $890,048. The average price per unit for the whole amount produced in the United States in 1909 was $6·50. In the early part of 1907 the price was $14, but it dropped to $9, and later to $5, and was still lower for most of 1908.

Electric Drive in Pumping.

The first of a series of valuable articles on electrically-driven pumps inaugurates the new Industrial Power Section of the *Electrical Review and Western Electrician*. The writer points out that "there is not a city, town, or municipality of any size, where pumping of some kind or other does not furnish a large load, and in most cases this load is of a very profitable kind, and is especially adapted for electrical operation. There are, indeed, very few cases in which the electric motor is not better adapted for pumping than the steam engine or other forms of prime movers." The testimony of leading manufacturers is adduced to

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show that the electric drive for pumping operations effects a marked economy over the direct acting steam pump, and also that the arrangement of pumping machinery for electric drive is a very simple matter. Some typical installations of electrically-driven pumps are described and illustrated.

Colossal Electric Trust.

What is regarded here as the first step in the formation of a colossal electric power and traction trust has been taken in Chicago in the conclusion of a $70,000,000 deal for the consolidation of all the surface traction lines of the Southern Division of Chicago, including the Hammond, East Chicago and Whiting, of which I have already transmitted to you some preliminary details. The Trust proposes to control all the traction utilities, surface and elevated of Chicago and its environs, and a new Company, christened the Chicago City and Connecting Railways has been formed by a group of local capitalists in which has been merged the Chicago City Railway Company, the Calumet and South Chicago Railway Company, the Southern Street Railway Company, the Hammond, East Chicago and Whiting Railway Company. The completion of the deal was announced officially by Ira M. Cobe, Samuel Insull, president of the Commonwealth Edison Company; Emil K. Boisot, vice-president of the First Trust and Savings Bank, and Thomas E. Mitten, president of the Chicago City Railway Company. The merger marks the divorcement of Chicago traction affairs from the New York syndicate which, under the leadership of J. P. Morgan, owned a majority of the stock of the Chicago City Railway Company. The market value of the stocks and bonds of the joined companies totals $70,000,000. The corporations own and operate 407 miles of track, and during the present year have carried 220,000,000 passengers at cash fares and 120,000,000 more on transfers.

Electric Railway Signalling.

The remarkable development of electric railway signalling may be judged from the following synopsis of the orders filled by two firms alone during the past year. The Nachod Signal Company, of Philadelphia, has delivered signals to the following among other roads: the Mahoning and Shenango Railway and Light Company, Youngstown, Ohio; Public Service Railway, Newark, N. J.; Chicago and Milwaukee Electric Railroad, Highwood, Ill.; Spokane and Inland Empire Railroad, Spokane, Wash.; Fort Smith Light and Traction Company, Fort Smith, Ark.; Little Rock Railway and Electric Company, Little Rock, Ark.; Chattanooga Railway and Light Company, Chattanooga, Tenn.; Los Angeles Pacific Company, Los Angeles, Cal. The signal is an automatic signal, as distinguished from a dispatcher's signal system, and is operated by a trolley contact switch with one line wire. During the same period the United States Electric Signal Company, of West Newton, Mass., installed its automatic block signals on the following electric railways: Boston (Mass.) Elevated Railway; Mattoon (Ill.) City Railway; Boston (Mass.) Suburban Railways; Aurora, Elgin and Chicago Railway, Wheaton, Ill.; New Jersey and Hudson River Railway and Ferry Company, Edgewater, N. J.; Northampton (Mass.) Street Railway; Joliet and Southern Traction Company, Joliet, Ill.; Holyoke (Mass.) Street Railway; Tampa (Fla.) Electric Company; Charlestown (S. C.) Railway, Gas and Electric Company; Savannah (Ga.) Electric Company; Rio de Janeiro Light and Tramway Company; Worcester (Mass.) Consolidated Street Railway; Chicago and Joliet Electric Railway, Joliet, Ill.; Birmingham (Ala.) Railway, Light and Power Company; Fairmont and Clarksburg Traction Company, Fairmont, W. Va.; United Traction Company, Albany, N.Y.; Elmira, Corning and Waverly Railroad, Waverly, N.Y.; Knoxville (Tenn.) Railway and Light Company.

New Pelton Wheel.

The Pelton Water Wheel Company announce that they have under construction at their San Francisco shops for the Whatcom County Railway and Light Company a new multiple wheel Pelton impulse unit of unique design, to develop 3,200 h.p. under a head of only 165 ft. The wheel unit direct connects to an electric generator running 200 r.p.m. Under these conditions six impulse runners are employed on one shaft, each runner being supplied with water through a double nozzle. Ultimately the head will be increased to 400 ft., at which time, four of the runners will be taken from the wheel unit, leaving it a twin runner equipment when it is still to develop 3,200 h.p. By reason of the great difference in pressure under which the wheel will temporarily and ultimately operate, the unit is of particular interest and design. It replaces an Eastern-made turbine. The water at this plant is particularly gritty, rendering the life of the existing turbine equipment short.

Niagara Power Company's Bonds.

The Niagara Falls Power Company has made application to the Public Service Commission for permission to issue its refunding and general mortgage gold bonds secured by its mortgage or deed of trust securing an authorised issue of such bonds not to exceed $10,091,000. The proceeds of the bonds are to be used for refunding of obligations amounting to $9,076,000, and the balance for extensions and improvements of its present plant. Among these are additions to the plant of its auxiliary company, the Canadian Niagara Power Company amounting to $404,285 and additions and improvements to its American plant amounting to $611,000. There is no opposition to the application, but in the course of the hearing it was brought out that the government restrictions in regard to the use of water in Niagara River will cost the Company $350,000 of the $10,091,000 to be realised from the bonds, $9,076,000 to be used to meet obligations and the balance for improvements. These improvements will allow the Company to take more water than it is able to do at present under the Burton act.

Current Items.

Speaking broadly, electrical securities in this country are declared to have never looked healthier than they do at the present moment.

The pastor of the First Reformed Church in Brooklyn has abolished bell-ringing at evening, and installed in the church tower a powerful electric searchlight which "flashes at intervals throughout service time to attract the tardy and backsliders."

One of the advantages made possible by the $70,000,000 merger of Chicago's South-side Street Railways (referred to in detail elsewhere) will be a 35 mile ride for 5 cents.

The Manhattan Bridge Three Cent. Line of Brooklyn has been incorporated with a capital of $50,000 with the ultimate object of operating an electric surface line, 5 miles long, from Fourth-avenue Brooklyn to Manhattan Borough.

The General Electric Company is suing the City of Dunkirk, New York State, in respect of their purchase and installation of a 500 kw. turbo-generator, which is now part of the city's electric light and water plant. The Allis-Chalmers Company installed the generator, and the General Electric alleges infringement of patent rights, so that though nominally the city is being sued, the Allis-Chalmers Company are the actual defendants.

The largest power transmission system in the world will soon be in operation by the Southern Power Company. The Company's transmission lines at present stretch over a distance of 800 miles, and on the completion of several power houses under way, the total power generated will be 200,000 h.p. Fifty sub-stations scattered through North and South Carolina are now in operation. From the Great Falls plant, three trunk lines emanate. The line to Greensboro' on the north and Greenville on the south cover a railroad distance of 202 miles.

Dr. L. W. Dudley, speaking at a meeting of the Physical and Inorganic Chemistry Section of the American Association for the Advancement of Science, at Boston, declared that neon was the direct cause of the aurora borealis. Dr. Dudley has what he asserts to be the only sample of uncombined neon in this country, and states that the friction of this gas against mercury will produce a yellow light, and that a glow is caused when the gas is acted upon by Hertzian waves. The small quantities of neon in our atmosphere are sufficient to produce the boreal glow.

The application of electricity to the curing of bacon and ham has been adopted with conspicuous success by the Electric Meat Curing Company of Cleveland, Ohio, and the process is described and illustrated in the Chicago *Electrical Review* of January 8.

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The electrical equipment of the new National or Millionaires' Theatre at Central Park, in this city, forms the subject of an extremely interesting and profusely illustrated article by Mr. N. M. Schoonmaker in the issue of the *Electrical World* for January 6. The service feeds 19,000 electric lamps and 1,131 h.p. in electric motors.

The Dayton (Ohio) Lighting Company has some salesmen of whom it should be proud. It has 2,250 private customers for electric lighting. Among these in three months the Company has sold 600 electric irons at $4·50 cents each, 25 vacuum cleaners at $125 each, 60 sewing machine motors, and more than 2,000 electric heating pads. Between September 27 and December 7 the same Company sold 3,000 tungsten lamps and $3,000 worth of fixtures, of which about 35% displaced gas lighting.

The United States Steel Corporation contemplates a large extension of its steel plants between South Chicago, Illinois and Gary, Indiana, and will spend $100,000,000 on new equipment, including large installations of electrical plant.

"TANTALUM" FIRE BRIGADE SUPPER.

Messrs. Siemens, Dalston Works Fire Brigade, held their first annual supper and concert at the *Star and Garter Hotel*, Kingsland, on Friday, January 21. The proceedings were restricted to the members of the Brigade and staff, and a company of about 80 enjoyed an evening's entertainment, the standard of which is only equalled by the success which attends the sales of "Tantalum" lamps and fittings.

A substantial *menu* was provided, which the members thoroughly appreciated, and everyone present seemed to feel similarly to consumers who instal "Tantalum" lamps, "Satisfied." After supper an excellent concert was arranged by the committee, and although it is difficult to make exceptions, the humorous items of Messrs. A. E. Watts, R. E. Hinton, B. H. Gingell and C. D. Gray were the main factors of the evening's entertainment. Mr. A. Macfarlane, who has a fine baritone voice, sang "Thora," "The Swallow's Return," and "John Peel," whilst Messrs. Jarvis, Lucken, Beddoes and Hillier contributed very enjoyable items. Mr. W. F. Collins at the piano also showed himself an able accompanist. The chair was occupied by E. P. Barfield, Esq., manager of the sales department of the firm, who, in proposing thanks to the committee, said that it had been a great pleasure to be present; he had been delighted with the programme, and was proud to know there was such excellent talent in the firm. Mr. Le Marechal, the works manager, ably proposed the toast of the Fire Brigade and Staff, to which Mr. S. H. Callow, the captain of the Brigade, replied. The unity of feeling which characterised the evening, was the most pleasant feature, and the comradeship which existed between the youngest and the oldest, the men of humble position and those of higher, the office boy to the official, made everybody present quite at their ease, and all were enthusiastic in enjoyment of the affair. The entire absence of class distinctions, together with good catering and a fine concert, left nothing to be desired, whilst the desire for more frequent functions of a similar character was freely expressed.

LONDON ELECTRICAL RAILWAYS.

Three London "tube" railway Bills have been passed by Mr. Campion, the senior examiner, at the sitting of the Examiners of Standing Orders, in the House of Commons. These are the Baker-street and Waterloo Railway Bill, under which it is proposed to make subways under Regent-street and Oxford-circus: a Bill to empower the Charing Cross, Euston, and Hampstead Railway Company to raise £400,000 additional capital, for the purpose of extending the line to the Thames Embankment, where traffic will be exchanged with the District and Bakerloo Railways, and where public subways will be made; and a third Bill, which will authorise the amalgamation of the Great Northern, Brompton, and Piccadilly Railway with the Baker-street and Waterloo and the Charing Cross, Euston, and Hampstead Railways. There was no opposition, and the three Bills were ordered to be reported for first reading.

ELECTRICAL TRADES BENEVOLENT INSTITUTION

Sir William H. Preece, K.C.B., F.R.S., President of the Electrical Trades Benevolent Institution, writes to point out that the society is greatly in need of funds, as there are many deserving cases requiring immediate assistance. A festival dinner in support of the fund is to be held at the Whitehall Rooms, Hotel Metropole, S.W., on Wednesday, February 23. Professor Gisbert Kapp, President of the Institution of Electrical Engineers, will preside, and he will be supported among others by Sir William Preece, Mr. W. M. Mordey, Mr. W. Finlay (President of the Electrical Contractors' Association), and Mr. Emile Garcke. Tickets for the dinner, price one guinea, may be obtained from Mr. W. Davenport, Secretary of the Institution, Ridler-place, Holland-street, Blacktriars, London, S.E.

CATALOGUES AND PRICE LISTS.

The Sun Electrical Co., Ltd., has sent us an illustrated price list of their "Thruster" iron-cased waterproof circular electric bells. There appear to be excellent appliances, specially valuable for outdoor positions. They are made for both primary battery and continuous current circuits, in the latter case ranging from 80 to 600 volts.

In a handsome little pamphlet on "Natural Rock Asphalte," Messrs. John Dickson & Co. (Bolton), Ltd., give an interesting account of Limmer and Seyssel natural rock asphalte and its many applications, including its use in electrical engineering work. It may be mentioned that their acid-proof asphalte has been used in the accumulator battery house of the Manchester Municipal Electricity Works.

Messrs. Dorman and Smith are about to issue a new catalogue which comprises 225 pages, and covers the whole of their standard lines of fuses, switches, circuit breakers, together with fittings and accessories for all classes of work. In addition a number of new lines have been introduced, among which may be mentioned the "easy wiring" series of iron-cased switches. In this series, the switch is provided with a detachable inlet, which enables the switch box to be removed without disturbing the pipes or wires, and also facilitates the work of wiring up. The fittings and accessories sections have been brought thoroughly up-to-date by the inclusion of a range of sockets and plugs, hand-lamps, etc., designed and made in accordance with the latest regulations of the Home Office. Another new line which should be mentioned is the "L" series of patent "easy-wiring" mill fititngs. This line of fittings should be welcome to contractors and users generally, inasmuch as it has been designed with the object of facilitating wiring up, this result being attained by the usual lamp-holder nipple being dispensed with, the wires having a straight run through from the tube into the lamp-holder insulator, thereby eliminating dangerous bends in the insulated wires. All the various types of mill and other fittings are stocked of suitable size for metallic filament lamps. The fitting section also includes a line of porcelain body fittings, suitable for use in dyeworks, chemical works, laundries, etc. A new series of brass' ships fittings, possessing the same advantages as to easy wiring as the "L" series of iron fittings mentioned above, is also shown. All types of apparatus are fully illustrated; prices are clearly set out, showing reductions for quantities, and particulars given as to dimensions, etc.

MILLING BY ELECTRICITY.

Messrs. Christy Bros. & Co., Ltd., electrical engineers, of Chelmsford, have carried out an installation of electric power in the flour mill of Messrs. E. C. Robson & Sons, Sunderland, which has a capacity of nearly 3,000 sacks of flour per week. Electric power is purchased from the Sunderland Corporation, and it is expected that the motors will use about 1½ million units per annum. The installation comprises a number of motors, the largest being 275 h.p. for driving the roller plant, 60 h.p. for cleaning the wheat, and a number of smaller ones for various purposes. Messrs. Christy Bros. & Co. designed and erected the whole installation, as well as carried out the negotiations beforehand on behalf of Messrs. Robson as to the special terms on which they should purchase their power from the Sunderland Corporation.

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BUSINESS NOTES AND NEWS.

LIGHTING AND GENERAL—Home.

BECKENHAM.—Mr. A. H. Dykes has resigned the chairmanship of the Urban District Council's Electricity Committee owing to his disagreement with the policy pursued.

DUNDEE.—A movement is on foot for the incorporation of the suburbs of Broughty Ferry and Monifieth with Dundee. It is said that this would prove a benefit all round, and not least so as regards electricity. At present Broughty Ferry has an electric undertaking of its own, but ratepayers have to pay more for both power and light than dwellers in Dundee itself. The Dundee Electricity Engineer says that the Broughty Ferry Electricity works and staff could easily be absorbed, and yet an economy effected. At present public lighting at Broughty Ferry costs £1,024 7s., and at Monifieth £180 14s. per annum.

DUNDEE.—The new Corporation electricity station, which has been in partial use since July, is to be formally opened shortly. The Electricity Committee have paid Messrs. Grimand £1,250 as damages for non-supply of electricity under a contract.

FLEETWOOD.—An inquiry has been held by the Local Government Board into the application of the Council for sanction to the borrowing of £3,197 for electric light apparatus.

GRIMSBY.—In connection with the scheme for lighting the town by electricity, the Engineer, Mr. Vignoles, has had specimen lamps erected, and as soon as a selection has been made by the Town Council, specifications will be prepared and the work hurried forward. Flame arcs are to be used and £2,000 spent on the improvement.

HORNSEY.—The Education Committee have decided to light the Stroud Green schools with electric filament lamps, taking current from their own undertaking.

LONDON: HAMMERSMITH.—The Board of Guardians have decided to spend £173 12s. 10d. on fitting up Osram lamps at the Workhouse, and £9 18s. on two transformers. The work is to be carried out by Messrs. T. Hellyar & Co., of Hammersmith.

LONDON, WESTMINSTER.—The City Council are contemplating a new scheme for lighting Victoria-street, and have, in this connection, arranged an experimental installation to display improved lighting by electricity.

NEWPORT.—The Electricity Committee have received the report of Mr. C. P. Sparks (Chief Engineer to the County of London Electric Supply Co.) upon the working and position of the Newport municipal electrical undertaking. Mr. Sparks was called in to investigate and report upon the matter in view of the loss which the electricity department has been making for some years. The working of the trams has not been a loss, but upon the supply and sale of power there has been a deficiency. Mr. Sparks has gone into the history and position of the concern, and it is understood that amongst his recommendations there are suggestions for revising the tariffs at which power is sold. Half-a-dozen years ago the scales were reduced in such a way that over £1,000 per annum was taken off the revenue.

NORTH BERWICK.—The Town Council have been approached by Messrs. Crompton & Co. on the question of a company being formed to supply the burgh with electricity. The Council are favourably inclined subject to conditions, and provided that a friendly agreement could be adjusted, and that Messrs. Crompton & Co. intimate the terms upon which they would promote and work the scheme.

SOUTHAMPTON.—Owing to the great rapidity in the increase of the Corporation's electricity business, the Engineer was instructed to prepare a report showing what additional plant was required. The provision of further plant was estimated to cost £13,000. The annual charges for interest and sinking fund would be about £900; the earning capacity of the plant about £6,500 per annum. Mr. Street added: "I think it is only reasonable to expect a similar increase next year to what we have experienced this year. We seem to be going forward on the top of quite a boom in electric lighting, and nothing ought to be done which would tend to stay this progress; the fatal error of six years ago, when consumers had to be refused, should not be repeated. We must also expect a largely increased demand from the Tramways Department in the immediate future." The Electricity Committee will recommend the Council to adopt the report and to make application to the Local Government Board to sanction a loan of £13,000 for additional plant.

TAUNTON.—The Electric Lighting Committee report that, notwithstanding the increase in the use of Osram lamps, the output of current had been maintained. The use of motors was increasing, the total number now connected with the mains being 115, making a total of 355 h.p., and there was a prospect of more to follow. The additional connections to the mains during the past quarter were equivalent to 1,236 8-c.p. lamps, as against 897 for the corresponding quarter of last year.

WATFORD.—The Urban District Council are applying to the Board of Trade for an Order to enable them to supply electricity to the Bushey district.

WINCHESTER.—The Corporation have given a twelve months' notice to the Winchester Electric Light and Power Co., Ltd., of their intention to purchase the undertaking. The Company's capital is about £90,000, and it is hoped that the loan to be raised may be made repayable over a period of 16 to 20 years, in which case the present profits would be sufficient to cover interest and sinking fund.

LIGHTING AND GENERAL—Overseas.

COLOMBIA.—The official *Diario* publishes a decree declaring of public utility the works necessary for the installation of electric light and the construction of electric tramways in the town of Cali. The materials for these works may be imported free of duty.

MEXICO.—A contract has been entered into between the Mexican Government and the Compañia Agricola y de Fuerza Eléctrica del Rio Conchos, by which the company is empowered to build a dam 70 metres (about 229 ft.) high in the river Conchos, to store up the flood waters of the river up to a quantity of 1,019,000,000 cubic metres; also to generate electrical energy, and to set up overhead or underground lines for its transmission. The works must be begun within six months, and finished within seven years, from the date of promulgation of the contract. The company is to construct, where necessary, bridges over the canals it makes, and it may set up telegraph and telephone lines for its own use. The company may import free of duty, once only, all the machinery and apparatus necessary for these works.

ROME.—The Societa Anglo-Romana per la Illuminazione di Roma has been compelled to make large additions to its plant. The Society started in 1886 with two steam engines, each of 100 h.p., and giving a current of 2,000 volts. By the end of 1889 they had a second power station, with four steam engines of 600 h.p.; and, in 1892, the water power station at Tivoli was completed with six 350 k.v.a. machines, giving a voltage of 5,000. By 1902 a second Tivoli plant was in full operation, with seven 3,000 k.v.a. machines giving 10,000 volts. In 1905 the hydraulic station at Subiaco was started with two 5,200 k.v.a. machines for 30,000 volts. Finally, in 1909, the installation at Arci, with the same plant as that at Subiaco, was started. Rome has, it is evident, rapidly increased its use of electric current for all purposes.

TRACTION—Overseas.

SANTA FE.—The municipality is still dealing with the question of electrification of its tramways. Several tenders have been received, but as no special specification was prepared, the tenders vary to such an extent that it is difficult to ascertain which is the most suitable. It is suggested that the Municipality should engage the services of a duly qualified Engineer to prepare specifications, and then call for fresh tenders.

COMPANIES' MEETINGS AND REPORTS.

CITY AND SOUTH LONDON RAILWAY CO.

The report of the directors, with statement of accounts for the half-year ending December 31, 1909, will be submitted at the general meeting to be held on February 1. The following is a brief abstract: The receipts from all sources for the past half-year have amounted to £89,884 16s. 3d. and the cost of working has been £41,274 19s. 7d., leaving a profit of £48,609 16s. 8d. Inclusive of the balance brought forward from June 30 last, the net revenue account shows an aggregate total of £50,021 8s. 8d. After making provision for the debenture stock interest, rent charge, and the transfer to the renewal fund of £1,500, a balance remains available for dividend of £33,963 9s. 1d. Out of this sum your directors recommend that the full dividend of 5% per annum be paid on the preference stocks, 1891, 1896, 1901, and 1903, and that a dividend at the rate of 1¾% per annum be paid upon the consolidated ordinary stock for the half-year, leaving a balance of £712 6s. 1d. to be carried forward to the next account. In spite of the competition intensified by the further electrification of the L.C.C. tramways during the past half-year, the directors have pleasure in reporting an increase both in receipts and in the number of passengers carried. A Bill has been deposited by the Metropolitan Railway Co. for powers to construct a low level subway to link up that company's station at Moorgate-street with this company's and that of the Great Northern and City, whereby passengers will be enabled to interchange without coming to the surface; a convenience which cannot fail to be appreciated. The cost of construction will be borne by the three companies in equal proportions, and in compliance with Standing

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Orders the Bill will be submitted for approval at the special meeting to be held at the conclusion of the half-yearly meeting. The drawings and specification for the high level subway at the Bank station, mentioned at the half-yearly meeting in July, 1909, are being prepared; and the contract for the construction will be entered into shortly.

LIVERPOOL OVERHEAD RAILWAY CO.

The accounts of this Company for the past half-year show an available balance of £8,965 10s. 4d., and the directors have resolved to recommend payment of dividends at the rates of 5% per annum on the (1892) Preference shares and 5% for the year on the (1900) Preference shares, leaving a balance of £4,613 16s. 4d. to be carried forward.

COMPANIES REGISTERED.

BRADFORD ELECTRICAL CO., LTD.—Capital, £1,000, in £1 shares. Objects: To carry on the business of electricians, engineers, workers of electricity, motive power and light, etc. Private company. The first directors are: A. Whitehead and J. Garnett. Qualification, £5. Registered office, 56, Manningham-lane, Bradford.

EBRO-LIGHT AND POWER CONSTRUCTION CO., LTD.—Capital, £100,000, in £1 shares. Objects: To carry on the business of electricians, engineers, promoters and workers of tramways, railways, electric, hydraulic and other works, etc., and to adopt an agreement with A. Parrish. Private company. The first directors (to number not less than three nor more than five) are to be appointed by the signatories. Remuneration, £500 each per annum.

GEORGE H. SCHOLES AND CO., LTD.—Capital, £8,000, in £1 shares (5,000 Pref.). Objects: To take over the business of an electrical and mechanical engineer carried on by G. H. Scholes at Blantyre-street, Chester-road, Manchester, as George H. Scholes & Co. Private company. G. H. Scholes is permanent governing director, subject to holding 1,000 of the Ordinary shares allotted to him under purchase agreement, with £300 per annum. Registered office, 27, Blantyre-street, Chester-road, Manchester.

R. PAIN & SONS, LTD.—Capital £6,000, in £1 shares. Objects: To carry on the business of engineers, electricians, plumbers, &c., and to acquire the business carried on at Woking and Byfleet, Surrey, as R. Pain & Sons, and to adopt an agreement with R. Pain, H. Pain and B. Pain. Private company. Registered office, High-street, Woking.

REID BROTHERS, ENGINEERS, LTD.—Capital £30,000, in £1 shares. Business: Adopt an agreement with J. Reid and E. J. Reid, and carry on business of electrical, telegraph and telephonic engineers, manufacturers of cash carrier systems, &c. Private company, Registered office, 12, Wharf-road, City-road, London.

SHEFFIELD ELECTRIC POWER CO., LTD.—Capital £2,000, in £1 shares. Objects: To acquire the business relating to the hire of electric motors carried on by W. E. Burnand, and to carry on the same and the business of mechanical, electrical and gas engineers, manufacturers of and dealers in electrical and mechanical appliances and devices, &c. Private company. Registered office, Chippinghouse Works, Lowfields, Sheffield.

WESTERN ELECTRIC CO., LTD.—Capital, £500,000, in £5 shares. Objects: To acquire the business and undertaking carried on in the United Kingdom by the Western Electric Co. of Chicago, Illinois, U.S.A., and to carry on in the United Kingdom or elsewhere the business of dealers in telephones, telephonic, telegraphic and electric-lighting apparatus, instruments and machinery, electrical cables, wires and goods, electricians, etc. Private company. The first directors (to number not less than three nor more than seven) are: F. R. Welles, G. E. Pingree and A. Williamson. Qualification, one share.

CONTRACTS OPEN.

Home.

ASHTON-UNDER-LYNE.—Corporation Electricity Committee.—Section A, one counter current jet condensing plant; Section B, one natural draught cooling tower; Section C, one exhaust turbine and 400 kw. direct current generator; Section D, one electric balancer. Specification, £1 1s., Borough Electrical Engineer, Wellington-road. February 9.

BELFAST.—The Tramways and Electricity Committee invite tenders for twelve months' supply (ending March 31, 1911) for the following:—

Section 1: 1, Lubricator and gauge glasses; 2, packings; 3, oils; 4, rubber goods; 5, bricks, firebricks and fireclay; 6, tools; 7, incandescent lamps; 8, arc lamp carbons; 9, galvanised wire; 10, asbestos goods.

Section No. 2: 11, Trolley wire; 12, overhead line material.

Section No. 3: 13, Refined Trinidad bitumen; 14, bitite strip, prepared tape, and rubber tape for joints; 15, joint box compound; 16, fuse wires; 17, wood troughing; 18, C.I. street box frames and covers; 19, glazed stoneware conduits; 20, cast iron pipes; 21, lighting feeder and section pillars; 22, glazed stoneware cable bridges; 23, copper cable connectors.

Section No. 4: 24, Electricity meters; 25, electricity maximum demand indicators; 26, automatic time switches; 27, house service cut-outs.

Form of tender (bound up in 4 sections) and further particulars may be obtained from Thomas W. Bloxam, M.Inst.E.E., City Electrical Engineer, Electricity Works, East Bridge-street, Belfast, on payment of 10s. per section, which will, after the Council or their Committee have come to a decision on the tenders received, but not before, be returned to the tenderer, provided he shall have sent in a *bona-fide* tender, and shall no have withdrawn the same. The whole or any part of a tender sent in may be accepted, and tenders shall be open for acceptance until May 1 next. Tenders endorsed "Tender for Stores, Electricity Department," shall be lodged with the Town Clerk, City Hall, Belfast, not later than 10 a.m. on Monday, February 2, 1910.

LONDON COUNTY COUNCIL TRAMWAYS.—(i.) The Council invites tenders for the roadwork and platelaying required for the construction on the conduit system of the Council's authorised tramway from Brockley-lane Station to Forest-hill, *via* Brockley-road, Stondon Park, Stanstead-road, Sunderland-road, and Park-road. The route is equivalent to about 4½ miles of single track. The contractor will be required to use the track rails, with their fastenings, the slot rails and conductor rails, and the special work for the cross-overs, etc., which will be provided by the Council under other contracts, but all the remaining metal work and other materials will be included in the contract. Persons desiring to submit tenders may obtain the specifications, bills of quantities, forms of tender, and other particulars on application to the Chief Engineer of the Council, Mr. Maurice Fitzmaurice, C.M.G., at the County Hall, Spring-gardens, S.W., upon payment to the Cashier of the Council of the sum of £5. This amount will, after the Council or its Committee shall have come to a decision upon the tenders received, but not before, be returned to the tenderer, provided he shall have sent in a *bona fide* tender and shall not have withdrawn the same, but in no case will the fee be returned unless a *bona fide* tender shall be submitted. Full particulars of the work may be obtained on application at the County Hall before the payment of the fee for the specification, etc.

The contractors will be bound by the contract to pay to all workmen (except a reasonable number of legally bound apprentices) employed by them in and about the execution of the contract or any part thereof wages at rates not less, and to observe hours of labour not greater, than the rates and hours set out in the Council's list, and such rates of wages and hours of labour will be inserted in and form part of the contract by way of schedule. Each tender is to be delivered at the County Hall in sealed cover, addressed to the Clerk of the London County Council, Spring-gardens, S.W., and marked "Tender for Road-work and Platelaying, L.C.C. Tramways." No tender received after 11 a.m. on Tuesday, February 1, 1910, will be considered.

LONDON COUNTY COUNCIL TRAMWAYS.—(ii.) The Council invites tenders for:—

(*a*) The supply and delivery of about 3,000 tons of steel girder tramway track rails and fastenings.

(*b*) About 1,500 tons of slot-rails and conductor tees, required in connection with the construction or reconstruction of the Council's tramways for electrical traction.

The supply and delivery of the track rails, etc., and the supply and delivery of the slot rails and conductor tees will be under two separate contracts.

Persons desiring to submit tenders may obtain the drawings, specification, bills of quantities, forms of tender, and other particulars on application to the Chief Engineer of the Council, Mr. Maurice Fitzmaurice, C.M.G., at the County Hall, Spring-gardens, S.W., upon payment to the Cashier of the Council of the sum of £2 in the case of each contract. This amount will, after the Council or its Committee shall have come to a decision upon the tenders received, but not before, be returned to the tenderer, provided he shall have sent in a *bona fide* tender and shall not have withdrawn the same, but in no case will the fee be returned unless a *bona fide* tender shall be submitted. Full particulars of the work may be obtained on application at the County Hall before the payment of the fee for the specification, etc.

The contractors will be bound by the contract to pay to all workmen (except a reasonable number of legally bound apprentices) employed by them in and about the execution of the contract or any part thereof wages at rates not less, and to observe hours of labour not greater, than the rates and hours set out in the Council's list, and such rates of wages and hours of labour will be inserted in and form part of the contract by way of schedule. Each tender is to be delivered at the County Hall in a sealed cover, addressed to the Clerk of the London County Council, Spring-gardens, S.W., and marked "Tender for Track Rails and Fastenings, L.C.C. Tramways," or "Tender for Slot Rails and Conductor Tees, L.C.C. Tramways," as the case may be. No tender received after 11 a.m. on Tuesday, February 8, 1910, will be considered.

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LONDON COUNTY COUNCIL.—Electric Lighting of Cow-lane School.—The Council invites tenders for wiring and fitting for the electric lighting of the Cow-lane elementary school, Rotherhithe. Persons desiring to submit tenders may inspect the drawings and obtain the specifications, bills of quantities, form of tender, and other particulars on application to the Chief Engineer of the Council, Mr. Maurice Fitzmaurice, C.M.G., at the County Hall, Spring-gardens, S.W., upon payment to the Cashier of the Council of the sum of £1. This amount will, after the Council or its Committee have come to a decision upon the tenders received, but not before, be returned to the tenderer, provided he shall have sent in a *bona fide* tender and not have withdrawn the same, but in no case will the fee be returned unless a *bona fide* tender is submitted. Full particulars of the work may be obtained on application at the County Hall before the payment of the fee for the specification, etc. The contractors will be bound by the contract to pay to all workmen (except a reasonable number of legally bound apprentices) employed by them in and about the execution of the contract or any part thereof wages at rates not less, and to observe hours of labour not greater, than the rates and hours set out in the Council's list, and such rates of wages and hours of labour will be inserted in and form part of the contract by way of schedule. Each tender is to be delivered at the County Hall, in a sealed cover, addressed to the Clerk of the London County Council, Spring-gardens, S.W., and marked "Tender for Electrical Installation at the Cow-lane Elementary School, Rotherhithe." No tender received after 11 a.m. on Wednesday, February 2, 1910, will be considered.

NEWCASTLE-ON-TYNE.—Corporation Tramways Department: Renewal of tramway junction. Specification from the City Treasurer, 21s. February 5.

WORKSOP.—Urban District Council.—Underground Cables.—Particulars from the Electrical Engineer. February 2.

Overseas.

AUSTRALIA.—Tenders will be received at the office of the Deputy Postmaster-General, Sydney, up to 3 p.m., on March 9, for the supply and delivery at the Departmental Stores, Sydney, of magneto switchboards for metallic lines, and switchboards for private branch exchanges for common battery working, in accordance with Schedule N.S.W. E.E. 114/09. Tenders must be endorsed "Tenders for Switchboards, Magneto, and Switchboards, Common Battery, for Private Branch Exchanges," and addressed to the Deputy Postmaster-General, Sydney. Schedules, specifications, etc., may be obtained at the General Post Offices at Sydney, Melbourne, Adelaide, Brisbane, Perth, and Hobart.

LONDON (Ontario).—New tenders will be invited for the electrical equipments required at the power station. The former specifications are said to have contained too many alternative propositions. The machinery required includes transformers, motor generator set, voltage regulators, switchboards, lightning protectors, instruments, arc and incandescent street lighting systems, and E. I. Sifton is the chief electrical engineer.

MIDLAND (Ontario).—Tenders for hydraulic and electrical equipment.—Sealed tenders, endorsed "Tender for Hydraulic Equipment," or for other respective sections, will be received by the Secretary of the Simcoe Railway, and Power Co., Ltd., at the Head Office, Midland, Ontario, until February 1, 1910, for the following: For generating station at Big Chute, Severn River—Hydraulic equipment, penstocks, electrical equipment; for 27 mile transmission line—Wire, insulators, crossing towers; for receiving station at Midland—Electrical equipment. Specifications for the above may be seen at the office of the Secretary, Midland, Ontario, or at the office of Engineers, C. H. & P. H. Mitchell, Traders' Bank-building, Toronto, Ontario. No tender necessarily accepted.

WINNIPEG (Manitoba).—Tenders will be received up to Tuesday, February 15, for the supply and erection of the various portions of the equipment for the terminal station at Winnipeg, and for the turbine governors and gate valves for the generating station. Specifications and plans, etc., may be seen at the office of Messrs. Smith, Kerry & Chace, Confederation Life-building, Toronto, and Carnegie Library-building, Winnipeg. Individual tenders will be received for:—

18, Terminal station; 19 and 20, step-down transformers and terminal stations witching and accessory apparatus; 21, terminal station, light, heat and power systems; 22, terminal station, light, heat and power systems; 24, testing transformers and apparatus; 26, turbine governors (seven); 27A, two 5 foot gate valves. M. Peterson, Secretary, Board of Control.

TENDERS ACCEPTED.

LONDON.—The London County Council have accepted the following tenders: Electric lamps, the British Tungsten Lamp Co., Ltd., Huyton Quarry, near Liverpool; electric carbons, Wm. Geipel & Co., Vulcan Works, St. Thomas-street, S.E., and Ship Carbons, Ltd., 67, Aldersgate-street, E.C.

TENDERS INVITED.

MANCHESTER.—Corporation Tramways Department, for scrap material. February 1.

DIARY.

FRIDAY, JANUARY 28.

INSTITUTION OF ELECTRICAL ENGINEERS (Leeds Section).—At 6.30 p.m., at the Metropole Hotel, Leeds: The Annual Dinner.

TUESDAY, FEBRUARY 1.

INSTITUTION OF ELECTRICAL ENGINEERS (Manchester Students' Section).—At 7.30 p.m., at the Municipal School of Technology, Mr. J. G. Travis on "Face-plate Type Starters and Contral Apparatus."

WEDNESDAY, FEBRUARY 2.

INSTITUTION OF ELECTRICAL ENGINEERS, BIRMINGHAM.—At 7.30 p.m., at the University of Birmingham, ordinary meeting.

ROYAL SOCIETY OF ARTS, ADELPHI, at 8 p.m., Mr. Augustus Rosenberg on "An Improved Method of Electro-plating."

INSTITUTION OF ELECTRICAL ENGINEERS (Students' Section).—Meeting at 92, Victoria-street, at 7.45 p.m. Paper by E. V. Pannell, "Direct Current Railway Motors for High Voltages."

SATURDAY, FEBRUARY 5.

NORTHAMPTON INSTITUTE ENGINEERING SOCIETY.—At the Institute, Mr. L. Wallis, "History and Manufacture of Electric Glow Lamps."

TUESDAY, FEBRUARY 8.

INSTITUTION OF ELECTRICAL ENGINEERS (Glasgow Section).—At 8 p.m., at the Lecture Hall, Bath-street, ordinary meeting.

WEDNESDAY, FEBRUARY 9.

ASSOCIATION OF ENGINEERS-IN-CHARGE.—At 7.30, at the St. Bride's Institute, London, E.C., Mr. A. Angold on "Modern Arc Lamps and their Application."

INSTITUTION OF ELECTRICAL ENGINEERS (Manchester Section).—At 7.30, at the Physical Laboratory, University of Manchester, Mr. A. G. Cooper, A.M.I.E.E., on "Three-Wire Balancers."

ELECTRICAL ENGINEERS' TERRITORIALS (London Division).—Orders for week ending February 5.: Monday, January 31, "A" Company, Technical Drill, 7 to 9.30 p.m.; Tuesday, February 1, "B" Company, Technical Drill, 7 to 9.30 p.m.; Wednesday, February 2, Gymnasium, 6.30 to 9.30 p.m.; Thursday, February 3, "C" Company, Technical Drill, 7 to 9.30 p.m.; Friday, February 4, "D" Company, Technical Drill, 7 to 8.30 p.m.; Infantry Drill, 8.45 to 9.45 p.m.; Saturday, February 5, N.C.O.'s Mess Dinner, to be held at the Café Monico, Piccadilly-circus, W., at 7-7.30 p.m. (Signed) P. H. Campbell, Capt. R.E., Adjutant.

OBITUARY.

We regret to announce the death of Mr. Julius Wallach, senior Managing Director of the Stern-Sonneborn Oil Co., Ltd. Mr. Wallach had been ailing for some time past.

TRADE NOTES.

It is announced that henceforth the British Thomson-Houston tungsten lamp will be known as the "Mazda" lamp, and will bear that word as a trade mark. This new name will be used on the lamps, packing-cases, cartons, etc., as rapidly as the change can be effected, and in the meantime the public are notified that any lamps they may receive marked "B.T.H. Tungsten" are the same as the "Mazda" lamp. These lamps embody the most recent and important developments in high efficiency metal filament lamps. They represent the composite result of the research work and experience of the laboratories and factories of some of the most important lamp manufacturers and inventors of the world. The "Mazda" lamp will be the British Thomson-Houston Co.'s standard metal filament lamp in future, and efforts are being continually directed towards making greater refinements and achieving higher perfection in its manufacture.

ANCHOR CABLE COMPANY'S STAFF DINNER.

The sixth annual staff dinner of the Anchor Cable Co., Ltd., Leigh, Lancashire, was held on Friday evening last at the White Horse Hotel, Leigh. About thirty members and guests were present to dinner and subsequently the works manager, Mr. J. Bowyer, presided, and a capital concert was provided by Mr. Walter Darlington, I.S.M., and party. The chairman in his remarks referred to the successful working of the company during the past 12 months, and thanked the staff for their co-operation and support. Extensions were being carried out at the works to cope with the increase of business, and he thought this augured well for the continued success of the company.

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PATENTS.

Regulation of Alternating Current Commutator Dynamo Electric Machines.

20005—1909. Siemens Bros. Dynamo Works Ltd., Westminster. Single phase alternating current commutator dynamo electric machines having shunt or separate excitation do not correspond completely in their characteristics to continuous current dynamo electric machines having the same kind of excitation, a particular feature of difference being that in the former machines, even with the best conditions for obtaining good commutation, the inductive voltage drop in the armature is considerable. In consequence of this inductive voltage drop the ratio of speed to applied voltage with change of turning moment is not so constant in the case of an alternating current commutator motor as it is in the case of a continuous current motor. When an alternating current machine is connected as a buffering machine in shunt across the mains of a supply system for the purpose of equalising the load on the main generators the power factor of the generated or absorbed current is low. An available means to obviate these difficulties is to alter in known manner the phase angle between the armature voltage and field according to the load on the machine; but in practice this is not always satisfactory. When, for example, the inductive voltage drop in the armature is sufficiently great to bring about a considerable divergence between the characteristics of the machine and of an otherwise similar continuous current machine, it is yet not great enough to make great variations in the phase of the armature voltage and field necessary. Delicate arrangements for regulating the field phase are in consequence rendered necessary. In order to secure the desired result, it is often necessary to also vary the value of the field itself when the same objections also apply. The present invention is a more satisfactory arrangement for neutralising the inductive voltage drop in the armature by providing a winding on the stator or field magnet system

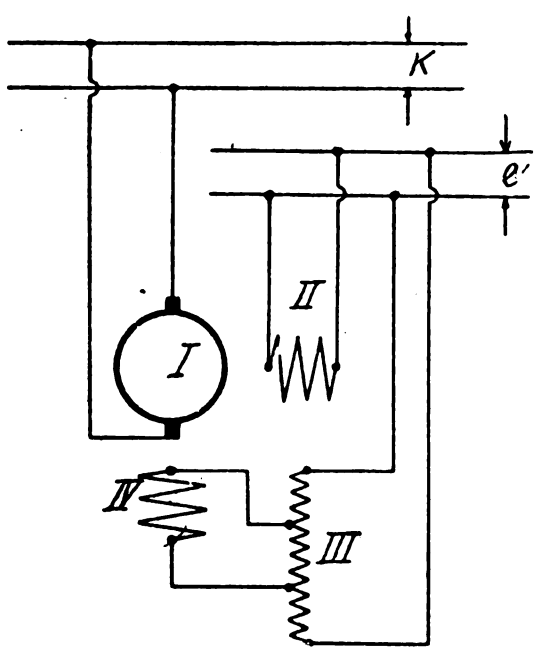

FIG. 1.

in inductive relation to the armature windings and supplied with a voltage of such magnitude and phase that the electromotive force of self-induction in the armature windings is partly or completely neutralised by transformer action between the winding on the stator system and the armature windings. Fig. 1 is a diagram of the invention in its most simple form, applied to a commutator dynamo electric machine, and Figs. 2 and 3 are explanatory vector diagrams. In Fig. 1, I. is the armature of the machine, II. the field winding, III. an adjustable transformer, and IV. is a winding which in position and arrangement is comparable to the usaul compensation winding which it replaces. The armature I. is supplied with current from a source of supply having voltage k, the electrical phase of which is displaced by about ninety electrical degrees from the voltage e_1, which supplies current to the windings II. and IV. In Figs. 2 and 3, k denotes the applied armature terminal voltage; e the electromotive force required to overcome the couuter electromotive force in the armature by reason of its rotation in the field f; wli, the electromotive force required to overcome the voltage drop; i, the armature current; and e_1 the voltage applied to the field winding II. to produce the field f. The effect of the ohmic resistance of the armature has been omitted for the sake of simplicity. Evidently Figs. 2 and 3 differ in the phase angle between k and e, in Fig. 2 this angle being equal to a, and in Fig. 3 to zero. In Fig. 2 also, wli is the resultant of k and e, but in Fig. 3 it is clear that wli may be produced by transformer action alone by means of the winding IV., which latter is most suitably supplied, as shown in Fig. 1, from the same source as the winding II. The transformer III. must have a variable ratio of transformation in order that the proper current may flow in winding IV. at all loads to neutralise the inductive drop wli, which is itself proportional to the load current. Fig. 2 in fact applies to the known arrangement for neutralising the inductive voltage drop by altering the angle a, and Fig. 3 to the new arrangement according to the present invention. It will be clear that the current taken from e_1 by IV. for neutralising the inductive voltage drop in the armature is a wattless current. The current in II. is also practically wattless, and therefore wattless current alone is taken from the supply e_1. It will, of course, be understood that the ratio of voltage transformation between IV. and I. may be arranged to have any desired value, always provided that a voltage of a suitable magnitude is applied to the terminals of IV. If, as explained in the case of Fig. 1, the winding IV. is similar to the known form of compensation winding, but no voltage is applied

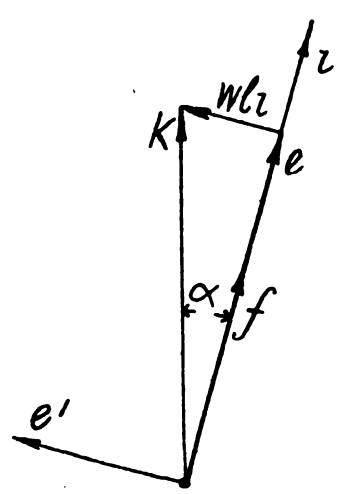

FIG. 2.

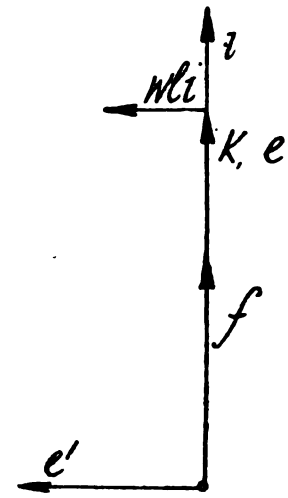

FIG. 3.

to its terminals, the latter being merely connected together so as to short circuit IV., the armature current will induce a current in IV. which will to some extent neutralise the electromotive force of self induction in the armature windings, but not completely, owing to the presence of leakage magnetic lines of force which only cut the armature conductors. It is not necessary to arrange the armature transformer winding IV. in exactly the same manner as a compensation winding. It could, for example, be arranged to produce the necessary transformer action if concentrated in a small space on the field system, and having the same axis as the compensation winding instead of being arranged as a distributed winding in the manner of compensation windings. Since the inductive voltage armature drop is compensated it is clear that the ratio connecting speed and applied armature voltage will be more constant for varying loads and will therefore compare more favourably with the same ratio in a continuous current machine with shunt characteristics. In order to prevent brush sparking it will usually be necessary to provide a commutation field which cuts the short circuited armature coils in known manner. For this purpose, commutation poles and windings can be fitted to the machine without interfering with the arrangements for compensating the inductive drop. Fig. 1 shows a separately excited machine, the field winding II. being connected across the separate source of supply e_1. It is clear, however, that the machine may be shunt excited; that is to say, that field winding II. may be supplied with current from the voltage supply k, provided a suitable phase transforming device is introduced between k and II.

Excitation of Commutator Dynamo Electric Generators.

20899—1909. Brown, Boveri & Co., Baden. This is an improvement in commutator generators as are used for the starting of dynamo electric machines, and more particularly to this excitation. It has been proposed on electric installations to start, brake or perform similar functions with the polyphase motors having no commutators by driving them by means of a special alternating current commutator starting generator, which is supplied with exciting currents of slowly increasing voltage and periodicity, so that the starting dynamo or dynamos, if several are used, gives or give out current of gradually increasing voltage and periodicity, which current allows the polyphase motor to be started with a great turning moment or torque. As such installations are usually on a large

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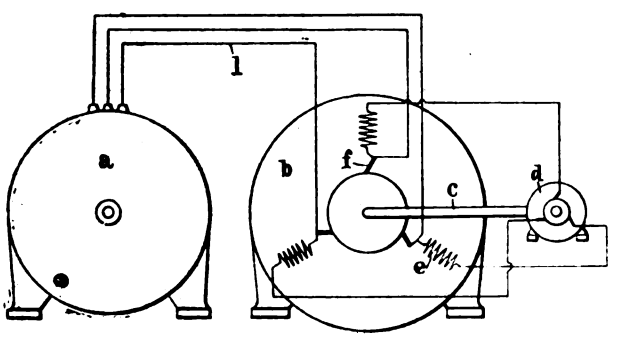
scale, the kilo-volt-amperes to be provided by the starting generator are fairly considerable, and, therefore, although the energy necessary for exciting its fields is not very large, nevertheless, large machines must be at disposal for generating the high kilo-volt amperes. This disadvantage can only be avoided by causing the single or polyphase alternating current commutator starting generators to excite themselves. In this case a separate exciting machine can be dispensed with, and the dimensions of the generators will have to be only slightly increased. Assuming that the k.v.a. necessary for the excitation of the commutator generator amount to 25% of the output of the generator, then if a special exciting machine were used it would have to be capable of supplying this extra 25%; whilst if the generator itself were used for self-excitation, as this exciting current only constitutes a small component at right angles to the working current, its current need only be increased by about 3%, the phase of the current being moved through an angle whose tangent is 0.25 (about 14 degrees). Pure self-excitation, however, cannot be produced in commutator generators in a manner which would be free from objections, as such excitations are unstable. In the present invention the advantages of the self-excited commutator generator and the advantages of a special exciting machine are obtained with a minimum of their



disadvantages. The invention consists in exciting the commutator generator mainly from its own terminals, and partly by means of an additional machine which can be varied as to voltage and periodicity. The diagram shows one manner of carrying the invention into effect. In this form, to the motor *a*, which is a three-phase motor without a commutator, is connected the commutator generator *b* by leads *l*. The field *e* of this generator, it will be seen, is supplied in part from the generator itself through the brushes *f*, and in part from an additional machine *d* on the same shaft *c* as the rotor of the generator *b*. The exciting dynamo *d* may be a synchronous generator, or, for instance, a direct current machine, the brushes of which are revolved so that varying voltages or pressures are produced. The type of construction of the machine is of no importance whatever, only it must be possible to produce an alternating current or rotary current, over the periodicity and voltage of which there is perfect control. The commutator generator *b* may be shunt series or compound wound so long as most of the excitation is furnished by itself and the additional part by the machine *d*, and if compound wound it may include the current flowing in the leads *l*. Thus the essence of the invention consists, broadly speaking, in the principle that as large as possible a portion of the exciting energy is furnished by the generator itself, whilst an amount of energy just sufficient for determining the step, or phase, is produced by a special exciting machine.

Attachment of Telegraph Wires to Insulators.

1009—1909. W. E. Bandfield, Wolverhampton. A U-shaped clip is made partially to surround the insulator. The line wire is introduced within the forked ends of the clip in such manner that the clip and wire effectually grip the insulator.

Electrical Heating Apparatus.

1414—1909. A. F. Berry, Ealing. This apparatus comprises incombination with a hot plate winding an auto-transformer with invariable points of connection with the supply conductors and means for connecting the hot plate through a switch, and contacts to different parts of the winding of the auto-transformer. A further patent (1415-1909), protects a means for controlling the temperature of these apparatus. The hot plate winding is arranged to be connected to the winding of the auto-transformer and can be altered in active length or divided into parts according to the degree of heating required by a regulating switch.

Electrical Government of Turbine Speed.

2900—1909. A. Martin, Wolsingham. This is an electrical marine engine and turbine governor, which prevents the racing of turbines at all speeds when the propellers leave the water. It comprises the use of a small dynamo driven from the main shaft of the propeller, two series or two shunt coils with their iron cores, a rocking bar and connecting rod for governing the throttle valve, and two insulated resistance tubes fixed on the ship's stem.

Multiple Switch Starters.

5280—1909. Cutler-Hammer Manufacturing Co., Milwaukee. This device comprises a plurality of separate manually operated switches tending to stand in open position, a retaining magnet for holding one of the switches in close position, interlocks between the switches insuring the closure of the switches in a definite sequence and for retaining them in close position so long as the electromagnetically retained switch is closed, and a manually operated auxiliary switch, which, if released before all the switches of the sequence are closed, causes the de-energisation of the retaining magnet.

Steel Armouring Electric Cables.

6809—1909. C. A. Claremont, Old Trafford. The steel tapes spirally wound round the cable are provided with longitudinal ribs in such manner as when wound upon the cable to form a channel, which prevents the tapes from becoming displaced.

Machine for Covering Electric Conductors with an Insulating Material.

7532—1909. H. L. Owen, New York. This machine comprises a bare wire reel, rotatably mounted at one end, a rotary insulation applier, a rotary device for compressing the insulation upon the fibre, means for conveying the bare wire reel to the insulated wire reel, and a compensating insulated wire reel upon the other end of the machine.

Splicing Ear for Electrical Conductors.

11209—1909. J. C. Russell, Brooklyn. The splicing ear is composed of two parts halved down the middle. The parts have grooves so that when secured together the grooves constitute passage ways for the cable ends.

Electric Dynamos.

15081—1909. H. B. van Daalen, Maida Vale. In order to obviate sparking in electro dynamos, the field winding are superimposed in such a manner that the axis of one winding passes through the other winding superposed thereon and *vice versa*, without the two axes coinciding with one another.

Electrical Relay.

20772—1908. B. Thomas, Manchester. In this relay, which is intended for use with such gear as automatic accumulators, arrangements are made whereby the relay shall make circuit only, the circuit being broken elsewhere.

Cluster Lamp Holder.

26929—1908. J. Sax & Co., London. The cluster holder is provided with inter-connected clips for securing the holder in the crown piece. The clips are drawn together by a spring arrangement, the catches of which are provided with notches. The main terminals of the holder are distinct from the individual terminals.

Detecting the Passage of Electric Impulses.

28367—1908. A. Orling, Tooting. This electro-capillary contrivance consists of a suspended oscillating member, which, on the passage of an electric impulse, vibrates by reason of the displacement of two contacting immiscible electro-conductive liquids relatively to a capillary tube within which they are contained. The oscillating member forms the capillary tube and is so shaped and situated relatively to its axis of suspension that the tube can move with a minimum displacement of the liquids relatively to the fixed base of the instrument, which liquids will then be restrained in their movement by their inertia, with or without the use of stops bearing on the exposed extremities of the plugs of liquid.

Electric Transformer Distribution.

92—1909. Allgemeine Elektricitats Gesellschaft, Berlin. The relay is provided with a winding in series with the transformer. The relay connects one or more transformers in parallel with the first mentioned transformer when the load on the latter increases beyond full load so that the additional transformers share the load which would otherwise overload the primary transformer.

Production of Electric Arcs.

16225—1909. P. Bunet, Paris. In order to produce electric arcs intended for the formation of compounds of nitrogen and oxygen, one electrode of the apparatus is central while the other is formed of two or more lateral arms arranged symmetrically in relation to the first. By enlarging the surface of the electrodes an increased number of arcs can be obtained.

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TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns per week.			Increase or decrease.		Mil track	of open.	Accounts for past year.							Cost per car mile.
	Ending	1909-10.	1908-9.	Week.	Current year.	1909.	1908.	Ending	Total receipts.	Passengers carried.	Car miles run.	Receipts per Passenger.	Car mile.	Mile of track.	
		£	£	£	£				£						
Aberdeen Corporation	Jan. 19	1,179	1,165	+ 13	— 837	27¼	27¼	May 31	71,930	17,517,304	1,566,119	·98	11·02	4,940.	5·53
Ayr Corporation	Sept. 18	671	562	+ 108	—	8	8	—	—	—	—	—	—	—	—
Baker Street and Waterloo Ry.	Nov.	8,141	6,070	+2,071	—	4·25	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	Jan. 9	1,080	1,030	+ 50	— 39	24·003	13·52	—	—	—	—	—	—	—	—
Birmingham Corporation	Jan. 15	6,897	6,378	+ 519	—	56·792	58·52	—	—	—	—	—	—	—	—
Blackburn Corporation	Oct. 6	1,100	1,293	— 173	—1,036	24·53	28·3	—	—	—	—	—	—	—	—
Blackpool Corporation	Aug. 26	2,152	2,050	+ 102	+ 732	—	—	—	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams	„ 8	2,304	2,309	— 24	—	—	—	—	—	—	—	—	—	—	—
Bolton Corporation	Oct. 10	2,416	2,337	+ 79	— 259	42	42	Mar. 31	117,799	25,492,902	2,492,147	1·1	11·34	2,804	6·54
Bournemouth Corporation	July 21	1,681	1,723	— 42	— 23	29½	29½	„ 31	86,225	13,991,328	1,766,068	1·47	11·71	2,912	7·22
Bradford Corporation	Jan 8	4,691	4,340	+ 351	+ 7,256	98	54·81	„ 31	235,258	47,839,569	5,331,007	1·17	10·59	2,378	—
Brighton Corporation	Jan. 23	722	664	+ 58	+ 2,015	9·5	—	—	—	—	—	—	—	—	—
Bristol Tramway Company	Jan. 21	5,807	4,867	+ 940	—	57	51½	Dec. 31	265,262	46,652,389	5,756,842	—	—	—	—
Burnley Corporation	Jan. 22	1,144	1,116	+ 28	—	19½	19½	Mar. 31	64,261	12,355,958	1,202,330	1·23	12·83	5,971	7·32
Burton Corporation	Jan. 23	239	224	+ 15	— 169	6½	6½	„ 31	14,918	3,221,595	430,913	1·04	8·30	1,460	5·53
Cardiff Corporation	April 3	2,000	1,957	+ 43	—	—	—	„ 31	109,979	25,058,146	2,497,169	—	10·57	—	—
Carlisle Tramways Company	June 19	170	175	— 5	— 89	—	—	—	—	—	—	—	—	—	—
Central London Railway	Jan. 15	5,607	5,661	— 54	— 215	6·32	5·77	Dec. 31	350,150	41,898,373	1,456,781	2·01	5·769	55,404	30·27a
Charing X, Euston, & Hamp. Ry.	Nov.	6,822	6,092	+ 730	—	7·75	—	—	—	—	—	—	—	—	—
City and South London Railway	Jan. 23	3,321	3,338	— 17	— 78	7·26	7·26	—	—	—	—	—	—	—	—
Colchester Corporation	July 14	200	219	— 39	—	8	—	Mar. 31	10,983	2,308,721	349,539	1·09	7·74	1,477	6·54
Cork E. T. and L. Company	Jan. 20	433	397	+ 36	— 15	9·89	9·89	Dec. 31	24,044	5,737,478	890,945	—	6·43	—	4·43
Croydon Corporation	Dec. 31	1,706	1,155	+ 551	+ 6,290	11½	—	Mar. 31	74,132	16,277,418	1,884,137	1·06	9·56	3,703	7·169
Darwen Corporation	Oct 1	239	256	— 17	— 201	7·23	7·23	„ 31	13,899	2,557,654	245,584	1·30	13·68	1,922	9·41
Dover Corporation	Sept. 18	230	252	— 22	— 395	7	—	„ 31	11,593	2,697,672	316,754	·98	8·78	—	—
Dublin and Lucan Electric Ry.	Jan. 21	97	101	— 4	— 18	7	7	—	—	—	—	—	—	—	—
Dublin U.T.	Jan. 21	4,960	4,785	+ 174	+ 403	54½	54½	—	—	—	—	—	—	—	—
Dundee City Tramways	Oct. 6	1,332	1,305	— 27	— 569	—	26½	May 15	60,573	16,367,911	1,281,552	·875	1·9	2,371	7·46
East Ham Corporation	Jan. 22	936	894	+ 42	+ 4,974	15	15	Mar. 31	47,430	15,355,703	1,091,586	·73	10·26	—	6·96
Glasgow Corporation	Jan. 8	19,403	17,746	+1,662	— 8,043	189	181	May 31	907,494	226,948,290	20,766,722	·96	10·49	5,080	5·99
Gloucester Corporation	Oct. 6	395	425	— 30	+ 535	15	—	—	—	—	—	—	—	—	—
G.N., Piccadilly and Brompton	Nov.	13,429	9,354	+4,075	—	9·25	—	—	—	—	—	—	—	—	—
Halifax Corporation	—	—	—	—	—	52·574	37	Mar. 31	81,872	20,378,672	1,786,390	11·40	11·19	1,528	5·49
Huddersfield Corporation	Dec. 4	1,613	1,357	+ 256	+ 2,663	28	28½	„ 31	84,704	16,200,020	1,960,329	1·29	10·37	2,421	5·10
Hull Corporation	Jan. 22	2,667	2,387	+ 280	+ 5,305	29	26	„ 31	128,722	30,964,254	3,022,844	1·	10·22	—	6·04
Ilford Corporation	Jan. 8	495	431	+ 64	+ 1,656	10	10½	„ 31	25,328	6,385,466	634,446	·87	9·58	2,066	6·42
Ilkeston Corporation	Jan. 19	115	118	— 3	— 250	4	4	„ 31	7,214	1,968,850	198,415	9·1	7·9	1,803	7·64
Kirkcaldy Corporation	Sept. 8	269	266	— 7	—	7½	7½	May 15	14,993	4,874,199	459,066	·711	7·838	1,856	5·26
Lancashire United Tramways	Jan. 19	1,152	1,159	— 7	+ 109	39	39	Dec. 31	68,904	12,554,593	2,244,344	—	—	—	—
Leeds Corporation	Sept. 18	6,896	6,624	+ 272	+ 3,662	108	96½	Mar. 31	340,368	75,734,083	7,694,989	1·06	10·62	3,527	5·31
Leicester Corporation	Sept. 11	2,162	2,130	+ 32	—	—	—	—	—	—	—	—	—	—	—
Liverpool Corporation	N v. 6	10,803	10,687	+ 116	— 1,977	109	104	Dec. 31	572,822	124,043,239	12,231,799	1·108	11·24	5,508	7·94
Liverpool Overhead Railway	Jan 9	1,337	1,378	— 41	— 7	6·65	2·40	June 30	79,004	11,171,515	1,106,386	—	—	—	—
London County Council	Jan. 1	40,923	28,975	+11,948	+84,397	128½	121	Mar. 31	1,274,660	279 166,461	25,591,028	1·08	11·74	—	6·79
Lowestoft Corporation	D c. 11	155	150	+ 5	+ 10	3½	—	Sept. 30	11,399	2,645,206	370,320	1·03	7·36	2,279	6·12
Maidstone Corporation	Jan. 8	148	138	+ 10	— 341	7·4	—	—	—	—	—	—	—	—	—
Manchester Corporation	Sept. 11	15,631	15,297	+ 334	— 2,871	183	181	—	—	—	—	—	—	—	—
Metropolitan District Railway	Jan 22	10,832	9,949	+ 883	+2 672	24	24	—	—	—	—	—	—	—	—
Metropolitan Railway	Jan. 16	17,023	16,418	+ 605	+ 1,118	24½	24½	June 30	680,357	99,846,735	—	1·46	—	—	—
Nelson Corporation	Oct. 16	151	131	+ 20	+ 7	2½	2½	Mar. 31	7,362	2,060,712	204,740	·85	8·63	1,907	—
Newcastle-on-Tyne Corporation	Jan. 1	4,110	3,813	+ 297	— 1,301	60½	59½	„ 31	211,085	46,203,164	4,411,745	1·10	11·48	3,504	6·58
Newport (Mon.) Corporation	Oct. 9	663	638	+ 25	— 311	14½	14½	„ 31	35,531	8,174,003	798,029	1·04	9·89	2,450	7·21
Oldham Corporation	Jan. 24	1,778	1,516	+ 262	— 386	—	—	—	—	—	—	—	—	—	—
Portsmouth Corporation	Oct. 10	2,046	1,809	+ 237	—	28½	28½	Mar. 31	97,741	21,247,048	2,309,439	1·10	10·15	—	—
Reading Corporation	Jan. 20	589	562	+ 27	— 48	13½	13½	„ 31	32,769	7,933,572	915,481	—	8·93	—	4·65
Rochdale Corporation	Dec. 26	1,240	1,126	+ 114	+ 746	20·9	20·93	„ 31	56,558	10,196,148	1,252,925	1·32	10·83	2,693	6·47
Rotherham Corporation	Feb. 4	554	587	— 32	—	—	—	—	—	—	—	—	—	—	—
Salford Corporation	Sept. 27	4,996	4,662	— 66	— 3,326	78	74½	Mar. 31	244,065	45,771,611	5,486,150	1·25	10·67	3,185	—
Scarborough Tramways Co.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Sheffield Corporation	Jan. 9	5,853	5 203	+ 560	+ 4,191	39½	37	Mar. 25	280,745	17,568,686	7,065,380	·896	9·842	4,225	5·04
Southampton Corporation	Jan. 15	1,049	1,016	+ 33	— 94	18	18	„ 25	52,647	10,121,887	1,157,451	1·25	11·33	—	7·30
Southend-on-Sea Corporation	Aug 21	995	557	+ 438	+ 1,483	—	—	—	—	—	—	—	—	—	—
Stockport Corporation	—	—	—	—	—	25	25	Mar. 31	52,004	9,155,172	1,335,911	1·34	9·342	1,830	6·75
Sunderland Corporation	Jan. 27	1,310	1,336	— 26	— 7,984	—	—	—	—	—	—	—	—	—	—
Swindon Corporation	Dec. 11	126	114	+ 12	—	—	—	—	—	—	—	—	—	—	—
Torquay Tramways	Aug. 26	630	647	— 30	—	8·41	—	Dec. 31	15,065	2,880,420	353,297	1·40	1·023	—	—
Wallasey U.D.C.	Jan 22	791	760	+ 31	+ 853	12·68	12·45	Mar. 31	43,823	8,331,038	891,540	1·2	11·79	3,453	7·72
Warrington Corporation	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
West Ham Corporation	Jan. 13	2,295	2,177	+ 118	+ 6,162	27	14·7	Mar. 31	122,881	35,502,836	2,556,854	·789	10·95	4,417	6·79
Wolverhampton Corporation	Nov. 3	841	823	+ 18	— 206	21½	—	„ 31	44,432	9,440,369	975,714	—	10·929	2,190	6·506

a Train Miles. *h* Half-year's figures.

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THE
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NOTES.

A ROYAL CHARTER.

Mr. R. Hammond, at the annual dinner of the Students' Section of the Institution of Electrical Engineers, pleaded that the Institution should secure a Royal Charter of Incorporation. Little would be gained thereby apart from a few legal advantages of no great value, and a modicum of added prestige among the unthinking. The duty of the Institution is to remain young, energetic and splendidly selfish, eager to drag into its vortex every man endowed with a healthy belief in his own powers and in the future. Now, if the Institution once submits to the gilded shackles of a Royal Charter, it necessarily loses much of its present liberty and elasticity. Its President, from being a sane person, dispensing the vivifying wine of optimism, would become a frigid Grand Panjandrum, surrounded by a bevy of little tin-gods, whose main object would be to exclude young men with "revolutionary ideas." Then, the chief claim to a seat on the Council would be the candidate's thorough "orthodoxy," and his close approach to fossildom. Many a body has fallen out of the race of progress in this wise, which leads to a conservatism, a stagnation too often assuming the aspect of the moribund. Let the Institution be loyal, but for commonsense sake don't let it be Royal.

POWER FOR TRAMWAYS.

A well-known electrician, Mr. A. M. Taylor, makes a notable contribution to the discussion on the equitable charges for tramway supply, as will be seen on referring to our correspondence columns. His sympathies are clearly with the central station engineer. He considers the existing generally prevailing "fixed charges" calculations as eminently fair under all circumstances, and he gives figures to prove his case. But his notable suggestion lies in his declaration that the tramway engineers could, an' they would, escape this form of surcharge, by doing away with the necessity of providing standby plant. He argues that the tramway men should not require "peak loads" of any description, at least, as far as the supply station is concerned, and then he could be supplied with current at practically bulk rate. In which case, of course, Mr. Yerbury's contention that profit should be calculated only on the "running costs" would hold good. As it will be seen, the solution of the problem lies in the provision of accumulator sub-stations, which would enable diurnally or irregularly recurring "peak loads" to be met. The course advocated is calculated to startle the orthodox; nevertheless, the calculations which he places before our readers for candid criticism seem clearly to show a considerable saving in the system. He has apparently thought out the scheme carefully, and we can only add that the professional standing of our contributor warrants serious attention being given to his communication.

COMBINED STATIONS.

At the Leeds Section of the Institution the discussion on Mr. Yerbury's paper was opened by Mr. A. J. Cridge, of the Sheffield Corporation Electric Lighting Department, who read a communication from Mr. S. E. Fedden, Manager of the Sheffield Tramways Department. He was strongly in favour of combined stations, arguing that if at Sheffield the two stations had been combined, and the tramway profit employed to write off the capital charges, instead of being paid in reduction of rates, the city would have benefitted enormously. Mr. Cridge seemed to be of the same opinion, and he pointed out that a reduction on average charges to tramways could easily be allowed, chiefly on the ground that the "peaks" of tramway and private supply did not coincide in time, and therefore the load could be flattened out or averaged, to the relief of all concerned. He took the same view as we expressed in last week's leading article, that the profit of from 3 to 5 % on the running cost was too low, a point upon which most central station men will concur.

THE MILCH COW.

Mr. W. J. Wardale, also of the Sheffield Tramways Department, took the view that as a rule the tramways departments were victimised, being charged inordinantly because they could not help themselves. Unconsciously, Mr. H. Dickinson, chief engineer of the Leeds Electrical Supply Department, rather confirmed this view, for he argued that a good case could be made out for charging a high rate to tramways. The way out of the difficulty suggested by Mr. Taylor has not occurred to others.

PROPOSED CONFERENCE.

An excellent hint was thrown out by Mr. R. L. Acland, of Chesterfield, who is anxious to see a conference arranged between the Municipal Electrical Association and the Municipal Tramways Association. No doubt at a later stage such a coming together might serve a very useful purpose, especially after the subject has undergone the preliminary winnowing that Mr. Yerbury's paper has given the excuse for. It is one of the most keenly contested questions of the day, and a *modus vivendi* should be formed.

It will be seen that Mr. S. L. Pearce, speaking at Manchester on Mr. Yerbury's paper, announced that a joint committee of supply engineers and tramway managers will shortly meet to discuss the subject.

METER MISTAKES.

How much wrong may arise as the result of false economy was shown in a curious way at Hull, where a local manufacturing firm paid their electricity account to the Corporation under protest. The manufacturers pointed out that they had been using power passing through the half h.p. meter, and they contended that the quantity recorded on the 35 h.p. meter was running to waste and to their detriment. But the electrical engineer put quite a different complexion on the affair, explaining that the manufacturers were taking their units through a large meter instead of getting a small meter connected, one adequate for the work. As matters stood there was a little and a large meter, and as they were not adjusted for the work, their records did not coincide, so an average was struck. It is a pity, for the manufacturers feel that they have a grievance, the charge is probably rather too high—so electricity suffers, a state of affairs that could easily be obviated by a wise liberality as regards meters.

ELECTRICITY IN COAL MINES.

It is pleasant to find Mr. R. Nelson, H.M. Electrical Inspector of Mines, among the prophets. Last week he discussed before the Birmingham University Mining Society the subject of "Electricity in Coal Mines," and said emphatically that electricity had captured the coal mines and that its general introduction was merely a question of time, therefore making a knowledge of the application of electricity underground essential to mining engineers. He rather favoured the system of taking current from a supply company, and plumped boldly for the three-phase alternating current. Some new development might make D.C. possible for coal mines, but that was not yet, for it was not fit for underground work, at all events where there was danger of explosion.

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THICK GLASS UNDERGROUND.

A useful hint came from Mr. Nelson when reviewing the mines regulations. He said it would be well if the use of strong glass was not merely specified for certain instruments and positions, but was made imperative everywhere underground. As we know, the bulb of an incandescent lamp frequently becomes hot enough to ignite paper, cotton waste, brattice cloth, and similar easily ignitable material. The use of strong glass outer globes should, therefore, be universal in order to prevent contact with such material, apart from any question of the ignition of gas or coal dust.

ELECTRICITY IN POTTERIES.

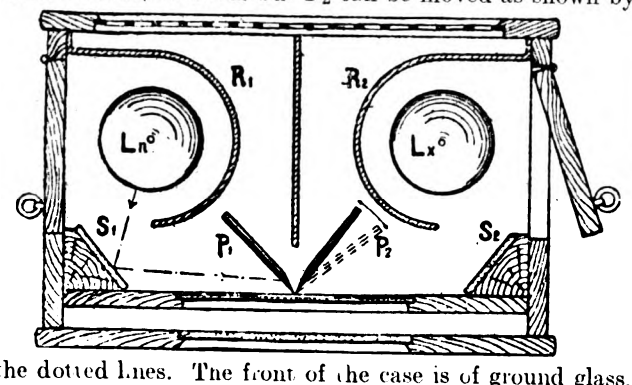
In the course of a lengthy and much appreciated lecture before the Wedgwood Institute, Mr. Ashton Bremner, Borough Electrical Engineer of Burslem, gave some cogent reasons for the electrification of pottery works, where the utmost economy of production is necessary. One difficulty met with was that of arriving at costs. Mr. Bremner acknowledged that it was nearly impossible to give details of the cost of fitting up pot-works, because conditions varied so much; but the cost of electrical energy could be given accurately. For this purpose he reckoned that the usual factory hours were 56 per week, and the works ran, say, 50 weeks per annum, so that the annual working hours might be taken as 2,800. It was difficult to estimate the average load. He had, therefore, carefully compiled figures taken from the Corporation's own consumers' demands, and from the actual accounts paid for electrical energy during one year. The average worked out at £3 per horse power per year. Anybody wishing to find out what electrical energy was likely to cost him, should he determined to electrify his works, should multiply the horse power of his motor or motors by £3, the average cost of electrical horse power in Burslem, to find out exactly what he would have to pay per year.

TORPEDO FACTORY AND ELECTRICITY.

An example is being set by the Admiralty in the equipment of the torpedo factory which is being removed from Woolwich to the Clyde. Electricity is being extensively used, both for lighting and for driving machinery. In this latter capacity, the installation is now being increased to treble the size originally intended, which is evidence that the experts have satisfied themselves as to the possibility of being able to hasten output by the general adoption of electricity as a motive force. The works, which will be far larger than the old ones on the Thames, are to be ready early in May, when upwards of 400 artisans will commence operations.

PORTABLE PHOTOMETER FOR FILAMENT LAMPS.

This photometer, with which is combined a lamp voltmeter and wattmeter, is made by Hartmann & Braun, A.G. In the Fig. R_1 and R_2 are two semi-cylindrical chambers, one for the standard lamp Ln, the other for the lamp Lx to be measured. The lamps being hung up, light from them reflected from the mirrors S_1 and S_3 on to the transparent surfaces P_1 and P_2. P_1, which receives the light of the standard lamp is fixed, but P_2 can be moved as shown by



the dotted lines. The front of the case is of ground glass, with a transparent circle in the middle, half of which is illuminated by each lamp. P_2 is then moved until the illumination of the two halves is the same. The ratio between the cosiness of the two angles of incidence gives the ratio between the lights, and a scale attached to the case permits of this being read off at once by means of a pointer actuated by the motion of P_2.

THE ELECTRICAL EQUIPMENT OF SMITH'S DOCKS, NORTH SHIELDS.

The equipment of a ship-repairing works presents many points of similarity to that of a shipyard proper, but there are also many points of difference. The North Shields branch of the Smith's Docks Co. consists of three dry docks ranging from 300 to 435 ft. long, and two pontoon docks, 365 ft. and 435 ft. long respectively. In addition, there is an extensive ship-yard for building steam trawlers, medium-sized cargo boats, and other small vessels, while, across the river at South Shields, a further set of three dry docks for repairing purposes is in operation. Increasing business recently suggested to the firm the removal of the shipbuilding branch to Middlesbrough, where extensive new works are now in operation, and the devoting of the space thus left at North Shields to greater repairing facilities, a 600-foot graving dock being in contemplation.

This company is of very old standing, being really an amalgamation of Messrs. T. W. Smith and Messrs. H. S. Edwards & Sons, founded in 1782 and 1786 respectively, so that it carries on one of the oldest ship-repairing industries in the kingdom, although it has been known by its present name since 1891. The great success of the firm is due to the fact that its policy has always been to keep up with engineering progress, and even before the amalgamation took place, electricity was being used to pump out one of its floating pontoons by the firm whose name is still retained by the limited company. This was before the days of municipal supply, so that a private plant was put down to operate the pumps electrically. Last year, on the advice of Mr. C. W. Fairweather, consulting electrical engineer to the firm, it was decided to change over and take electrical supply from the system of the Tynemouth Corporation Electricity Department. The steam equipment fed by three marine boilers was scrapped, such hydraulic and pneumatic systems as were in operation were operated electrically, and, wherever possible without incurring too much expense in changing over existing electrical machinery, a three-phase supply system was introduced. Where this was no possible, a direct current supply was taken from the town mains, the firm's old dynamo being dismantled. The practical effect on the time operations of the firm owing to the almost unlimited amount of power available from the central station plant is that all three docks can be used at one time, that is, three ships can be docked together, whereas it was formerly necessary to hold one ship back in order to spread the pumping over a longer period and lighter duty.

The system of electrical distribution is divided between a direct current supply from the Tynemouth Corporation main station, which is now being operated as a transforming station for transforming the high-tension three-phase bulk supply from the Newcastle-upon-Tyne Electric Supply Co. to a three-wire low tension direct current distribution at 440 and 220 volts, and a three-phase 40-period supply. The sub-station for this latter supply is erected on the premises, and the three-phase motors which are operated from this centre are, with the few exceptions mentioned later, of the squirrel-cage induction type. In connection with the pumping of the two large graving docks mentioned above, a pump room is installed on the pier between the docks, the whole of the plant being underground.

The installation consists of two main twin horizontal Worthington pumps each of 16 in. diameter direct driven by a 150 h.p Westinghouse alternating current motor, an 8 in. drainage pump, operated by a 25 h.p. Westinghouse alternating current motor, to drain the docks after pumping, while for ballast purposes a 17½ h.p. alternating current motor operates an 8 in. delivery ballast pump, and a 2 h.p. alternating current motor drives a small priming pump.

Space is economised as much as possible by placing the centre line of each combination parallel to the axis of the pier, but inverting the relative position of the motor and pump in one set so as to bring the two sets close together. The lighting for this room is taken from one phase to earth.

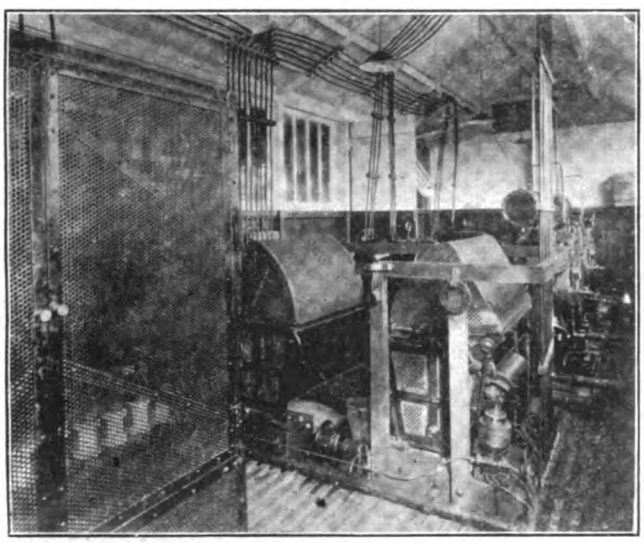
It has been found possible to empty the smaller of the two docks completely in an hour-and-a-half when using both sets of pumps, while the larger one takes two to two-and-a-half hours according to the size of the vessel which is being docked. For opening and closing the gates of both

these docks a capstan made by Messrs. Clarke, Chapman & Co., is used, the arrangement of chains being such that one of these passes through an eye on one gate to a bolt on the other; the tension of this chain, therefore, drawing both gates close together. Another chain, divided at a point along its length into two separate chains, is suitably arranged for throwing the chain wheels into and out of gear with the drive, which is accomplished by a 25 h.p. slip-ring motor.

In connection with these docks, a Ransomes and Rapier jib crane of 15 tons' capacity, at a radius of 45 ft., is also in operation on the three-phase system, having motors of 30, 20, 20 and 10 h.p. for lifting, derricking, slewing and traversing respectively. On this pier is also a fitters' shop driven by a 30 h.p. Westinghouse motor. The supply for this crane is taken from a plug box some 10 yards away through a flexible armour-covered cable to the crane, and fed through a hollow vertical shaft, on which the crane superstructure rotates, to slip rings, from which it is taken to the switchboard. Each gear is equipped with an electro-magnetic and foot brake for use in cases of emergency.

The other purposes of the three-phase supply are for operating 20 and 15 h.p. Westinghouse motors respectively for punching machines erected in the open for working large plates, the motors being mounted on the top of the machines and supplied by an overhead pole construction, which is clearly shown in Fig. 1, and two 65 h.p. Westinghouse slip-ring motors for driving air compressors, which supply power for working pneumatic tools for the ships being repaired in the docks. Each of these slip-ring motors is controlled automatically by a liquid starter operated by a small motor which is thrown on and off the line by a switch controlled by the air pressure in the air receiver. The pressure at which this switch operates can be adjusted by altering the weights attached to the movable blade of the switch. Fig. 2 gives a photograph of the air-compressor room, and shows this automatic gear very plainly.

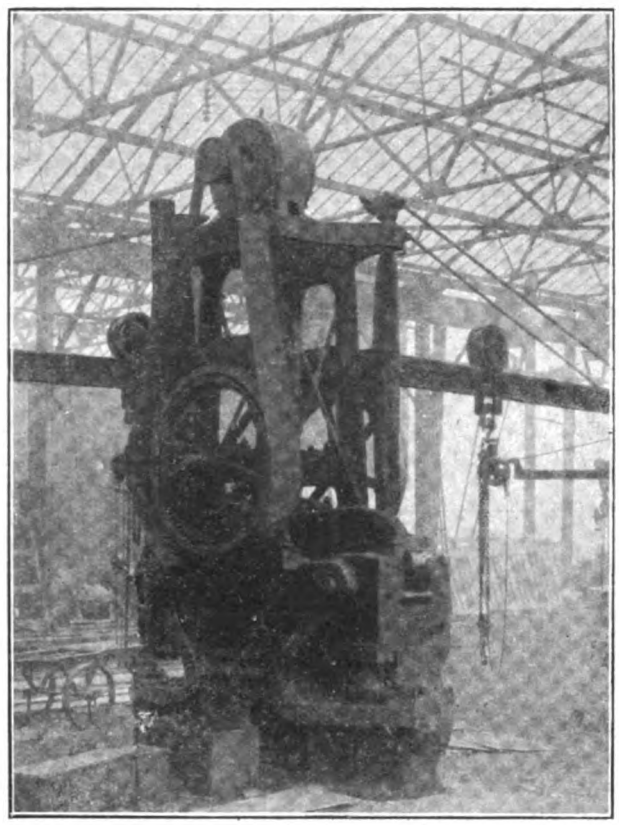
A direct current supply, of which there are four services direct from the Corporation mains, is used for driving motors for the blasts in the coppersmiths' and blacksmiths' hearths and machine tools; and also for the flame-arc lamps which are used throughout the yard for outside lighting and for the enclosed lamps for inside illumination.



In the shipyard, which forms the middle section of the area covered by the firm, a number of tools are driven by direct current motors. Among the heavier machinery may be mentioned a joggling machine driven by a 40 h.p. direct current motor, a large punch and shears driven by a Westinghouse direct current motor, shown in Fig. 3, and large mangles for straightening plates operated by a 17 h.p. direct current motor. As the work on the last machine is very fluctuating, a large-scale ammeter is installed in view of the man using the controller, so that he can regulate the rate at which work is being done. A fine plate-planing machine 22 ft. in length is driven by a 30 h.p. Westinghouse alternating current motor. Close to this machine is a drilling and counter-sinking machine for working on the plates, driven by a 7½ h.p. alternating current motor.

An interesting feature in the shipbuilding department is the erection of a main switchboard, controlling the power circuits, on a platform 30 ft. above ground, and closed in from the shop by glass windows, so that the operator has a full view of every machine in the department. Double-pole fuses and switches are provided for each circuit, together with main switch and fuses, and necessary volt-meters and ammeters.

At the entrance to the Pontoon Department is situated No. 6 graving dock, which is used for docking the smaller boats. The pumping equipment, which is capable of empty-



ing the dock in about 2½ hours, is contained in an underground room at the side of the dock and consists of a centrifugal pump, with a capacity of 6,000 gallons a minute against a head of 26 ft., direct-connected to a 70 h.p. Westinghouse vertical alternating current motor operated by an autostarter, and small draining and priming pumps direct-driven by alternating current motors.

One of the main features of interest in connection with the pontoon department, which also forms one of the outstanding features of the works as viewed from the river, is a travelling jib crane on the wharf side, which is used for such purposes as placing very large propellors, etc., on boats lying alongside the quay. It was constructed by Messrs. Ransomes & Rapier to lift 25 tons at a radius of 43½ ft., and is operated by four direct current motors of 40 h.p. for the hoist, 20 h.p. for derricking, 10 h.p. for travelling, and 15 h.p. for slewing.

An extensive fitting shop is in operation in connection with the pontoons, some of the machines, such as lathes and drilling machines, being of considerable power. Amongst these may be mentioned a four-tool lathe with a bed taking work up to 40 ft. in length, and a planing machine of 10 ft. by 4 ft. These two machines, together with three other lathes, are operated by a 50 h.p. Westinghouse induction motor which also drives, by means of a rope belt and friction clutches, a 20-ton overhead travelling crane. The smaller machines in this shop are driven from a shaft by a 30 h.p. Westinghouse motor, whilst the joiners' shop, which is used for ship repairing work, is operated by a 15 h.p. Westinghouse motor.

In the hydraulic house, adjacent to this department, is installed a pump for working the accumulator for the hydraulic system of the works, which is maintained at a pressure of 900 lbs. per sq. in. The pump is driven by an 85 h.p. Westinghouse slip-ring motor, which, with the exception of the air compressor plant, one capstan, and one crane equipment, is the only slip-ring motor in the place.

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It is provided with an automatic liquid starter for starting against load, being controlled by the rise and fall of the accumulator. A 50 h.p. Westinghouse alternating current motor drives the compressor for the pneumatic hammers and rivetters in the docks, which are supplied at a pressure of 40 lbs. per sq. in. In this connection it may be mentioned that the hammers in the blacksmiths' shops were recently converted from steam to pneumatic drive. The blacksmiths' department in this section comprises a series of 20 fires, the blast for which is maintained by a Roots blower driven by a 10 h.p. Westinghouse alternating current motor. Two other motors, each of the same capacity operate punching and shearing machines, and a mangle and drilling machine in the high shed (pontoon department). There are, amongst other heavy machinery, a fine set of rolls by Messrs. Hugh Smith & Sons, capable of taking plates up to 30 ft. in length, driven by a 55 h.p. direct current motor. In this section the same arrangement of main switchboard is adopted, namely, an elevated gallery at such a height that the whole of the machinery can be seen at one time by the operator, isolated from the dirt and dust of the shop by glass partitions. For the purpose of pumping out pontoons Nos. 7 and 8, a series of four and eight pumps are respectively installed, each pump having a delivery pipe of 18 in. diameter, and being operated by a 60 h.p. Westinghouse alternating current motor. It may be taken that any further extensions of this set will be carried out by means of three-phase power.

The whole of the alternating current electrical equipment —consisting of three-phase motors, autostarters which are of the oil immersed type, controllers and automatic liquid control and electro-magnetic brake gears—was supplied by the British Westinghouse Electric and Manufacturing Co., Ltd. The wiring was carried out by Messrs. Warren, Beattie & Co., of Middlesbrough.

DIMENSIONS OF SELF-OILING BEARINGS WITH LOOSE RINGS.

The self-oiling bearing fitted with a loose ring running on the shaft and dipping into an oil reservoir may be considered the universal type for dynamos and motors. Except for a very low speed machine, such as is coupled direct to a slow running Corless engine or a high speed machine for coupling to a steam turbine, the loose ring method is perfect.

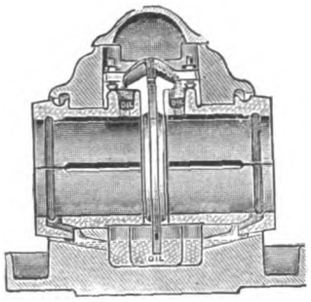

FIG. 1.

It has been somewhat of a surprise that mechanical engineers have not adopted it more extensively, for as a matter of fact, the idea came originally from a line shaft bearing which had a fixed ring shrunk on the shaft. The writer first saw one of these line shaft bearings in the old Brush Electrical Engineering Co.'s works at Lambeth, in 1890. So the idea is at least 20 years old.

The trouble with that particular bearing was that as the ring was small in diameter not much of the periphery dipped into the oil, and as it ran at the same speed as the shaft the oil was thrown rather violently.

The writer was designing a line of direct current dynamos for the Brush Co.at the time, and he used self-oiling bearings having chains which dipped into the oil. and which the friction of the shaft gradually worked round. They lifted up a large amount of oil, and the chains took up little room sideway. It could be put on after the bearing was fixed, but it eventually gave place to the cheaper and just as effective loose ring method.

It is interesting to note that mechanical engineers are now adopting this method of automatic lubrication, and one of the first firms to standardise and supply bearings so fitted is Croft & Perkins, of Bradford.

Below are given line drawings showing the general design, with a table of dimensions for shafts from 1½ to 8 inches in diameter. Referring to the numbers on the drawing, 1 is the oil reservoir, 2 is the oil ring, 3 is the channel for assisting the oil to flow along the shaft, 4 four-arc grooves to arrest oil from flowing along the shaft, 5 is the inspection lid, 6 is an oil gauge, 7 is the drain for oil reservoir, and 8 8 are dishes to receive any drip.

Dia of shaft	Dimensions.									Bearing surface 2 diameters			Bearing surface 2½ diameters			Fixing bolts	
D inches	H inches	C inches	B inches	L inches	W inches	T inches	A inches	S inches		X inches	Y inches	Z inches	X inches	Y inches	Z inches	Dia inches	No
1½	2¼	6¼	-	8½	2½	15/16	5¼	8¼		5	3¾	2⅞	5¾	4½	3⅝	½	2
1¾	2½	7¼	-	9¾	2⅞	⅞	5¾	9		5½	4⅜	3¼	6⅜	5¼	4⅛	½	2
2	2⅝	7¾	-	10½	3¼	1	6¼	9¾		6⅝	5	3⅞	7⅝	6	4⅞	⅝	2
2¼	3	8¾	-	11½	3¾	1⅛	6 15/16	11		7⅛	5⅝	4⅜	8¼	6¾	5½	⅝	2
2½	3¼	9¼	-	12	4¼	1¼	7½	11¼		8	6¼	5	9¼	7⅛	6¼	¾	2
2¾	3½	10¼	-	13	4⅝	1½	8¼	12¾		9	6⅞	5⅜	10⅜	8¼	6¾	¾	2
3	4	11	-	13¾	5	1⅝	9	13½		9½	7½	6	11	9	7½	¾	2
3¼	4¼	11½	-	14¾	5⅜	1¾	9⅝	15		10⅜	8⅛	6½	12	9¾	8⅛	⅞	2
3½	4½	12	-	15¾	5¾	1⅞	10⅛	15½		11	8¾	7	12¾	10½	8⅜	⅞	2
4	5	13½	-	17½	6½	2⅛	11⅝	18		12¼	10	8	14¼	12	10	1	2
4½	5½	15½	-	20	7½	2¼	12⅝	19½		13¾	11¼	9	16	13½	11¼	1⅛	2
5	6	16	-	21	8½	2¼	14⅜	22		16	12½	10	18½	15	12½	1¼	2
5½	6½	17½	-	23	9¼	2½	15¼	23½		17½	13¾	11	20¼	16½	13¾	1¼	2
6	7	18½	5	25	10	2¾	16⅜	25		18½	15	12	21½	18	15	1¼	4
6½	7½	21	5½	27	11	3	17¼	26½		20½	16¼	13	23¾	19½	16¼	1¼	4
7	8	22	5¾	28	11½	3	18⅜	28		22	17½	14	25½	21	17½	1¼	4
7½	8½	23½	6	30	12¼	3¼	19	29½		23½	18¾	15	27¼	22½	18¾	1½	4
8	9	25	6½	32	13¼	3¼	20¼	31		25	20	16	29	24	20	1½	4

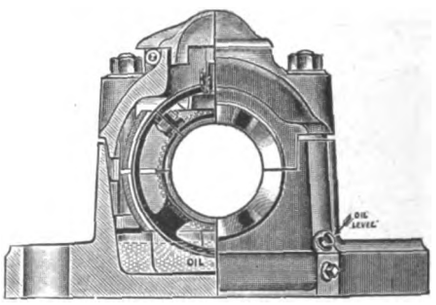

FIG 2.

In one respect the design is not so good as that usually employed on dynamos in that there are no channels to return oil from end of bearings back to the reservoir. But as giving the dimensions which have been adjudged correct by a first-class Yorkshire firm of mill furnishing engineers, the particulars are of special interest. E. K. S.

DUBLIN ELECTRICAL CONTRACTORS' ASSOCIATION.

The annual dinner of the Dublin Electrical Contractors' Association was held in *Jury's Hotel* on the 27th ult. Mr. C. Cummins presided. After dinner, the Chairman proposed the toast of "The Institute of Electrical Engineers," and said the Institute had done much for the good of the profession, and was entitled to the support of the members of the profession.

Mr. M. Ruddle, who responded on behalf of the Institute, said it had achieved a remarkable success, but there was a danger that it would content itself with its present comfortable position, and not do as much for the profession as it might. He hoped they would soon have an Irish Institute of Electrical Engineers, and civil and mechanical engineers, as it was not always satisfactory for them to be a branch of an English institution.

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INSTITUTION OF ELECTRICAL ENGINEERS (STUDENTS' SECTION BANQUET).

The presence of the President and two Past Presidents of the Institution of Electrical Engineers gave an added interest to the proceedings at the sixth annual dinner of the Students' Section, held at the Trocadero Restaurant, Piccadilly Circus, London, W. In the chair was Mr. R. C. Plowman (Chairman, Students' Section), supporting whom were Dr. Gisbert Kapp, M.Inst.C.E. (President of the Institution of Electrical Engineers), Professor Sylvanus Thompson, D.Sc., F.R.S. (Past President, I.E.E.), Mr. W. M. Mordey (Past President, I.E.E.), Mr. R. Hammond, M.Inst. C.E., M.I.E.E., Mr. H. W. Gregory (Vice-Chairman, Students' Section), etc. After the tables had been cleared, the company settled down to harmony and conviviality, the programme being interspersed with several appropriate toasts.

Proposing "The President and the Institution," Mr. Gregory recognized the indebtedness of the Students Section to the Institution for its assistance. Referring to the work of the Section, he said that the Students' Committee thought it would be advantageous if abstracts' of the papers were printed. Under existing conditions, out of 30 papers read only the four premium papers were printed.

Dr. Kapp, in responding, voiced the pleasure it afforded him to meet the members of the Students' Section. Classifying electrical engineering students, he remarked that he liked best the student who picked holes in his lectures and took nothing for granted. The student should go in for his work at the university and at college, as he would have to go into it in after life, with the searchlight of previous experience and science thrown on any question, taking nothing for granted, investigating and experimenting intelligently, and when sure of his facts applying them to practical life. That was the type of student who got on eventually. He thought it was quite right that the student should take an interest generally in literature, languages, and even in sports. His students, he found, were, to a certain extent, handicapped by their want of knowing another language. When he said knowing, he meant really knowing: not the French they learnt at school, which they often forgot or pronounced in an abominable manner afterwards, but knowing it sufficiently to read scientific books and literature. In Germany the student did not get his degree unless he passed an examination in English and French, both orally and in writing; and, to his mind, that was an excellent arrangement. In Birmingham a scheme was going to be introduced whereby the degree would only be given to engineering students who passed an examination in two languages, apart from their own. He impressed upon his hearers the desirability of learning one or, preferably, two languages. He recommended German as one, and as the other he was inclined to think that Spanish would be most useful, because the expansion of English trade would be mostly in South America, where Spanish was chiefly spoken. His experience was that the English young engineer, although he might not be quite so highly primed as the German in what might be called the high mathematical science, had the advantage of having been taught from his school days to think independently. The English young engineer was more versatile and knew best how the generality of jobs were to be done. The great advantage of English education from the elementary school upwards was that it gave boys an opportunity of thinking independently, and that would make a good engineer. Engineering was not simply applying forms out of a text book, like a cook applies recipes out of a cookery book, but it was thinking and applying science in a new way. The Englishman was, on the whole, a more all-round useful man. At the present time there was a difficulty of finding jobs for the men who had left college, and that difficulty would always be. The profession was over-run, but he thought the difficulty was lessening. There were indications of times becoming better: the general outlook seemed to be brightening. One of the technical papers estimated that in 1910 no less than 50 millions would be spent on electrical undertakings. That seemed to be an exaggeration, but putting the amount at only a quarter of the sum mentioned, it still meant a great deal of employment. Concluding, Dr. Kapp drew particular attention to a problem which requires young and vigorous minds to solve—the problem of efficient earthing. If they looked through various wiring rules and safety regulations for mines, it would be found specified that "so and so must be efficiently earthed." It was very easy to say this, but a mighty difficult thing to do. In fact, the problem of efficient earthing was one of the most difficult in electrical engineering. Now the Italian Minister of Agriculture, Industry and Commerce, instigated to it by a lamentable accident last August, offered a prize of £400 to the man who would show him how to earth efficiently. The competition was open to the end of 1911, and he advised young engineers to try and solve the problem.

Mr. W. M. Mordey also responded in a witty and humorous speech. All would agree, he thought, that the Council were wise in adopting a policy of making the subscription of students as low as possible, lower, indeed, than the expenses of the Section would demand if it were looked at merely from a business point of view. They expected that the students would grow up to be useful members of the Institution and of this great industry, and he was sure they would pay it very well indeed then.

Introducing the toast of "The Students' Section," Professor Thompson said he hoped they all understood what great ambitions the Institution cherished for them. In the years to come they would have to take the places of the older men as they dropped out. Looking ahead, he said great success would come not to everybody, but to a few: some would get rich and retire early and some would become famous; but the Institution of Electrical Engineers would profit by them all. The Institution would become a more important body from year to year: it would be consulted more and more by the Board of Trade, the Local Government Board and the County Council in regulations for earthing and other safety rules. Indeed, there would never be any electrical legislation on which their opinion would not be valued. The Institution had a great part to play.

In responding, Mr. R. C. Plowman emphasised the advantages of joining the Students' Section, and mentioned that a number of men who had blossomed out very considerably owed a great deal to their first papers at the Students' Section. He hoped the Council would concede the request for printed abstracts of paper at the Students' meetings.

Mr. F. E. Burnett (of Faraday House) gave the toast of "The College," and Mr. R. Hammond, in replying, spoke in favour of a movement to get a Royal Charter for the Institution of Electrical Engineers. Mr. Hammond concurred in the remarks by Dr. Kapp on the value of a knowledge of foreign languages, and spoke of how Spanish had been helpful in his own case. He advised young engineers to learn Spanish in preference to Italian.

Other toasts included that of "The Health of the Honorary Secretary," the services of Mr. G. H. Stevens being referred to in eulogistic terms by the Chairman.

The musical programme arranged by Mr. H. Nadand was of a delightful character, one of the most entertaining features being a humorous sketch by Mr. Selwyn Driver.

TRADE NOTES.

Mr. C. S. Northcote, M.I.E.E., desires it to be known that he is in no way connected with the firm of electrical engineers, Messrs. Northcote, Heaver & Co.

The Key Engineering Co., Ltd., have transferred their Manchester offices to their works at Elevator-road, Trafford Park.

Mr. Charles Pullan, electrical engineer, has given up his contracting department, to devote himself to consulting work and the supply of electrical materials, his address being at 51, King's-arcade, Bradford. His old contracting business has been taken over by Mr. George Newby, who will carry it on at 51, Tyrrel-street, Bradford.

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LORD KELVIN AND TELEGRAPHY*

By PROFESSOR J. A. EWING, C.B., F.R.S., Member, Director of Naval Education.

At the end of my first Session at the University of Edinburgh, I was invited by Fleeming Jenkin, who, besides being Professor of Engineering at Edinburgh, was Sir William Thomson's partner in consulting work relating to submarine telegraphs, to become one of the firm's assistants. Such a chance was not to be missed. In this way began a personal connection with Kelvin which lasted, on that basis, for several years, and continued on the wider basis of discipleship and friendship to the time of his death.

Lord Kelvin's work was great and many-sided. We might compare it to the cathedral in some crowded mediæval city where no place can be found commanding a general view. You approach by one narrow street or another, seeing from each only some portion of a particular face of the building. The Kelvin Lecturer has, as it were, to select his view-point, conscious that he must concentrate his attention on what is after all but a small part of a gigantic whole. The lecturer might, for instance, take up the mathematical work of Kelvin in the theory of electrostatics, in the theory of magnetism, in the theory of elasticity, in hydrodynamics, in the wave theory of light, his contribution to thermodynamics which included the establishment of an absolute scale of temperature and the enunciation of the principle of the dissipation of energy, his experimental work on the electrodynamic quality of metals, his speculations on the structure of matter, his views on the age of the earth, his share in fixing the electrical units, or, on the more practical side, his electrical measuring instruments, from the electrometers of the early days to the ampere balances and wattmeters which he designed when the need for such instruments became apparent with the growth of electrical engineering. Any one of these subjects, or others that might be named, would provide a more than ample text. To-night I have selected two portions of Lord Kelvin's work as the most suitable to bring before you, namely, his work in submarine telegraphy and in navigation. Both of these are practical matters which appeal to members of this institution. They illustrate well the bent of his genius as an engineer. In both of them he made inventions of first-rate importance—inventions which not only met an immediate requirement, but have stood the test of time. And an additional reason for the selection is the personal one that both in telegraphy and navigation it was my good fortune as one of his young assistants to see some of his inventions in the making.

His connection with telegraphy had begun long before, when he was only 30 years of age. It dates from 1854, and to appreciate rightly the part he began to play then I must ask you to go back as far as 1850, the year of the earliest submarine telegraph. It was in August, 1850, that a line consisting of a single copper wire, insulated by guttapercha, wound on a great reel on the deck of a steam tug in Dover Harbour, was laid from Dover to Calais. There was no sheathing or protection of any sort; the line was what we should now call a bare core, and so light was it that lead sinkers were attached at every hundred yards to ensure its going to the bottom. In a few hours it was cut by the anchor of a fisherman, who took home a piece to show to his family as a curious new kind of seaweed, but during its brief life it gave the operators much food for thought. Accustomed only to the clear, sharp signals of land lines, they could make nothing of those got from the cable, and Mr. Willoughby Smith tells us how at each end of the line it was regretfully concluded that the operator at the other end must have been lunching not wisely but too well. This was the earliest experience of the effects of electrostatic induction in retarding the signals and altering their character. The cable is equivalent to an extended Leyden jar of large capacity, and at every application of the sending battery there is a gradual charging up, so that the signal current which arrives at the distant end does not at once reach its full strength. And, further, when the contact with sending battery stops the current does not at once cease, but tails off slowly as the cable discharges the electricity it has accumulated. The current accordingly arrives in the character of a wave, slowly rising to a maximum value and then slowly subsiding, each time a signal is sent.

In a short cable this causes little trouble; it only makes the process of signalling a little slower, but the instruments which serve on land lines may still be used. A successful Dover-Calais cable properly covered with a protecting sheath was laid in 1851 and was soon followed by other short lines. The general character of the electrostatic charge in a cable was explained by Faraday, and it was experimented on by Latimer Clark in a cable, 110 miles long, laid to connect England with Holland: But no one knew then in what manner the retardation of signals to which it gives rise depended on the electrical characteristics nor how it would be affected in cables of different lengths or with different dimensions of core. It was in 1854 that Thomson's attention was drawn to the subject by Stokes, following on a conversation at the British Association, and in this way began the connection with submarine telegraphy which was to prove of momentous import.

You must think of Thomson then as a young man of thirty—already for eight years a Professor at Glasgow—unknown to the general public, but with a European reputation among scientific men for his far-reaching investigations in the mathematical theory of electricity and in thermodynamics. Helmholtz, whom he met for the first time a few months later, thus records the impression he produced: "I expected to find the man who is one of the first mathematical physicists of Europe somewhat older than myself, and was not a little astonished when a very juvenile and exceedingly fair youth, who looked quite girlish, came forward. . . . He far exceeds all the great men of science with whom I have made personal acquaintance, in intelligence and lucidity and mobility of thought, so that I felt quite wooden beside him sometimes."

Thomson attacked the problem with characteristic ardour, and in less than 12 days he sent a complete solution to Stokes, which was published in fuller form in the proceedings of the Royal Society for May, 1855. In this paper he points out that the effect of electrostatic induction is to make the flow of electricity in a cable correspond to the flow of heat in a solid conductor as investigated mathematically by Fourier. He formulates the equations and draws what is called the *curve of arrival*, the curve, namely, which shows in what manner the current gradually reaches its full value, at the distant end of the cable, when contact with the battery is made at the sending end. He also shows how the current falls away when the battery is removed and the cable is put to earth. In the diagram the full line is the curve of arrival. For a certain interval a after the battery is connected practically no effect is felt, but soon after that the current becomes of sensible magnitude. It continues to rise; and after a time nearly equal to $5a$ it has attained half its final value; after a time $10a$ it has come within 10% of the final value, and its rise has then become very slow. To reach completely the full value an infinitely long time would be required. The dotted line shows how the current at the distant end decreases when the sending end is removed from the battery and put to earth. In this case the contact has lasted for the interval $3a$. When it ceases the current at first continues to increase, soon passes a maximum, and then gradually tails away, requiring an infinitely long time altogether to disappear.

Thomson showed that the quantity a varies directly as the product of the capacity of the cable and its resistance. Since both the capacity and the resistance increase directly with the length, if we compare two cables with the same core but of different lengths, a will depend on the square of the length. Hence also the time taken by the current to reach any particular fraction of the full value will vary as the square of the length.

This result of the theory was of fundamental importance. It was also, at the time, of particular interest, for the project was then beginning to be mooted of connecting England and America by wire. The only experience available as to speed of signalling was on short cables, and in passing from them to a line 2,000 miles long the "law of squares," as it was called, seemed at first to give little prospect that signalling across the Atlantic could be accomplished at a speed that would be commercially practicable. The "law of squares" was challenged by Mr. Whitehouse, who was interested in the Atlantic project. He failed to grasp Thomson's reasoning and its results, and misinterpreted

* Abstract of the second Kelvin Lecture delivered before the Institution of Electrical Engineers.

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some experiments of his own in a sense opposed to Thomson's theory. Thomson replied in two letters to the *Athenæum* (October and November, 1856), pointing out that Whitehouse's experiments, so far as they went, only tended to confirm his own conclusions, and emphasising the fact that a remedy for inconvenient slowness of action was to be found partly by increasing the diameter of the conductor, thereby reducing the resistance, and partly by increasing the diameter of the gutta-percha coat, thereby reducing the capacity. It appears to have been these controversial letters which led to his taking a share in the earliest attempt to lay an Atlantic cable, the attempt of 1857.

Two practical points at once engaged his attention. One was the question of copper resistance. "In measuring the resistance of wires manufactured for submarine telegraphs," he writes in June, 1857, "I was surprised to find differences between different specimens so great as most materially to affect their value in the electrical operations for which they are designed?" He looked at first for an explanation of these differences in the stranding of the wires or in the effect of covering with gutta-percha, but after various experiments (his laboratory was then a disused wine-cellar in the old Glasgow college) he was forced to the conclusion that the differences lay in the nature of the copper itself: that you might find specimens with twice or even more than twice the resistance of the best. Having discovered in this way the distinction between high conductivity copper and copper of other sorts he insisted on the use of copper of the highest conductivity and on the importance of systematic testing, though this came too late to affect the manufacture of the cable which was being prepared for the abortive attempt of 1857.

The other point which he took up was the invention of a method of signalling adapted to the character of the "curve of arrival." But before speaking of that, let me say a word as to his position among the Atlantic cable pioneers.

The Atlantic Telegraph Co. had been formed in October, 1856, and in December Thomson joined the Board as one of the Directors, elected to represent the interests of Scottish shareholders. Charles Bright was engineer-in-chief, and Whitehouse, who had misunderstood and disputed Thomson's electrical results, was electrician. Thomson had no technical position beyond being a director. Writing to Helmholtz in December, 1856, he says: "The Atlantic Telegraph is now in the process of manufacture. Two thousand five hundred miles of cable are to be finished and ready to go to sea by the end of May, and if no accident happens electric messages will be passing between Ireland and Newfoundland before July. I have been appointed one of the directors, and what I feel most anxious about now is the laying of the cable. The plans must be better arranged than they have been in all such operations hitherto, in which there have been almost as many failures as successes. However, the circumstances are in some respects more favourable than they have been in former cases. We have a soft level bottom (consisting of fine sand and microscopic shells) the whole way across, nowhere more than 3⅓ miles deep, which will be much better than the Alpine precipices and valleys below the waters of the Mediterranean. The cable is much lighter than any hitherto laid, weighing only 18 cwt. per mile, or in water only 10 cwt. The practical men engaged have all the experience of previous failures, and it is to be hoped have learnt some of the causes and will know how to avoid them. Altogether I think there is a good chance of success."

That hope was not destined to be immediately fulfilled. To lay the cable it was coiled on board two ships of war, the British battleship *Agamemnon* and the United States frigate *Niagara*. On August 5, 1857, the shore end was landed at Valencia and the *Niagara* began to pay out, the intention being that her section should be laid first and the *Agamemnon* should continue the work after making a splice in mid-ocean. But the paying out gear was very crude: the brake for maintaining a proper tension in the cable was difficult to regulate, and after 300 miles were laid there was a mishap at the brake and the cable parted in 2,000 fathoms. The ships returned to Devonport: the cable was stored for the winter, new machinery was designed, and some 700 miles of fresh cable were manufactured against the next attempt, to be made in the following year.

Thomson had joined the expedition at the request of his brother directors and was on board the *Agamemnon*. He came back full of ideas as to both the electrical and the mechanical sides of the great problem.

On the mechanical side he had worked out, for the first time, the theory of the forces concerned in the laying and lifting of deep-sea cables; this was published almost immediately after his return. Let me give you a brief sketch of the results of this theory.

A cable paid out from a ship going at uniform speed does not hang as a catenary, but takes the form, as it sinks, of a straight line stretching at a uniform slope from the ship's wake to the point far in the rear at which it touches the bottom. This is because each part of the cable in sinking through the water attains almost immediately a constant velocity of descent against the resistance which the water opposes to its motion. Imagine a ball, heavier than water, to be dropped from a ship. It will after sinking a foot or two attain a practically uniform velocity and keep that until it reaches the bottom. Imagine now a ship to drop a series of such balls, at regular intervals, while she streams ahead at a steady speed. At any instant the depth through each ball has sunk will be proportional to the time which has passed since it was dropped, and therefore to the distance run by the ship, and hence a line joining the successive balls will be a line of uniform slope. The continuous cable behaves in this respect like the row of balls, but with this important difference. Each ball sinks vertically, it has no tendency to do anything else. But the cable tends not only to sink, but to glide along the direction of its own length, just as a rope resting on an inclined plane tends to glide down it. A certain amount of such gliding is desirable, indeed necessary, for it secures the cables being laid with a sufficient percentage of slack to accommodate itself to any inequalities on the bottom, and to provide for the possibility of its being raised, should that be required. It is the function of the paying-out brake to apply just so much retarding force as will allow the right amount of this gliding to take place, and not too much. Taking any point P in the cable, the actual motion in settling to the bottom may be regarded as made up of two components, one a component transverse to the direction in which the cable lies (P M) and the other the longitudinal or gliding component P N along that direction. The result is to give a resultant motion which brings the point P along the line P R to the bottom at R. If there were no slack, the movement would be along P Q, where O Q = O P, but even in that case there would be a small amount of longitudinal motion, since P Q lies to the right of the normal component P M. As cables are actually laid there may be 10 or 12% of slack, and this means a considerable velocity of gliding motion. In a cable of the type which was afterwards successfully laid across the Atlantic the straight line had a slope of about 1 in 8½—in other words, with a depth of 2 miles there were 17 miles from the ship to the place where it touched bottom. On the gliding motion down this long slope the frictional resistance of the water is an important factor: it reduces very much the retarding force needed at the brake. If it were simply a question of holding the cable from gliding down the slope at all, the retarding force would be equal to the weight, in water, of a length of cable equal to the depth. In fact, however, it is about half that, the other half being accounted for by the frictional resistance the cable experiences in gliding down the slope.

In the early summer of 1858 the cable squadron was again ready to put to sea. New paying-out brakes had been devised. Thomson had succeeded, with much difficulty, in getting systematic tests of the conductivity established during the manufacture of the additional 700 miles. And, most important of all, he had invented a new signalling and testing instrument which was to make Atlantic telegraphy commercially practicable. This was the mirror galvanometer, the first description of which is found in his patent of 1858. Mr. Whitehouse, still officially the electrician of the company, had provided an elaborate paraphernalia of relays and induction coils which experience was to prove useless. Just before the ship sailed there was handed to Thomson on board the *Agamemnon* a precious package brought hot-foot from Glasgow by his assistant. This was the earliest marine mirror galvanometer—one of a pair completed only just in time. The other went to the *Niagara*.

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It is now preserved in the museum of the Glasgow University laboratory, and here we have a photograph. This is the actual instrument by which a message was first received across the Atlantic.

In its simple form the mirror galvanometer consists of a tiny circular glass mirror no bigger than a threepenny piece, to the back of which are cemented two or three pieces of steel watch-spring flattened and hardened and permanently magnetised. This is hung by a silk fibre in a horizontal tube a little bigger than the mirror itself; the suspending fibre, which is quite short, passes out at a hole in the upper side of the tube and is secured there by a drop of wax or cement. Mirror and magnets together weigh less than a grain. The tube, with the mirror on it, is pushed into the centre of a coil through which the current passes. Outside there is an adjustable magnet, or pair of magnets, to give a suitable controlling field. A beam of light from a lamp falls on the mirror and is reflected on a scale. Thus we have, as it were, a very long pointer to exhibit the deflection entirely destitute of inertia. The next slide, showing a simple form of mirror galvanometer, is copied from the patent of 1858. The marine form, which is also described in that patent, differs in the method of suspending the mirror. The suspender is a long thread held tight at top and bottom, to the middle of which the mirror is attached. This makes it independent of gravity, so that it is not disturbed by the motion of the ship. The instrument is sensitive in responding to the slightest current or fluctuation of current: there is no friction to be overcome, and almost no inertia in the moving parts.

These are the characteristics which Thomson aimed at in this remarkable invention, for he saw that they were required as a direct result of his theory.

Go back to the "curve of arrival," and you will notice that to make rapid signalling practicable, we must be content to deal with only the earliest stages in that curve. Even in a modern Atlantic cable the time unit a is about the fifth of a second: in the original cable of 1858 it was much longer. If the transmission of a signal required a time equivalent to many times a the number of words got through per hour would be impracticably small. Hence also the impulses constituting successive signals must follow so quickly on one another's heels, that the cable has no chance to get rid of the effects of one before the next is upon it, and the next. To exhibit these as signals it was clearly impossible to use an instrument like on electromagnetic relay of even the most sensitive type: you must have an indicator which will follow every fluctuation in strict proportion, not requiring to come back to zero between the impulses, frictionless, and not introducing any distortion by virtue of the inertia of its own moving parts. This Thomson achieved by his invention.

We have no time to linger over the story of the cable of 1858. This time the two ships, after encountering a storm of great severity in which the coiled cable suffered severe damage, met in mid ocean, spliced the cable, and began to pay out simultaneously, the *Agamemnon* steaming towards Ireland the and *Niagara* towards Newfoundland. The cable broke when only 6 miles were paid out. Again the ships met, to make a fresh splice, and again the cable failed when some 80 miles had run out. A third attempt promised better, for some 200 miles were laid, when again the cable broke, this time at a place where it had been injured in the storm. The ships returned to Queenstown: Bright, Thomson, and the other leaders, disappointed but not discouraged, advised the Board to order a fresh attempt. Their advice was taken. The ships once more met at the mid-ocean rendezvous, and this time success crowned their efforts. On August 5, both ships completed their task, and the ends of the cable were brought to land.

Scarcely had the enthusiasm awakened by this great event begun to subside when it was apparent that all was not well. The Irish end of the cable had been handed over to Mr. Whitehouse, who attempted with little or no success to establish communication by means of his own signalling instruments. It was only when the galvanometer of Thomson was resorted to with a simple Daniell battery to send the current that messages were transmitted. The Board, dissatisfied with Whitehouse's action, directed Thomson to take complete charge. Various important messages passed, but the tests showed that the insulation of the cable had broken down, a bad fault developed, which had doubtless been intensified if not produced by the high-tension induction coils used by Whitehouse. The signals grew more and more feeble, and in a few weeks the cable altogether ceased to speak.

It never spoke again, and not till 1865 was the attempt made to lay a new Atlantic cable. By that time much had been accomplished. It was in the intervening years that the work of establishing standards for electrical measurement was undertaken by a committee of the British Association. The committee was appointed at the instance of Thomson, and he took a prominent part in its work. Besides this, the cable engineers were busy and were gaining experience from lines laid in other places. Methods of systematic testing were devised: a type of cable was designed which was better adapted than before to bear the strain of laying, and especially the much severer strain of picking up, and material improvements were made in the paying-out machinery. Thomson encouraged a fresh attempt. "What has been done," he said, "will be done again. The loss of a position gained is an event unknown in the history of man's struggle with the forces of inanimate Nature." On the financial side it required some faith and courage to engage in the enterprise at a time when it was said that out of 9,000 miles of cables already laid, only 3,000 were in working order. We cannot wonder that there was some delay.

In 1865 the *Great Eastern* was available for laying the cable. Thomson, along with Cromwell Varley, went as a consulting expert on behalf of the company. Twelve hundred miles were successfully laid, and then a fault showed itself: picking up was begun, but in manœuvring the ship the cable parted in deep water. Attempts were made to recover it by grappling; three times it was hooked and brought part of the way to the surface, but the shackles used to couple up successive lengths of the grappling rope were too weak to stand the strain. Grapnel, rope, and cable were lost, and the ship returned with the task unfinished, but with every one now full of confidence nor only that a sound cable could be laid, but that the lost cable would be found and lifted.

In 1866 the thing was done; an entirely new cable was laid with complete success, and then the *Great Eastern* with her consorts proceeded to the lost end of the cable of 1865, and began once more to fish in water over 2,000 fathoms deep. A fortnight passed before the watchers at Valencia saw any sign; then the spot of light began to flicker, and presently the flickerings shaped themselves into letters and sounds. The cable had awakened to life. A few days more and it too was complete.

Throughout the operations Thomson was on the ship; Varley remained at Valencia. Thanks to their labours, and to those of Mr. Willoughby Smith, the contractors' electrician, the appliances for testing on board ship had been brought to a degree of perfection that left nothing to be desired. By this time it was generally recognised that the credit for Atlantic telegraphy, regarded as an electrical achievement, belonged to Thomson, though in his characteristic manner he would, when speaking of the subject, dwell on the parts played by others. Along with Mr. Canning, the engineer of the expedition, and Captain Anderson, who commanded the *Great Eastern*, he received the honour of knighthood.

For a time his mirror galvanometer remained the only instrument by which conversation could be carried on. He now proceeded to design a substitute for it, which should give a record of the successive electric impulses instead of merely exhibiting them to the watchful eye of a skilled clerk. To secure greater power in the movement of the indicator he inverted the function of magnet and coil, making the coil the movable piece and the magnet the fixed piece. The coil was, therefore, made very light: the magnet, which being stationary might now be very heavy, was made exceedingly strong and was arranged so that the coil lay in an intense field between its poles. The movement of the coil actuated a very light pointer or rather pen in the form of a siphon-shaped tube of fine drawn glass, from which ink was deposited on a running paper band. Here we find the earliest example of the moving coil type of galvanometer, often called the D'Arsonval type by those who do not recognise its real origin. It is a type now familiar in

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many practical instruments for the measurement of direct current amperes and volts. But an important element in the invention is still to be named. It was essential that the glass pen should write without friction, and Thomson effected this by the happy device of electrifying the ink so that the ink and the paper attracted one another, with the result that the siphon was maintained in a constant state of rapid vibration, alternately advancing to the paper to deposit a minute drop of ink and then springing back, but all the time free to follow without friction the movements of the coil in obedience to the electric impulses arriving through the cable. Dynamically the siphon recorder has to satisfy the same conditions as those that determined the design of the mirror galvanometer. It draws on the moving strip of paper a curve of arrival for every one of the successive currents of which the signals are composed.

Here we have a view of the recorder substantially in the form in which it first came into use in 1870 and also a later form, and here is a specimen of recorder strip showing a succession of alphabets. To this day the recorder remains in universal use as the standard instrument in submarine telegraphy. It has been simplified by the substitution of permanent field magnets for electromagnets, and by the use of an electromagnetic vibrator for the siphon instead of electrification—changes which were made in later years by Thomson himself.

Thomson was now beginning to reap some reward for his inventions. He had formed, in 1865, a partnership for telegraphic patents with Cromwell Varley and Fleeming Jenkin. Varley's chief contribution was the highly important device of signalling through condensers, and Jenkin was associated with Thomson in the invention of what is known as "curb sending." This is a method of sharpening the signals through a cable by following up each signal-current with a reversed current of somewhat shorter duration, instead of putting the cable to earth, the effect being to get as it were a quicker emptying of the cable in preparation for the next charge. Much ingenuity was spent in perfecting apparatus for carrying out this principle, but it did not come into very extensive use, and substantially the same result is now arrived at by other means.

Besides this triple partnership in patents there was a separate partnership between Thomson and Jenkin which lasted until Jenkin's death. Among the cables for which they acted were the Western and Brazilian line, the first section of which was laid in 1873 by the steamship *Hooper*, a ship specially built for cable-laying with what was for those days a phenomenally large capacity. I recall a voyage of the *Hooper* when in mid-ocean she dropped one of the two blades of her single screw: she completed the round trip to Rio Janeiro and back, including the laying of the cable, on a single blade; and it puzzled us youngsters to understand how the run, the day after the blade was dropped, was better than any run made before! Sir William Thomson went out in the *Hooper* on her first trip, and at Madeira, where there was some delay through the cable having to be turned over in the tanks to cut out a fault, he met the lady who afterwards became his wife. In teaching her the Morse alphabet the acquaintance ripened fast. Thomson was at that time an ardent advocate of the use of Morse by occulting lamps and other devices as a means of communicating intelligence at sea. In one of his letters home he says: "We had some admirable lamp signalling several evenings between the *Hooper* and Mr. Blandy's house about 1½ miles distant. The Miss Bladys learnt Morse very well and quickly, and both sent and read long telegrams the first evening they tried it, to the admiration of France and other old telegraphers on board." Those of you who have known Lady Kelvin do not need to be told how happy a chance this meeting proved to be, nor how much he owed, throughout all the remainder of his life, to her understanding sympathy and unceasing solicitude.

Those were days when the testing-room of the cable factory was a better school in which to learn electricity than any laboratory. Practice, which owes so much to science, was just then giving back, in that department of knowledge, as much as she received, or more. The electricity of the workshop had outstripped the electricity of the schools: it had become more scientific than the electricity of the lecture-room and of the text-book. Members of this Institution have no need to be ashamed of the heritage that has come to them from the earlier Association from which this one sprang—the Society of Telegraph Engineers. To the telegraph engineer of the sixties and seventies is due most of the exact measurement and much of the exact thinking which supplies the foundation of the electrical engineering of to-day.

DESIGN OF SURFACE CONDENSERS.*

By MR. R. M. NEILSON.

Since surface condensers for steam engines were first introduced about a century ago, it has been customary to design them to allow a certain cooling surface per horse power or per pound of steam to be condensed. In fixing this figure the temperature and nature of the circulating water, the vacuum required, and some other conditions are generally—although not always—taken into account, and a guess is made as to the consequent increase or decrease to be made to the cooling surface.

There is certainly much excuse for this unscientific working; but it stands to reason that, if important factors which influence the extent of the requisite cooling surface are ignored or their effect merely guessed at, condensers must in many cases be either much too large or much too small for their duty. The difficulty, as far as the manufacturers are concerned, is met to a certain extent by the latter not guaranteeing a vacuum, a practice which, however, is not satisfactory to the purchaser.

In turbine power stations it is usual to allow from 3 to 4½ sq. ft. of condenser cooling surface per kilowatt of rated capacity of the turbines, so that the condensation rate is from 3 to 6 lbs. per sq. foot at the full rated load of the turbines. The turbines are, however, usually expected to carry a considerable overload.

The condensation rates which can be obtained under suitable conditions are greatly in excess of these figures.

The condensation rate depends on:—

1. Inlet temperature of circulating water.
2. Velocity of circulating water.
3. Diameter of tubes.
4. Length of tubes.
5. Number of passes made by water through the condenser.
6. Cleanness of tubes.
7. Vacuum.
8. Temperature and wetness of steam when entering the condenser.
9. Amount of air entering the condenser with the steam.
10. General design of condenser as regards flow of steam.
11. Capacity of the air pump.

We suffer greatly from lack of knowledge of the influence of the above factors on the condensation rate. Much research work has been carried out on condensers with considerable useful results, but, either from want of appreciation of the nature of the problem or from the difficulty of the task, this research work appears to have provided very little data which are of use in scientifically proportioning the cooling surfaces to meet the requirements of the case.

The author has made out a scheme for the design of condensers which, he believes, allows for all the varying conditions usual in practice which are worth taking into account. In view of the want of experimental knowledge, he has had to make assumptions which further knowledge may show to be more or less inaccurate; but the scheme will, he hopes, illustrate what could be done after further experimental data have been obtained.

The scheme is as follows:—

Let S = aggregate cooling surface in sq. ft.
" N = number of tube elements.†
" L = length of tube elements in feet.†
" P = number of water passes.
" D = external diameter of tubes in inches.
" t = thickness of tubes in inches.
" d = internal diameter of tubes in inches.
" l = length of tubes in feet.

* Abstract of paper read before the Institution of Engineers and Shipbuilders of Scotland.

† By a tube element is meant the one, two, three or more tubes which the water passes through in series. If a condenser has 4,000 tubes 12 ft. long, and the water makes two passes through the tubes, there will be 2,000 tube elements each of a length of 24 ft.

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Let v = velocity of water through tubes in feet per second.

„ Q = aggregate weight of water passed through tubes per hour in lbs.

„ W = aggregate weight of steam condensed per hour.

„ t_e = temperature corresponding to vacuum for pure steam. Fah. scale.

„ t_i = inlet temperature of circulating water. Fah. scale.

„ t_o = outlet temperature of circulating water. Fah. scale.

„ θ_m = mean difference in temperature between steam and water in degrees Fah.

„ p = absolute pressure in condenser in lbs. per sq. in.

„ k = British thermal units transmitted through metal of condenser tubes per sq. foot per hour per degree Fah. mean difference in temperature between steam and water.

„ K = lbs. of steam condensed per sq. foot of cooling surface per hour per degree of mean difference in temperature Fah. between steam and water.

A is a factor depending on the air richness of the steam entering the condenser.

Y is a factor depending on the cleanness of the tubes.

Z is a factor depending on the general design of the condenser.

Before designing any condenser, W, p and t, must be known. These particulars are usually supplied to the designer; if they are not, they must be assumed. He must also be given or must assume particulars, which will allow him to give values to A and Y. According to the present scheme the designer will then set about the design of the condenser as follows :—

Firstly, he will fix upon the general nature of the design; this will determine the value of Z. Then he will fix upon D and t.*

Thereafter, from past experience or from a brief preliminary investigation, he will decide upon a suitable value for t_o. Any value may be fixed upon for t_o greater than t_i and less than t_e. The nearer t_o is to t_i, that is, the less the rise in the temperature of the circulating water, the greater must be the quantity of water passed through the condenser per hour or per minute in order to condense the given amount of steam. On the other hand, the nearer t_o is to t_e, the less is θ_m, and hence the greater must be the cooling surface for any given value of K. When water is cheap and pumping power small, t_o should be given a lower value than when water is dear or the pumping power high. When cooling towers are employed, it is desirable to keep down the value of Q, firstly, to reduce the expenditure of power in pumping the water up the tower, and, secondly to lessen the cost of the tower, the latter expense being more affected by the quantity, than by the temperature, of the water. A relatively high value of t_o should, therefore, be chosen in such cases.

Having fixed on t_o, the designer will calculate Q and θ_m. Q can be obtained from the equation

$$Q = \frac{1{,}000W}{t_o - t_i} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

This equation is only approximately correct; it is sufficiently good for condenser work, and is convenient to use. It assumes that 1,000 B.Th.U's. are put into the circulating water for every lb. of steam that is condensed.

In the calculation of θ_m it should be noted that the mean temperature of the circulating water is not necessarily—although it often is approximately—the arithmetic mean of t_o and t_i. The mean temperature of the steam is a certain amount below the inlet temperature according to the quantity of air in the steam, the capacity of the air pump and other conditions. Equations for θ_m involving the use of hyperbolic logarithms are not to be recommended for condenser work. The usual hyperbolic equation is based on the assumption that the fluid on each side of the tubes is homogeneous, which is far from being true in the case of the air-steam mixture in a condenser. A simpler formula, such as

$$\theta_m = t_e - \frac{t_o + t_i}{2} - C \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

in which C is varied slightly to suit the conditions of the case, is to be recommended.

The designer will now fix on v, which may be given any value. A very small value of v is objectionable as making K low. On the other hand, a very high value involves a very great frictional head. What is the best velocity in one case is not the best in another.

N can then be obtained from the equation

$$\frac{Q}{60 \times 60 \times 62{\cdot}4} = N \times \frac{\pi d^2}{4 \times 144} \times v \quad \ldots\ldots\ldots\ldots\ldots\ldots (3)$$

which simplifies into the form

$$N = 0{\cdot}000816 \frac{Q}{vd^2} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

The designer will now calculate K from an equation of the nature of

$$K = \frac{C_1}{\frac{C_2}{\frac{p}{A} + \frac{1}{Z}} + Y + \frac{C_3 d^{C_4}}{C_5 + v}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$$

This equation takes into account all the factors which influence K, and which are considered of sufficient importance to be allowed for. The values of C_1, C_2, C_3, C_4 and C_5 should be obtained from experimental investigation.

The designer can now calculate S from the equation

$$W = S K \theta_m \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (6)$$

and from S and N he can obviously get L from the equation

$$S = N \times L \times \frac{\pi D}{12} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (7)$$

which can be expressed in the more convenient form of

$$L = 3{\cdot}82 \frac{S}{N D} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (8)$$

The determination of L allows the designer to fix on a suitable value for P, so as to have a convenient and economical tube length, l.

This completes the design of the condenser except for details.

The author hopes that he has shown by the above example of the employment of his suggested scheme that, after certain constants have been obtained by experimental research, it will be possible to design condensers in a scientific manner which will allow for all important conditions and will involve a minimum of guess work. Even before further experiments have been made, a scheme of this nature would appear to be of some use.

* The question of the best diameter of condenser tubes constitutes too big a subject to be fully discussed here; a few remarks on the subject are, however, made later on. t is determined by practical considerations only.

RIVER PLATE DEVELOPMENT.

The River Plate Electricity Co., Ltd., is evidently in for a big thing. It has succeeded in purchasing a fine waterside site at Port Ensenada, near La Plata, and is about to erect thereon a large electricity generating station. The current generated will be 3-phase at 6,000 volts, and will be transmitted to La Plata by underground cables, where it will be transformed into low tension continuous current for the a centre of the city. But there seems to be a great future for local development at Ensenada for industrial enterprise. There appears to be considerable probability of the Federal Government declaring the port a "free zone," and if so Ensenada would soon become the Hamburg of South America, to the enormous benefit of the company and to electrical engineers generally. The plant to be laid down at present consists of three marine type Badcock and Wilcox boilers (with iron chimneys and induced draught), and two 2,000 kw. turbo sets with surface condensors, for which tenders are being invited. The works are expected to be ready by April of next year.

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PROBLEMS OF THE FUTURE.

Speaking after the banquet of the Student's Section of the Institution of Electrical Engineers, Dr. Gisbert Kapp dwelt, with his usual healthy believe in the vitality of our enterprise, on certain problems that will have to be faced in the future, and which particularly concern the younger members of the profession of electrical engineering. Briefly, and in happily chosen language, he showed that electricity is making good progress, and that most of the difficulties as they crop up find someone ready to show a way to overcome them. Though this is true in a general way, yet there are some questions that have been perplexing electricians for many years past, and that still remain to worry the practitioner. One, and perhaps the greatest of these, is the problem of effective "earthing." Really very little is known on the subject. As Dr. Kapp pointed out, Government regulations and specifications lay down the conditions that such and such an apparatus is to be efficiently earthed, but remain absolutely mute as to how this is to be done. And there is ample reason for this judicial silence, for, so far as we know at present, there are many disturbing causes ill understood that vitiate the best of laid plans. We have seen some minor instances of this in our own collieries, and there is the much more startling instance of the Italian disaster of last March. This last, as the learned Professor reminded his auditors, has induced the Italian Minister of Agriculture, Industry and Commerce to offer a prize of £400, open to all, for a solution of the problem of safe earthing, a competition which remains open until next year, and for which the students were advised to compete. It is a very big question, the solution of which would bring, if not wealth, at least fame to the happy competitor, and certainly immense relief to the industry. At present doubtful earthing stands in the way of progress along railway electrification, transmission of high tension power, and mining equipment. An apt illustration of this latter phase is afforded by the discussion on underground earthing discussed recently by Mr. W. L. Spence (ELECTRICAL

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ENGINEER, Vol. XLV., page 1). He advocated the method of running a special earth wire down the mine shaft and along the workings to each piece of electric plant, an expensive and not always easy method to carry out. Many men, acknowledged authorities and others almost daily brought up against practical applications of theories, have turned their attention to the matter, but that is no reason why the younger generation should not adopt the President's hint and try their hands at what is well worth attempting. It is only applying Dr. Kapp's text: that the electrical engineer student's task is to think for himself, to question every practice, and to strive hard. This necessity for hard work was shown in another direction: the obligation that rests upon those who wish to succeed to acquire familiarity with at least two other languages than their own. In the speaker's opinion German and Spanish were the languages to be chosen. German because it opened up a technical literature rich in original research both on the theoretical and practical sides; and Spanish because our chief market in the future appears to be Spanish speaking America. This is sound enough advice. We would only add that if time can be found for the study of a third language, then Italian should be chosen, for the compatriots of Galvani and Volta are still doing excellent work both in the laboratory and the workshop. Mr. Mordey, on the same occasion, took the opportunity of supporting his successor in the Presidency of the Institute, and generously expressed his faith in the rising generation, for whom the Institution opens its doors in a most hospitable spirit, a hospitality justified even on utilitarian grounds, as the future of the industry rests with the students. Another veteran, Professor Sylvanus Thompson, also dwelt on the brightening future, in which some of those present were destined to win fame, some wealth, but all would profit from the general striving towards progress. There are some who cavil at the stereotyped phrase that electrical engineering is "in its infancy." Exaggerated as the expression is, in view of the giant strides made of late, yet when we come to sum up our definite knowledge, and to count the blank gaps that impede the way of enquirer and practitioner, it must be confessed that the phrase still embodies much truth. We need not despair thereat, provided that the words are regarded as an incentive to further efforts. Indeed, if the words are considered in the spirit in which these acknowledged lights of the profession—Dr. Kapp, Mr. Mordey, and Professor Sylvanus Thompson—spoke, then the fact that in some way electricity may be counted as being in its adolescence or infancy, should be an encouragement, for this very fact, while meaning that difficulties will present themselves, also shows that there are fields in which the daring may go forth and conquer. Probably this will always remain true, and so long as it does there is hope and a future both for the science and the industry of electricity.

THE ELECTRICAL TRADES BENEVOLENT INSTITUTION SECOND FESTIVAL DINNER.—Mr. F. B. O. Hawes, A.M.I.C.E., of the National Electrical Manufacturers' Association, Incorporated, has joined the organising committee.

CORRESPONDENCE.

TO CORRESPONDENTS.

All communications intended for the Editor should be addressed "THE EDITOR, 149, Fleet Street, London, E.C." Anonymous communications will not be noticed. Letters should reach the Editor not later than Tuesday afternoon to be included in that week's issue of the Journal.

The Editor is not responsible for, nor does he necessarily endorse opinions advanced by correspondents.

EQUITABLE CHARGES FOR TRAMWAY SUPPLY.

Sir,—Mr. Pearce's charges, as given by Mr. Yerbury, are, I believe, perfectly fair. They err on the side of modesty, when compared with "fixed charges" which I obtained about a year ago from an analysis of the Manchester figures, extending over several years, made with the sole object of getting at the true "fixed charges."

Taking a load factor of 30%, the 29½ million units referred to in the paper would, neglecting losses in distribution, correspond with a maximum demand of 11,200 kw.: and the "fixed charges" per unit given by Mr. Yerbury then work out at the following annual charges *per kilowatt of maximum demand*:—

Coal, £0·47; oil, etc., £0·013; salaries, etc., £0·755; repairs, £0·702; rates, etc., £0·952; management, etc., £0·394; interest, etc., £4·82; renewals suspense, £1·32: *total*, £9·45 *per kilowatt of M.D. per annum.*

Now, sir, I beg to suggest that the dissatisfied tramway men have the remedy in their own hands. For, if the above are true "fixed charges," in the sense that they represent the additional annual charge to the station for every additional kilowatt of load taken on during the peak (as I believe they do), it follows that if the tramway men make arrangements to entirely remove their load during "peak" hours, the station is left free to take an additional lighting power load to that extent, without increasing their plant or their staff; and, therefore, the station should, in equity, remit the whole or the greater part of the "fixed charge" and charge only for the units consumed, at so much per unit.

Suppose, then, that the Tramway Department were to put down accumulator sub-stations at various parts of the city, in order to carry the above 11,200 kw. for, say, two hours (which would certainly cover that part of the power and lighting peak overlapped by the tramways); the capital cost, including buildings, would not be materially over £11 per kilowatt, of which the batteries would represent some £7 per kilowatt. We then have:—

	per ann. per kw.
Interest at 3½% on £11	£0·38
Sinking Fund at 5% on £11 (including depreciation)	0·55
Perpetual Maintenance on Cells at 12% on £7	0·84
Salaries and Wages, say, ½ of steam	0·37
Maintenance of Boosters and Buildings, say, 5% on £4..	0·20
Total	£2·34

Now—

	per ann.
11,200 kw. at £9·45 (as above) ..	£106,000
11,200 kw. at £2·34	26,200
Saving per annum ..	£79,800

This saving would, of course, only be effected if the "running charge" remained unaltered.

From the figures in Mr. Yerbury's paper I gather that the "running charge" is (1·04 — 0·865 =) 0·17 penny. If this is correct, then the "running charge" will be:—

	per ann.
29,500,000 units at 0·17 penny ..	£20,900

But the battery losses may render it necessary to purchase, say, another 7,000,000 units, costing another £5,000, and we have:—

	per ann.
Gross saving	£79,800
Deduct cost of extra units	5,000
Net saving per annum ..	£74,800

Of course, there are other factors concerned with the capital invested in feeders, etc., of which due account

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would have to be taken in considering the revised "fixed charge" to be levied by the station, and if the tramway load was unduly large in proportion to the station "private" load, the occurrence of "abortive" peaks would have to be discounted for; but the balance in hand in the above is so considerable, as to set off a great many such considerations.

I have, to simplify matters, considered only the units sold, as at the generating station, which is, of course, incorrect, but does not very materially affect the result. The £20,900 charge is common to both schemes, and need not, therefore, be considered.

My analysis of the Manchester costs disclosed the fact that when curves are plotted over several years connecting certain annual costs per kilowatt with increasing kilowatts of maximum demand, these curves tend to become asymptotic; hence Mr. Pearce is quite right in taking these values as "fixed charges," since every added kilowatt means a correspondingly increased annual charge.—Yours faithfully,

A. M. TAYLOR.

RADIO-TELEGRAPHIC MEASUREMENTS.

Sir,—My transference of the discussion to your columns was necessitated by the rule of the I.E.E., that the corrected copy of one's contribution to the discussion should be returned within four days of the date on which it was sent out by the Secretary. As my copy was sent in fully four weeks ago, I assumed that Dr. Fleming's reply must be substantially the same as that published by him in your columns, and that the I.E.E. discussion was therefore closed.

I am pleased to see that Dr. Fleming admits that both my main criticisms are correct in theory. It was naturally quite impossible for me to give exact arithmetical results in either case, owing to the fact that Dr. Fleming had omitted to state the numerical values of the essential factors required for their calculation :—viz., the decrement and the currents during charge and discharge.

It is satisfactory to note, now that he has given the values of these quantities, that the errors in his results are of so comparatively small an order.

Yours etc.,

J. ERSKINE-MURRAY,
D. Sc., M.I.E.E.

Oswaldestre House, 34, Norfolk Street,
London, W.C., February 1, 1910.

CONVERSION OF A.C. TO D.C.

Sir,—I note in your last issue an excellent article on converting A.C. to D.C. by a transformer with swinging plates. Such a device is by no means new, for the Campania de Transia Electria de Cadiz has a very similar device installed at San Fernando Power House for converting a local A.C. supply into D.C. for their tramways. The set is of 120 kw. capacity, and was constructed by the A.E.G. I had an opportunity for inspecting this plant on a recent visit to Spain, and was highly impressed by its working.

The only noteworthy difference in its construction is that between the contacts there are two 70 Farad condensers to help to prevent sparking. Rather an interesting point cropped up in connection with its operation. However efficiently it worked, there was always some slight sparking on the contacts, and the ultra-violet rays emitted, had a deleterious effect upon the insulation, causing occasional breakdowns. In the end, the trouble was obviated by the use of a Selenium glass shield which, as is well known, is completely opaque to such rays, and it was thus possible to observe the action of the contacts and their freedom from harmful sparking.

In conclusion, I wish to congratulate you upon the improvements you have recently effected in your journal.

Yours etc.,

NORMAN B. GOODWIN,
M.Am.I.E.E.

Newlyn, Sydney Road,
West Ealing, W., January 31st, 1910.

EQUITABLE CHARGES FOR TRAMWAY SUPPLY.

DISCUSSION AT MANCHESTER.

Mr. S. L. Pearce: The paper was opportune, as a meeting of a joint committee, consisting of supply engineers, and tramway managers, was shortly to be held to discuss the question of charging for tramway supply. Mr. Yerbury made the mistake of supposing that the costs published for tramway supply were necessarily correct and comparable with the charges by combined stations. Often they were comparing costs from direct current stations near trolley line with alternating current high tension systems, at the busbars, without any losses; they were attempting to compare like with unlike. Rent and rates in connection with tramway supply are in some cases charged to operating costs. The Sheffield figure given, ·668 pence, omits the question of ratings on ducts and cables, and income tax, nor does it include the units lost in transmission (for which alone 6% must be added). Correcting the figure of ·668 for these items brings it up to ·81d. The figure for the central area of Manchester (which is strictly comparable with Sheffield) is ·88d. Sheffield has 13½ million units to Manchester's 8 millions in the central area, and has also a load factor some 10% better, so that these two figures agreed well when taken on a common basis. He had satisfied Mr. McElroy, the tramways general manager at Manchester, that their charge to the tramways department for power was perfectly fair. The figures had also been confirmed by Sir Alexander Kennedy. Why had not Mr. Yerbury mentioned Glasgow's figures? They were worse than Manchester's, and the Glasgow system was the only one that can be compared to that at Manchester, as a whole. Both have a composite system of high tension alternating current generation with sub-stations, and the outputs are approximately equal. The Glasgow figure is 1·26d. and Manchester 1·04d., both taken on the same basis. Regarding traction and power, load factors, Manchester traction load factor was 32 to 33%. At Stuart-street station it was 50% for traction, power and lighting. The industrial load factor was 60%. He thought Mr. Yerbury's traction load curves were very fine, and doubted if they were strictly normal. He showed records taken at Bloom-street, in the central area, which showed a peak morning and evening of 3,000 to 3,500 amps over normal. Since the peaks do exist, Mr. Yerbury's arguments all fall, because under these circumstances some proportion of the standing charges must be charged against the tramway account. He was in favour of letting the tramways have meters for checking purposes.

Mr. J. R. Salter: The trouble was that no supply authority would realise that a bulk supply to tramways effects a general reduction in the price per unit which can be charged. Many stations depended on the tram load for their existence, but no tram system was dependent on a lighting station for its power. In traction work the trams are charged from the switchboard and pay for all transmission losses, while the power and lighting consumer simply pays for the power delivered. Electricity is frequently supplied under cost price to large power consumers, simply because the station gets some extraneous advantages. Many stations get extraneous advantages from bulk supply to trams, but the trams are never supplied with power under cost. As the output increases, "running costs" become more running costs, and less of the nature of standing charges. With a certain staff it would be possible to generate perhaps 20 times the output, for which they are indispensible. He instanced the case of Heywood, to show how small stations benefit from a tram load. The Heywood Corporation station had an annual load of 68,000 units, and the cost was 4·1d. per unit. A few miles of tramways were laid down and supplied from the same station, whose output increased to 670,000 units, while the generating cost dropped to 1·23 pence per unit. Before the trams came, they could not get any power load, but the station was now looking for power customers at ·75d. They forgot what the trams had done for them, however, when charging the tramways department. Tramways always wanted its maximum power, when the ordinary station power load was off, and so the same plant is used, and the trams need no special stand-by plant. In one case the price charged to the South Lancashire Tramways Co. was a little over 2d. per unit. The charge was so high that it limited the number of

cars he could run over that line, because the maximum demand would be exceeded, and it might cost thousands more for another 5 or 6 cars run on a Bank Holiday, say.

Mr. C. C. Atchison: At Rochdale, at first, the trams cost the station much more than they paid. There is a traction peak load, and the cost of keeping steam up, etc., for this is an item. If the tramways are taking a supply for more than a few years, then they are getting the benefit after that time, of the plant, etc. In the matter of separate or combined stations, the tramways department did not expect to get the benefit; it was a matter of the town's interest as a whole. The combined station, with 25% extra plant, was admirable from this point of view.

Mr. Stewart: The load factor was important. In large stations some idea of it was got in the ordinary way, but in the smaller station the fluctuations were considerable, and a load of 500 kw. might be followed an instant later by "less than zero" load.

Mr. Miles Walker: The modern unity power factor plant ought to have some concession over the older plants. The price per unit due to capital charges amounted to about half the total price per unit. For a ·8 power factor plant, there was an increase in this of some 8½%. The unity power factor plant should be able to give a 10% reduction over the older plant.

Mr. Whysall: Everyone looked at this matter of charging from his own standpoint. Regarding separate traction stations, the conditions affecting the figure taken as the cost were largely in the hands of the engineer. In combined stations, the matter was much more complicated, as the buyer and the supplier had both to be satisfied. The method of aiming at the price to be charged must be standardised all round before any basis of comparison can be got.

Mr. S. J. Watson (Chairman): The matter of costs has always been controversial. Regarding the division into running and standing costs, this was correct for a plain traction station, but not for a combined station. If a station was always ready to run at a given load the resulting cost was of the nature of a standing charge. Most of the coal was a standing and not a running charge, and so also for other items. At Bury he had considered this in the tramway charges. The differences in charges to traction and power users was due to differences in load. At Bury they had a load variation of 100 to 700–800 kw. for traction, while the large power load was practically constant. With the power load, therefore, they must get more economical results. Even the lighting load during the hours it is on, is fairly constant. The tramway settle what their feeders are to be. They should, therefore, pay their cost, and stand the losses in them. He thought in many cases of smaller towns, the supply department's mains staff should do the cable repairs for the tramways department, but at the latter's expense. The traction peak load did not usually occur with the other peak loads, but there was no guarantee whatever that it would not. At Bury this year they got peak on top of peak. Also special tram services such as for football matches, etc., clash with other loads. In allocating general establishment charges, he takes all costs, deducts the cost of collecting from small consumers, and then deducts mains expenses. The great difficulty in comparing costs is due to capital expenditure. He has tried to bring these into line, for a few districts. In Blackpool, the Blackpool and Fleetwood tramroad station price per unit is ·97d., while for the Blackpool Corporation trams the electricity charge is 1·79d. per unit. The gross profits should be 9 to 10%. He tried several cases, and found they were making 6½% net profits. If the Corporation's price were reduced then, and the company's increased to bring it on the same basis, the two costs were found to agree fairly well. At Hull the costs similarly examined showed that the actual costs were in agreement. He asked why should the electricity department supply power cheap to the trams? The tramways department want to sell it to the public at a profit at the expense of the electricity department.

Mr. Yerbury (in reply): As regards Mr. Pearce's remarks about correspondence about the price at Sheffield, he had nothing to do with the information then given. The figures were not right. At Sheffield they had a large boosting load, and the price should, therefore, come down to ·75d. from ·81d. For direct current systems, the units generated were about 10% in excess of those sold. In alternating current with conversion, they were 20%; 14% for generating, etc., and 6% on the direct current side. He gave some figures of cost per kw. of plant, and cost per unit generated. Leeds cost is ·386d. per unit generated, plant £4 1s. 3d. per kw. installed.

Manchester, ·503d. per unit generated, £12 per kw. of plant.
Glasgow, ·391d. „ „ £3 5s. 5d. „

Peak loads were most in the small stations. He thought the pooling of fixed charges quite wrong. If this was done, the separate station was most economical. Those portions not connected with traction must be dissociated. The 1·75% allowance for depreciation was ample, and it must be remembered that during the first 5 years nothing would be required. At Sheffield during the past 10 years their renewal expense never amounted to more than £1,000, and the average was £450 per annum. They have a renewals fund of £82,000. He thought the present ratepayers should not be overburdened. The case of Heywood mentioned was to be expected for a small town. High charges to trams would be allowable if the profits of the electricity department went to the relief of rates, but instead it went to buy new additional plant and supply other people at less than cost. Regarding Mr. Watson's treatment of coal expense, he could not see how one could differentiate between coal used for load, and that in spare boilers. He thought 25% of spare plant was sufficient margin. The overhead men could deal with all cable repairs for the tramways department. He pointed out that the ratio of price charged to trams to total works costs varied within very wide limits. The average was 63% above works cost, though at Dundee it was only 7%.

CALLENDER'S HOSPITAL AND DISTRESS FUND.

The Committee, in presenting the seventh annual report, state that a very successful year's work has been accomplished and steady progress maintained. The Committee have been encouraged during the year with expressions of gratitude from those members who in very critical cases obtained the best possible surgical skill and medical treatment. A record was established in the number of hospital letters issued. The out-patient letters totalled 253 against 174, the highest figure previously reached, which is an increase of 79. These figures will show that the members make great use of the hospitals to which we subscribe. There were also four in-patient letters issued against seven in the previous year. For special nursing at home only two letters were needed, being 10 less than the year before. 68 surgical appliance letters were issued against 72 in 1908. Letters for a three weeks' stay at a seaside convalescent home were granted to six members and gratefully received. The new arrangements made last year to help those who suffer from defective eye-sight have been continued with every success and satisfaction, conferring a great benefit on a large number of our members. During the year, spectacles were supplied in 65 cases at a total cost of £8 6s. 3d. Applications from members for financial assistance in time of need were carefully considered by the Committee and 44 grants were made, the total amount being £54 8s. 6d. This was the means of giving a little practical help when most needed. The question of defective teeth has always been a difficult one, and this year the Committee obtained all the information possible on the subject. After much discussion and very careful consideration, it was found that the subscription of one penny per week would only allow the fund to continue the issue of letters for stopping and extractions. Therefore, the suggestion that artificial teeth be also supplied could not be adopted. The penny weekly subscriptions amounted to the sum of £187 2s. 8d., against £183 0s. 9d. last year, being an increase of £4 1s. 11d. We are pleased to report that every employee is a subscribing member. The total income was over £250, and the expenditure £261.

ROYAL INSTITUTION.—On Saturday (February 12) Professor Sir J. J. Thomson commences a course of six lectures on "Electric Waves and the Electromagnetic Theory of Light." The Friday evening discourse on February 11 will be delivered by Mr. Charles E. S. Phillips on "Electrical and other Properties of Sand."

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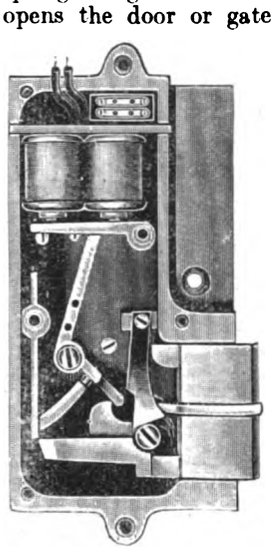
PUBLICITY.

In this Section of "The Electrical Engineer" we give Publicity to New Inventions and Specialities.

ELECTRIC LOCKS.

The "Sun" Electric Locks are likely to appeal to a very wide public owing to their simplicity and reliability. Our two illustrations show clearly enough the mechanism. These locks can be fitted on any type of door or gate, a spring being fixed in a small recess of the frame, which opens the door or gate which the lock controls. The operation is as follows: When the door is shut, pressure on the electric push-button releases the magnetic catch, and the door, while remaining closed, may be easily opened by lightly pushing or pulling it. When the person has passed through the door, it shuts and locks itself, and can only be opened by repeating the above cycle of operations. The smaller illustration is that of a special type—a combined electric and key operated lock. It can be opened from the interior, either by means of the electric movement or the handle provided, and also from the exterior, either by the key or the electric movement (except when double-locked). When desired the door can be double-locked from the outside, and can then only be opened by the key. By a simple arrangement the release action can be set in motion from a distance. An ordinary bell-battery is quite sufficient for these locks. They are made in a large variety of patterns, and all working parts are of hardened steel. It will be seen that they are capable of practically universal application.



GLOW LAMP ADAPTER.

We have much pleasure in calling the attention of both central station engineers and electrical appliance merchants to a clever little invention of Mr. N. W. Prangnell, distributing engineer to the Metropolitan Electric Supply Co., Ltd. This adapter he has devised to enable small apparatus such as irons, kettles, etc., to be connected to an ordinary lamp holder, without putting the lamp out of use, and at the same time enabling the carrying out of one of the requirements which the Fire Insurance Companies are now asking for, namely, that whenever an iron or such apparatus is used, it is advisable to have some indication that the current is on the apparatus. It will be seen that this is obtained with the adapter owing to it being possible for the lamp to be in use at the same time. It may be further pointed out that one of the chief reasons that led to the design of this adapter was that, with most of the adapters now on the market, it is necessary to remove any sort of shade that may be in use before the adapter can be applied; for if an adapter is put above the shade, the flex, which would be carried away for the iron or other apparatus, would cause the tilting of the shade.

There are many other useful purposes which this adapter serves, one of them being the ease with which a connection for table decorations can be made from an existing light above.

Arrangements have been made with Messrs. the Edison and Swan United Electric Light Co., 36–7, Queen-street, Cheapside; the General Electric Co., Ltd., 71, Queen Victoria-street; Messrs. Veritys, Ltd.; 31, King-street, Covent-garden; Messrs. Wm. McGeoch & Co., 90, Charing Cross-road; and the Simplex Conduits Co., Ltd., 113-117, Charing Cross-road, for the placing of this article on the market.

This appliance will be of special interest in these times when all are so keen on pushing the use of small apparatus on lighting circuits.

"IGRANIC" COMPETITION.

The Adams Manufacturing Co., Ltd., of 106, New Bond Street, London, and Bedford, the well-known manufacturers of motor controlling apparatus which they have sold for many years under the trade name "Igranic," received such a large number of enquiries from their clients from time to time regarding the meaning of the word "Igranic,' that they decided to offer a reward of £5 for the best definition of this word. They advertised the competition in the middle of December, and it was very gratifying to them to receive such a large number of replies.

In order that the final judging should be of absolutely impartial character, they submitted a selected number of the replies to Mr. Frank Broadbent, M.I.E.E., consulting engineer, whose experience as examiner in electric wiring to the City and Guilds of London Institute should render his opinion valuable and acceptable to all parties.

Mr. Broadbent has made his award to Mr. Alfred Cockburn, 9, St. George's Square, London, S.W., whose definition he adjudges the best as regards form, composition and definiteness. The definition is as follows:—

Inspires confidence.
Gives satisfaction.
Requires no attention.
Acts automatically.
Never goes wrong.
Is immensely popular.
Combines cheapness with efficiency.

The Adams Manufacturing Co., Ltd., would like to point out that the word "Igranic" is a coined word, and has no special definition.

"TANTALUM" TRACTION WORK.

"Tantalum" lamps have scored a notable success in traction work. A large number of these lamps have been installed on one of the Underground Tube Railways of London, and the following results have been supplied as a sample of their performance:

Six lamps which burned for 6,084 hours, are still good, and a further six lamps, which have given out, burned for an average of 5,167 hours, the individual life of each lamp being as follows:—No. 1, 7,218 hours; No. 2, 6,600 hours; No. 3, 4,400 hours; No. 4, 4,314 hours; No. 5, 4,440 hours; No. 6, 4,032 hours.

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It should be stated that the lamps used were of 2·2 watts efficiency, burning five in series, on a 600-volt circuit. As compared with carbon filament lamps, the amount of light is better, and there is at the same time a considerable reduction in the current consumption.

The figures here quoted are official, and they clearly demonstrate that there is a lamp of the metal filament class which has proved its superiority over all other makes, and also its suitability for traction purposes. These results are not surprising when one considers that the filament of the "Tantalum" lamp is a drawn wire, which has a greater tensile strength than mild steel of the same gauge.

This filament is mounted on a "spider," which supports it at various points, the length of each loop of filament being particularly short, so that the lamp may be installed in any position, and is capable of standing vibration of extreme severity. Without doubt these details of the manufacture account largely for the reputation which the "Tantalum" lamp possesses of being the strongest metal filament lamp on the market.

"Tantalum" lamps are being used in most situations where extreme vibration is experienced, and where other types of lamps have proved altogether unsatisfactory. It is encouraging to note that the economic advantages which these lamps afford in connection with traction work, are now being taken advantage of by many of the leading railway and shipping companies, and we would advise all who are interested in the illumination of rolling stock or vessels to instal a number of trial lamps, thus actually testing the suitability for the particular job in hand.

Any further information regarding "Tantalum" lamps will be supplied by Messrs. Siemens Bros. Dynamo Works, Ltd., Tyssen-street, Dalston, London, N.E., who have for some time manufactured "Tantalum" lamps at their Dalston Works.

WEST HAM ELECTRICITY DINNER.

The West Ham Corporation Electric Supply fourth annual staff dinner was held on Thursday, the 27th ult., in the Georgian Hall of the Gaiety Restaurant, Strand, W.C. Mr. H. H. Couzens, the electrical engineer of the department, was in the chair. Among those present were Alderman Crow, Chairman of the Tramway and Electric Lighting Committee, Alderman Littler, ex-Mayor, the Deputy Mayor, Alderman Spratt, Mr. H. E. Blain, of the tramways department, Mr. A. H. Seabrook. The visitors also included several well-known manufacturers and merchants. An excellent menu was provided. The toast list was a short one, and the speeches brief, though no less sincere in their sentiments, and thus ample time was allowed for the enjoyment of a capital musical programme. The loyal toast having been honoured, Mr. A. H. Seabrook proposed that of "The Mayor and Corporation of West Ham," coupling with it the name of Alderman Spratt, remarking that West Ham was the greatest industrial centre in the South of England, and by electrical engineers and the large number of manufacturers present with them that evening the policy of the West Ham Corporation in dealing with the power requirements of that important area should be welcomed. Everybody admitted that the position of the electrical industry at the present time was not what it ought to be. Some people told them that Tariff Reform was the only thing to have, while others said that Free Trade was the only thing to improve the prosperity of the country; but he thought it could not be denied that a great deal of the present position in the electrical industry was due largely to internal causes. If twenty large towns were to do the same as West Ham had done, and adopt their pushing policy generally, there could be no doubt that an enormous improvement would be made in the position of the electrical manufacturing industry at large. In conclusion, Mr. Seabrook remarked that the time spent at West Ham was one of the happiest periods of his life.

The Deputy Mayor, in replying to the toast, in the course of his remarks, said He appreciated the remarks of Mr. Seabrook. They were proud of their electrical department, but they were especially proud of their tramway department. West Ham had been incorporated 23 years, having sowed their wild oats, they were getting more stayed, and he thought there was a great hope for the future of West Ham.

Mr. Alderman Crow proposed the toast of "The Electricity Department," explaining he had the honour of submitting a similar toast about 12 months ago. At that time he ventured to praise the electrical engineer, and as a result of the praise then bestowed upon Mr. Seabrook, he came to him a short time afterwards and said he had got a far better job. Notwithstanding the fact that his speech that evening might land the Corporation in a similar position, in Mr. Couzens they had a most able successor to Mr. Seabrook. In connection with the supply of current, Mr. Crow said in nine months they had increased the revenue by some £5,600 and manufactured two-and-a-half million units more than any previous year. The cheap supply of power was attracting additional industries to West Ham, and some five or six large firms were now in negotiation with the electricity department.

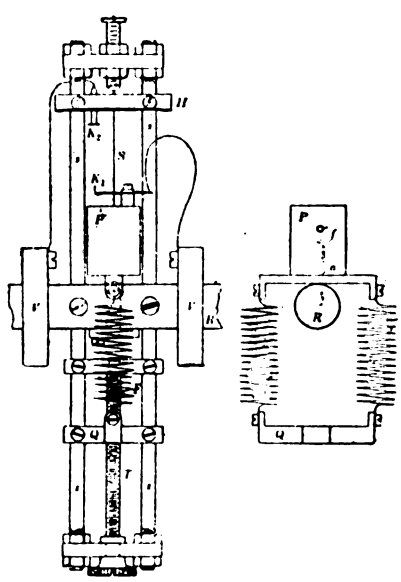
The Chairman, in responding to the toast, said that as regards the success achieved by the undertaking in the past and the present nine months, he thought the entire credit was due to his predecessor, Mr. Seabrook, and the staff who had helped him in every way to make the department a success. With regard to the tramway department, he had almost looked upon that as the aristocratic and most opulent section of municipal trading. Some sympathy should be extended to him in following Mr. Seabrook, for he had struck out in an entirely new line by establishing a sales department. In West Ham they had quite a large sales department, which had done very much towards the success of the undertaking. In the generating department, under Mr. G. Lloyd Jones, they had obtained results which had constituted a record in the country.

The toast of "The Visitors" was proposed by Mr. G. Lloyd Jones, and in a brief but happy speech Mr. Jones apologised for its briefness from the fact that he was apprenticed to electricity and not "gas."

Mr. H. E. Blain replied. During the progress of the musical programme encores were freely demanded of the talented artistes, and Mr. H. B. Johnson, hon. secretary, and other officers of the dinner committee are to be congratulated upon the excellent arrangements made.

ELECTROMOTOR GOVERNOR.

The diagram shows a new form of speed regulator for electromotors. The motor axle is coupled to the shaft R to which a frame formed by the rods " " is fixed. Attached to this by means of the cross-piece Q is a spring F, and a weight P which can slide along the wire S. If the number



of revolutions exceeds a figure depending on the position of Q and the tension of the spring F, the weight P is moved far enough by the centrifugal force to bring together the two contact pieces K_1 and K_2. A resistance is thereby thrown on to the motor, which reduces the speed until K_1 and K_2 are again separated.

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ELECTRICAL PROGRESS AT HOME & ABROAD

FROM OUR SPECIAL CORRESPONDENTS.

TYNESIDE NOTES.

NEWCASTLE-ON-TYNE.

Probably the recent storm which has visited Great Britain has been most severely felt in the North-Eastern area, which is exposed to unusual weather conditions. Widespread damage was caused to telephone and telegraph systems by the heavy fall of snow, together with the high gales, the result being that the telephone service to anything but the centre of the large towns, where the cables are laid underground, has been to a large extent disorganised owing to the breakage not only of the lines, but in many cases of the poles. It is estimated that in some cases considerable time will elapse before the service is again working satisfactorily, as the repairs to be made are extensive. The storm has been useful in one respect, inasmuch as it has put a heavy test upon the overhead pole line distribution adopted for both extra high tension and medium tension power in bulk supply by the Newcastle-upon-Tyne Electric Supply Co., Ltd., and its associated companies throughout Northumberland and Durham and North Yorkshire. It is satisfactory to note that over the whole of the area supplied in this way there has not been a single case of breakdown to the pole line distribution, pointing to the strong mechanical construction which has been employed. The value of concrete construction in connection with overhead systems of distribution at points of maximum strain is thus demonstrated. It is not probable that any more severe test will ever be put upon the mechanical strength of overhead systems. Another satisfactory feature as regards electrical engineering is the fact that the electric railway service of the North-Eastern Railway from Newcastle to the sea coast and along the north bank of the Tyne has been maintained in efficient working operation in spite of the depth of the snow fall, which might have been supposed to have affected the insulation of the third rail. The collection of the current from the third rail was effected without difficulty, owing to the fact that the snow fall was of a light and soft nature, easily removable by the plough affixed to the collecting apparatus. It, therefore, appears that the only danger to which third rail systems of collection are exposed in this connection is the formation of a thin, hard sheet of solid ice, which would have been experienced had a partial thaw and subsequent frost set in, and which an ordinary plough might conceivably not have been able to remove. The efficient working of the electric section has been emphasised by the delays which have been experienced on the steam-driven sections of the railway; but it is only fair to say that this, in many cases, was not due to the method of power used, but rather to the interruption of signalling arrangements caused by the dislocation of the overhead wiring communication. A smaller, though in one sense satisfactory, result of the hard weather has been that at the termination of the frost there has been an abnormal number of burst water pipes in private houses, and in many cases this has affected the wiring installations, with consequent advantage to the electrical contractors, who have been called in to effect repairs.

Protection of Portable Electric Mining Appliances.

An unusual and satisfactory feature of the paper which was read by Mr. Fisher before the local section of the Institution of Electrical Engineers, to which reference was briefly made last week, is that the author is a mining electrical engineer of considerable practical experience, and the paper was a distinctly practical, as opposed to a theoretical, contribution. Several speakers in the discussion, among them being Dr. Thornton, of Armstrong College, expressed the opinion that if the means of protection outlined in the paper were universally adopted, the problem of the safety of electricity in coal mines would to a very great extent be solved. The discussion was interesting as bringing to light several very valuable practical experiences as regards electrical shock in mines.

Institution of Mining Electrical Engineers' Meeting.

The question of electrical shock in collieries was still further investigated in a meeting of the above Institution held on Wednesday, the 26th ult., and practically the whole of the time of discussion was occupied in relating the exact circumstances under which operators sustained an electric shock. One point brought out was that a large proportion of fatal accidents have occurred on low tension systems, showing that death is apparently due to the quantity of electricity passed through the body, and also upon the portion of the body affected. The means of resuscitation were also discussed, and also first aid measures in relation to burns. Attention was drawn to the valuable properties of picric acid or thermine for treating burns, as this cleanses the wound from any copper deposit and allows the skin to heal comparatively quickly. The effect of an electric flash in a dark situation, such as a colliery working, upon the eyes was also noted, and the use of cocaine in this connection was advocated in order to reduce the inflammation. I understand that the practical data furnished by the discussion of this question, at this and other sections of the new Institution, will form the basis of a comprehensive report upon the safety of electricity in mines to be presented in some form or another to the Home Office Committee dealing with the question of the new rules.

Change on the North-Eastern Railway Engineering Staff.

Mr. Wilson Worsdell, who has hitherto held the position of chief mechanical engineer to the North-Eastern Railway Company, will retire from this post in the course of three or four months, and will thereafter hold the position of consulting mechanical engineer to the company. Mr. Wordsell, in addition to his well-known work in engine design, both for passenger and freight service, has effected considerable improvements in rolling stock equipments, and has carried out important tests upon locomotives by means of a specially designed dynamometer car. He was also responsible for the carrying through of the electrification of the Tynemouth and Whitley Bay section of the North-Eastern Railway, which has proved such a great success, and is at the present time, in addition to his other duties, in chief control of the large electrical department of the railway, whose chief departmental officer is Mr. J. E. Pigge, M.I.E.E. Mr. Worsdell's probable successor will be Mr. Raven, his chief assistant, and this change will probably accelerate the transference of the head executive office of the engineering department from Gateshead, where it is at present located, to Darlington, which is steadily becoming the centre of the North-Eastern Railway system.

Organ Blowing by Electricity.

A company has been formed under the title of The Sentinel Organ Blower Company, and having offices at Union Buildings, St. John-street, Newcastle-upon-Tyne, to develop the introduction of a type of electrical organ blower which has already met with a considerable amount of success in this area. The features of the blower are a positive drive without friction or other mechanical regulating device, operating directly on feeder bellows supplying the main wind chest of the organ. Control is obtained automatically in relation to the amount of wind in the main chest by means of a controller of the face-plate pattern, the details of design being the outcome of several years' experience in meeting the demands of organ builders.

MIDLAND NOTES.

BIRMINGHAM.

Among the electrical exhibits at the annual Conversazione of the Birmingham Metallurgical Society, which was held on Saturday evening at the Municipal Technical School, was a new electric muffle furnace exhibited by Messrs. Standley, Belcher & Mason, Ltd., of Ludgate-hill,

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Birmingham. The feature of this furnace is the use of a black powder, bearing the trade name of "Kryptol," which serves as a resistance, and develops to an unusual extent the heat from the electric current. The furnace is built of refractory material with an oval cavity of about 4 in. by 5 in., and the "Kryptol" powder forms a jacket surrounding the heating chambers. The heating is done very rapidly, and in the opinion of Mr. J. H. Stansbie, of the Birmingham Municipal Technical School, who conducted the demonstration, the furnace should have a great vogue in the future in such an important electrical and mechanical centre as Birmingham. It is considered particularly suitable for laboratory work, and already it has been utilised for experiments at some of the local educational institutions. During the demonstration, copper and zinc were melted very quickly, and metallurgical experts present considered the demonstration in every way a great success. Demonstrations were also given during the evening by Mr. T. J. Baker and Mr. C. R. Clark in the Electro-Deposition Laboratories of Metallochromes and electro-depositing work, which has been for some years past a notable department of the Metallurgical Department of the School under the direction of Mr. A. H. Hiorns.

Institute of Mining Electrical Engineers.

The inaugural meeting of the Warwickshire and South Staffordshire Branch of the Institute of Mining Electrical Engineers took place at the *Imperial Hotel*, Birmingham, on Saturday evening. This branch is one of the most recently formed of the eight now existing in various parts of England. Its initiation is mainly due to Mr. Arthur Hall, M.Inst.C.E., who took part in the formation of the parent institution, and who has been chosen as first local President of the Branch. In his presidential address on Saturday evening, Mr. Hall pointed out that the desirability of forming such an association was first suggested by Mr. Glyn Williams, Colliery Electrician, of Whitehaven, and associated with him was Mr. William Maurice, General Manager of the Hucknall Torkard Colliery, who had been chosen as the first President of the Institute. Mr. Harry Arnott, as provisional hon. secretary of the Birmingham Branch, had sent out a hundred circulars among the managers, engineers and electricians of collieries in the Birmingham district, and the branch commenced with 29 members and 11 associates. This membership Mr. Hall hoped would in a short time be doubled.

Accidents in Mines.

Acting upon a suggestion from the headquarters of the Institute, Mr. Hall directed the attention of the members at the first meeting of the branch to the subject of the causes of accidents, and the best means of prevention, the discussion being based upon part one of a paper on the subject by the President of the Institute (Mr. Maurice), this part dealing with "Electric Shock." Among the questions propounded in the paper were the causes of death by electricity, the special risks in mines, means of rescue and resuscitation, defective protection, and the relative safety of different systems. Several members expressed the opinion that a good deal of the trouble arises through the systems being inefficiently earthed. The inadvertent handling of live terminals was stated to be one of the most frequent causes of fatal accidents. An exception, the relation of which caused some amusement, was that of the seizing of a live wire by a workman whose hand was so horny that the current practically made no impression upon it, while a clerk from the office who rashly followed his example received a rather sharp shock. Some of the speakers complained about the frequent defects and unsuitability of apparatus which, it was considered, were a frequent source of accidents. It was agreed that the effect of a shock depends very largely upon the physical condition of the recipient. Mr. Hall gave an experience of his own, the receipt of a shock of 250 volts which cutting through a couple of wires with a pocket knife, the blade of which short-circuited the current through his body. It was generally agreed that the effect of the current depended more upon the amount received than upon the voltage. In the opinion of Mr. Gidwell, the non-observation of leakages was the most frequent cause of accidents.

Officers Elected.

The officers of the branch elected at Saturday night's meeting are as follows: President, Mr. Arthur Hall, M.Inst. C.E. (Nuneaton); Vice-President, Mr. C. F. Jackson, colliery manager, Exhall Colliery; Hon. Secretary and Joint Treasurer, with the President, Mr. H. Arnott (Bedworth); Committee, Messrs. J. Liddell, E. C. Knox, J. R. English, L. Smales and J. Parker; Hon. Auditors, Messrs. F. M. Iliffe and H. Gidwell.

Aston Manor Extensions.

The Electricity Committee of the Aston Town Council have prepared a scheme for extensions to the power station at an estimated cost of £13,550. The scheme includes the installation of one 2,500 kw. turbo-generator and condenser to be erected in the space left for this purpose alongside the existing turbo-generator; and one water tube boiler; the installation of one 250 kw. motor generator for converting purposes; one 350 kw. rotary converter, and one small balancer at Alma-street sub-station and the installation of the necessary high and low tension switch gear at Chester-street generating station and Alma-street sub-station to control the new machines. With the addition of the 2,500 kw. of generating plant installed last summer, this will bring the total capacity of the works to 5,265 kw.

LANCASHIRE NOTES.

MANCHESTER.

The state of the electrical industry here has been well maintained. One firm here has had such a demand for their instruments, that that department has had to work over several week-ends lately in addition to the usual overtime. Certainly a satisfactory state of affairs, as up to about two months ago that department had been complaining of "bad trade." Among cable makers the business is not at all satisfactory, and one firm in Trafford Park is working half-time. There are indications, however, of an early increased demand for cables and mains material in connection with extensions and new work. During the past week the exceptionally heavy snowfall and unusually severe weather has seriously interfered with the trams in outlying districts, and on several occasions it has been late in the afternoon before cars could be run through. It is interesting to note that the number of breakdowns of the cars due to snow in the motors, etc., has been only about 3 to 4% of the cars running.

Students' Section.

At the last meeting of the Manchester Students' Section of the Institute of Electrical Engineers, Messrs. P. Kemp, M.Sc.Tech., and W.A.Stephens, M.Sc.Tech., read a long paper describing a series of experiments recently carried out by them at the School of Technology, Manchester, on the "High Tension Spark Discharge in Air." They reviewed various theories previously propounded to account for the phenomena preceding and accompanying the passage of an electric spark in air. They reject the resonance theory and regard the "ionisation theory" as being the correct explanation. The paper dealt with the subject very exhaustively. Mr. J. Lustgorten, M.Sc, who has himself done a considerable amount of research work in the same field, was in the chair, and contributed largely to the discussion, favouring more the "resonance theory" than the author's explanation.

Human Telegraphy.

Prof. W. W. Haldane Gee has recently made known the result of some experiments carried out on the resistance of the human body. In the experiments, the two hands were immersed in separate vessels containing a solution of common salt, and the resistance taken by the drop of potential method. It was found that under ordinary circumstances the resistance thus measured was about 1,500 ohms, but might be more or less without indicating an abnormal condition of health. The resistance was found to increase for a time owing to polorisation effects, the body acting to a slight degree as a storage battery. After a time, however, it decreased again. Using an alternating current, the resistance by the same method was much less,

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700 to 800 ohms being about the average value. Previous experiments have shown that a greater muscular contraction is experienced on closing the cathode than on closing the anode, and it is possible, by moistening the fingers and touching the two wires of an ordinary 100-volt direct-current circuit to distinguish the cathode or negative pole from the anode or positive. Using this information, Prof. Gee has performed some experiments with a system of telegraphy based on it. The operator is provided with two vessels, containing a solution of common salt, and capable of being connected to either main. He immerses one hand in each vessel. A slight shock in, say, the right hand is agreed upon to denote a dash, and in the left, a dot, in the ordinary code. Prof. Gee points out that this method, which can be used for fairly long distances, might be of considerable value in cases of emergency. It certainly seems to have possibilities for field service in time of war.

The Driving of Mills.

Mr. G. B. Storie read a paper last Saturday before the Manchester Association of Engineers on the steam turbine in mills. He was chiefly interested in showing the steam turbine as a competitor of the reciprocating engine. Hitherto the turbine has made no headway towards the direct driving of mills (except in some small concerns), and of the 30,000 h.p. of turbines in British textile mills, only some 5,500 h.p. are arranged for mechanical drive. In the near future an attempt will be made to apply the rope drive to large mills by means of geared turbines in competition with turbo-electric drive. Mr. Storie gave some interesting figures for comparison between the reciprocating engine rope drive and the turbo-alternator drive, for a 60,000 spindle mill, 1,600 h.p., working 2,800 hours per year. In capital cost, the engine is £5,900, while the turbo-alternator is only £3,700. Again, the cost of engine house and foundations, and of travelling crane for the turbo installation is only half that for the engine. Against this, however, condensing plant, etc., and cooling tower for the turbo costs £1,640, an item not required for its rival. The total for engine plant is £13,000, and £11,700 for the turbo. Shafting for the latter drive was given at £3,200, against £5,200 (including £700 for ropes) for the engine drive. Motors, cables and switchboard cost respectively £3,000, £1,100, and £600. The total power equipment costs £18,200 for the reciprocating rope driving, and £19,600 for the turbo drive. The annual power cost, however, including 10% depreciation and interest on engine room plant, is £3,430 for the engine, against £3,210 for the turbo. It was claimed in the discussion, however, that the turbo has to provide 5% more power (conversion losses), and that, therefore, the power cost given for the turbo (which assumes equal amount of coal) would be too low. Although this argument was swallowed by the meeting, actual tests show that quite 5% (not included by Mr. Storie) is lost in mechanical drive, to say nothing of the large "Monday morning" overload due to increased bearing friction. With the geared turbine the same loss as for turbo-alternator will occur, and no increased steadiness will be obtained, so that it looks as if the geared turbine will not be a serious competitor at all. Lancashire mechanical engineers have always prided themselves on their vastly superior knowledge (over the electrical engineers) of the driving of textile mills. During the discussion on Mr. Storie's paper it became evident that they have more to learn yet, Mr. Blackmore pointing out that, judging from tests upon electrically driven mills, most of the powers given in textile machinery makers' catalogues are much on the low side. For instance, the power for Buckley's openers is listed at 12 h.p., but on test took 17·3 h.p. It is now proposed that some trustworthy tests under working conditions should be taken by an independent authority, such as the Manchester School of Technology. Much of the mechanical knowledge on the subject of mill driving is of the "rule of thumb" order.

AMERICAN NOTES.

NEW YORK.

The Mazda Lamp has achieved a remarkable triumph. Reference was made in these notes a fortnight ago to the fact that all the leading lamp manufacturers of the United States had combined to give this latest development of the metal filament lamp a great "send off." This they did by monopolising in three leading electrical journals between sixty and eighty pages of displayed advertisements. Thus the whole electrical community was set to talking of Mazda lamps. The Mazda was on everybody's lips, and the boom communicated itself to the public so that Mazda lamps were everywhere being asked for. Meanwhile merchants and dealers were stocking and exhibiting Mazda's in every variety of form, candle-power and voltage, and the final result was a phenomenal sale. The "boom" was magnificently engineered, for manufacturers here understand and appreciate the art of advertising to an extent which is hardly realized in Great Britain. And they reap a rich reward; as in this particular case of the Mazda lamp. But the lamp is worthy of the boom. Under every test it has proved itself a magnificent illuminant. It is probably not the final evolution of the metal filament lamp, but it is undoubtedly the best that this country has produced so far.

Mazda for Street Lighting.

The latest development is a 250-watt Mazda for street lighting. This has been privately under test for best part of a year, and has given remarkable results, showing a life of 1,300 hours as standardized by the General Electric Company, while tests made by a well-known illuminating engineer show that with the new General Electric wave reflector specially designed for it, the lamp gives about 250 candles in a direction for street lighting. Two hundred and fifty candles, 8 deg. to 25 deg. below horizontal, is considerably in excess of the light given by the 6·6-amp. series, alternating-current, enclosed arc lamp with clear inner and outer globes. It is claimed that, lamp for lamp, the new 250-watt Mazda may be substituted for the direct-current arc of 300–330 watts and 1,200 nominal candle-power and for the alternating-current inclosed arc of 400 watts. In substituting lamp for lamp, the power required is reduced from 330 watts to 250 watts in the case of the direct-current arc and from 400 watts to 250 watts in case of the alternating-current arc. In the latter case there is a 37% increase in the capacity of the power equipment, including series transformers, generators and engines.

Cost of Operation.

The cost of operating the Mazda street lamp for 4,000 hours' service per year, all night, every night, is stated to be $23 (£4 14s.), apportioned as follows: Fifteen dollars for energy at 1½ cents per kw. hour; $7.50 for lamp renewals and $1 for trimming and labour costs. This is considerably less than the cost of operating any series arc lamp, the latter being over $30 in case of the 6·6 amp., alternating arc (450 watts at lamp terminals); this figure includes energy at 1½ cents per kw. hour, trimming, electrodes, outer and inner globes, repairs and labour. The 250-watt Mazda series lamp operates satisfactorily on all series circuits. The lamp has a unity power-factor and shows practically no depreciation in candle-power throughout its life. The 250-watt lamp is made for current ranging from 4-amp. to 8-amp. and voltages from 62·5 to 31·2. The bulb has a diameter of 5 in.

Tantalum Economies.

In the course of an article in the Chicago *Electrical Review* on the use of tantalum lamps for ship lighting, Dr. A. Gradenwitz gives the following table of actual economies effected in a single vessel by the adoption of these lamps, in spite of their first cost—which is covered after the first few hundred hours:—saving in energy per year, 160,200 kw.-hours; coal consumption per kw.-hour, 7·25 pounds; saving in coal per annum, 1,163,052 pounds; saving in cost of coal per annum, $2,283; excess cost of tantalum lamps per annum as compared with carbon-filament lamps with a 1,000-hours' life of each lamp, $1,390; total saving per annum in the case of tantalum lamps, $893. And in this record no account has been taken of the saving in lubricating material for the machinery or the saving in cost of repairs and of maintenance, one machine or at most two, being worked instead of three under the old system. The total saving is not less than $1,250. The writer also points out that all experience goes to show that tantalum lamps are not damaged in any way

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by the vibrations of the ship. Those which have been installed on small ferry steamers, harbour tubs, etc., in spite of the many shocks imparted to such vessels, especially on touching the shore, have not undergone any deterioration from this cause. The fact that tantalum lamps are being used to a considerable extent also by the German navy proves their ability to withstand even the enormous vibrations of the hull that are produced by the firing of heavy guns.

Great Hydro-electric Project.

A syndicate of New York and Boston capitalists has undertaken to finance the erection of the second largest dam in the world, to span the Mississippi river at Keokuk, Iowa. Contracts have been taken by three Saint Louis concerns to furnish power from the dam to adjacent cities, and the work of building is to begin immediately, under the supervision of the War Department. The estimated cost of the dam is $15,000,000. One thousand men are to begin work on the structure of reinforced concrete 5,800 ft. long, which will harness the Mississippi. It is to be 37 ft. high, and will be built 7 ft. deep into the solid rock of the river bottom. The power plant to be erected on the Iowa side of the river will generate 200,000 h.p., and the dam will create a lake extending for 30 miles up the Mississippi.

Electrifying Boston Terminals.

Bills are being introduced in the current session of the Massachusetts Legislature providing for the electrification of the Boston Railroad terminals and also of all railroads within a radius of 10 miles of the capital. The matter of electrification of the south terminal and north terminal, and a further plan that will include, it is thought the entire Boston railroad zone has been considered by the officials of the New Haven, Boston Railroad Holding, and the Boston and Maine Companies. The consideration given the subject has been carried to the extent that it is roughly estimated that to electrify the zone mentioned will involve an expenditure of between $50,000,000 and $70,000,000.

An American Gyroscopic Railway.

Great interest was manifested among railway men, scientists and financiers in the first exhibition in this country of the gyrostatic mono-rail car, which was given in a Brooklyn rink by Richard Scherl, a young inventor, who is a son of the owner of one of Germany's greatest newspapers. A single-rail track had been laid on the floor of the rink in a circle, with about 13 laps to a mile. The car, which seats four passengers and two operators, and which is intended solely for demonstration purposes, worked perfectly. Under the car are two gyroscopes, each revolving in a vacuum at the rate of 8,000 revolutions a minute, one on a perpendicular axis and the other horizontal. These gyroscopes operated by an electric current of 110 volts picked up by shoes from wires laid on either side of the mono-rail, balanced the car, either standing or running. Mr. Scherl believes that a speed of at least 120 miles an hour can be reached and maintained by a gyrostatic mono-rail of regulation size.

Details of the Car.

The car is boat-shaped, with an over-all length of 18 ft. and a maximum width of 4 ft. The dead weight of the car is 5,500 lb., 5½ % of which covers the weight of the gyroscopes. The body is mounted on two double-axle trucks which are spaced 15 ft. centres and carry 16-in. diameter wheels with a 1·2 in. double flange. One wheel of each truck is driven through a double reduction gear by a 2 h.p., 110-volt, direct-current series motor, all the motors being operated from either end by a controller. Each gyroscope consists of a 110-lb. steel wheel rotating at 8,000 r.p.m. in an air-tight chamber in which the pressure has been lowered almost to a vacuum. Each wheel is driven directly by a ½ h.p., 110-volt, direct-current shunt motor. To obtain the balancing effort, their precession is artificially influenced by means of an apparatus operated by oil under pressure. Should the motors which drive the gyroscopes fail from any cause, the high-speed wheels operating in the partial vacuum would easily permit the car to run safely for a considerable period, but before the revolutions of the gyroscopes sink below a certain amount the motorman can apply an emergency brake, which consists of four vertical props, which are dropped to the ground to bring the car into stable equilibrium.

The Hutchison Tachometer.

A new form of tachometer for indicating the exact rate of rotation of any machine at distant points is being put on the market under the Hutchison patents. The instrument consists of an alternating-current generator, or magneto, of the revolving field inductor type, driven by the shaft, the speed of which is to be measured, and a voltmeter, wired up to the generator, and located at any remote point where indications of speed are desired. The voltage of the generator is proportional to its speed, so that the voltmeter can be calibrated to read direct in revolutions per minute. Practically any number of voltmeters or indicators, placed at widely separated points, may be operated from the same generator, so that the tachometer will indicate speeds at as many points as desired, as far away as desired, within reasonable limits. Thus a number of operators at widely separated points can have precise indications of speed always before them, so that concerted action may result, as, for instance, the marine engineer down in the engine room and the captain on the bridge. The alternating-current generator eliminates brushes and commutators, and the makers state that every joint in the circuit from the armature to indicators is soldered. The generator can be very small and compact, and the indicators built to operate on a minute current. The conductors are, therefore, small, and introduce little drop, and the load on the generator (even with a plurality of indicators) is comparatively small.

Tungsten Lamps for Motor Cars.

The application of the tungsten lamp in automobile service in displacement of oil and acetylene, forms the suject of an editorial in the current issue of the *Electrical Review*, of Chicago. Nowhere, it is pointed out, has the convenience of the incandescent lamp been more appreciated than in the field of automobile operation, and its superior safety and great simplicity challenge the competition of all lighting systems depending upon combustion for their successful operation. The use of low voltages in and around motor cars enables tungsten lamps with relatively short and thick filaments to be installed, and there is little or no difficulty in resisting the jar and vibration of the vehicle while the elimination of inflammable material and supplies from a machine is a step toward reduced fire risk no less than a gain in simplicity. The high efficiency of the tungsten filament enables a battery of moderate capacity to be used in the supply of current for lighting, where the old carbon lamp would be practically prohibitive. In a standard equipment of two twenty-candle-power headlights, two two-candle-power side lights and one two-candle-power tail light a 100-ampere-hour storage battery will supply these lamps continuously for twelve hours without re-charging.

The Best Results.

The life of the lamps and the capacity of the battery can be increased considerably in effect by cutting off the headlights when running in the towns and cities, and the ease of control is so great in comparison with that of gas or oil, that there is no tendency to leave the lamps burning when not needed, to escape the trouble of adjusting them. The use of four, six or eight-volt lamps enables the equipment to be installed in connection with the ignition battery service. To secure the best results with low-voltage tungsten lamps on a car, it is recommended that the wiring should be of fairly heavy cross-section, since such lamps are sensitive to a potential drop which would cut little or no figure on a 110-volt circuit. For headlight service No. 10 wire, B. & S., is about as small as appears desirable, and for the side and tail lights, No. 14 gives better results than a smaller section. As a rule it is desirable to equip the lamps with candelabra sockets, as the miniature sockets often found on small tungstens are too small to withstand heavy vibration and to carry the necessary current. Subdivision of the circuits is desirable in the interest of operating convenience and economy, with the provision of one or

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two outlets for the connection of portable trouble lamps or lamps for the examination of maps and road books. An extra switch is an advantage if located in an out-of-the-way place, so that unauthorized handling of the lamps will not take place in the absence of the owner. Small lamps of this type can be used acceptably over the speedometer, cyclometer, and oil gauges.

Electric Headlights for Locomotives.

The Indiana Railroad Commission has issued an order requiring all railroads operating in that State to equip their locomotives with headlights of at least 1,500 c.p. The order requires one-third of the locomotives to be so equipped by July, 1 one-third by January 1, 1911, and the remainder by July 1, 1911. The order does not expressly specify electric lights, only declaring that the present oil light is inefficient and shall be discontinued by the substitution of a high power lamp; but the Chairman of the Commission, in announcing the decision, said that the conclusion had been arrived at, after long and careful experiments made by the members of the commission in riding behind both oil and electric headlights, and also, experiments made by the dean of the engineering department of Purdue University. The best railroads in the country were, he said, installing electric lights on their engines and the commission had concluded that the objection urged by enginemen as to their blinding effect was overestimated, especially since the order requires that the new power lamp to be installed shall be equipped with a device which will enable the engineman to reduce the brilliancy of the lamp at will. The cost of installing each lamp is estimated at $125 to $300. There are upwards of four thousand locomotives used in Indiana which will come under the order of the commission.

Current Items.

New plant, estimated to cost $3,000,000, is to be laid down by the Belknap Power Company, for a new hydro-electric enterprise in the Sevier River district in Utah. The power to be developed is about 7,000 h.p.

A new scheme for the utilization of sunshine comes from Burlington, in Vermont, where Mr. G. H. Cove is reported to have applied the thermopile principle to the conversion of solar energy into electricity for charging storage batteries. The despatch which conveys this intelligence adds, "details are lacking."

The maximum load of the Commonwealth Edison Company, Chicago, for 1909 occurred on December 6 and reached 158,090 kw., which was also the maximum load in the company's history.

Nearly $60,000,000 has been spent for subways in New York city, according to figures sent to the Tax Department by the Public Service Commission. Of this sum nearly $7,000,000 has been expended on the new loop between the East River bridges, which Comptroller Metz used to call a "hole in the ground" and which will not be put in use for some years. The main subway, including the Brooklyn end, cost $52,254,468, including all the extensions, alterations, terminals, interest and damages.

The Shasta Power Company has been organized with a capital of $1,000,000 to develop electric power from the Pitt River, California, and will spend $2,000,000 in the construction of dams and the installation of plant.

Electric drive is rapidly superseding other agencies in North Carolina as a motive power for textile factories. Statistics compiled to the end of 1909 show that out of 312 cotton, woollen and silk mills, 118 use steam; 81 electricity; 42 steam and water; 34 water; 28 electricity and steam; 4 steam, electricity and water; 1 uses gas; 3 not reporting. Of the 63 knitting mills, 8 use electricity; 5 gasoline; 1 uses electricity and water, and the others use steam. It is clear, however, that while the use of electricity is rapidly growing, there is much room for the development of the electric drive.

FRENCH NOTES.

PARIS.

Although the worst of the floods are over, both as regards the capital and the whole country, much anxiety still exists in Paris, for the after effects may be very bad. There can be no doubt about it, electrical undertakings of all kinds have suffered severely, and it will be some time before all is in order again. So far as the electric railways are concerned, especially the underground ones, it is impossible as yet to estimate the amount of the damage, but in the Metropolitain the destructive effects of the flooding must be very great, for the waters have been racing through at a tremendous rate. As the waters recede subsidences may occur, as the result of the washing away first of the foundations of buildings and sub-ways, and then, still more alarming, of the vast net-work of disused quarries.

Steering by "Wireless" Telegraphy.

Some experiments which may prove of considerable importance have been carried out in the matter of steering launches and ships from the shore by means of wireless telegraphy. It was found quite easy to control the electrical steering gear from a considerable distance, launches being made to execute all kinds of evolutions. The experiments have a practical value, for it shows that ships can be, when circumstances render it advisable, piloted from shore. This might be very useful during storms, or say, in time of war, when the channels of an estuary or the entrance to a harbour were beset with sunken mines, and it was deemed best not to entrust the secret of their whereabouts to pilots.

Aluminium Cables.

I recently mentioned that the use of aluminium cables is much on the increase in France. A few statistics, given by the Société des Ingénieurs Civils de France, may prove interesting. The Energie Electrique du Littoral Méditerranéen has a line to Toulen 90 kilometres long of 107 milimetres, conveying a current of 30,000 volts, and another to Marseilles 250 kilometres long, of 107 milimetres, 50,000 volts. The Société du Sud Electrique has a cable 60 kilometres long of 120 milimetres, conveying 13,000 volts. The Société Biterroise de Force et Lumière also has a cable. The Société d'Energie du Centre has a cable of 93 milimetres, conveying a current of 3,000 volts. The Société Dauphiné-Centre has underground cables 200 kilometres long. The Société de l'Eau d'Olle is laying down a considerable length of aluminium cable for the transmission of power. The Compagnie Thomson-Houston, of France, is laying down in the Haute-Durance a line of 130 kilometres long, of 130 milimetres. The Compagnie Nord-Sud de Paris will have its feeder cables of aluminium of 300 milimetres, composed of wires 3·23 mm.

Aluminium Resists Sea Water.

It was said that aluminium cables, unless very thoroughly protected, could not be laid near the coast, because the sea air would soon corrode the metal. This has not proved to be the case at Salin-de-Giraud, where there exists a considerable length of aerial aluminium cable, unprotected and constantly exposed to the saline laden vapours arising from the salt pans over which it is stretched. This cable has been in use for a long time, and has given no trouble, which is certainly a contrast to the behaviour of copper under even less severe exposure.

Mercury Vapour Lamp and Water Sterilisation.

Dr. Nogier, of Lyons, has for some long time past been experimenting with the mercury vapour lamp, finding that the ultra-violet rays emitted therefrom are very powerful in destroying any bacteria that may be present in limpid liquids, especially water. He has succeeded in removing the most virulent germs from drinking water, without altering its chemical composition. One minute's exposure to the rays of the lamp suffices for the process of sterilisation. He has now perfected an automatic water steriliser, consisting of an aluminium tube containing a mercury vapour lamp, and controlled by an electro-magnetic tap, which at once stops the flow of water should the lamp be put out of action. This method of sterilising drinking water is claimed to be infinitely better—more certain, scientifically perfect and cheaper—than the electro-ozone process.

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Telegraph and Telephone Congress.

The following topics have been singled out for special discussion at the Second International Congress of Telegraph and Telephone Engineers, to be held here:

(1) Manual *versus* automatic systems of telephone working.

(2) (*a*) Simplification of telephone circuits; (*b*) selection of frequency and secondary potential (for purposes of theoretical investigation) with a view to facilitating the approach of the telephone current to the Sine wave-form; (*c*) the circumstances conditioning the adaptability of telephone apparatus to the lines, induction coils, microphone resistance, etc.

(3) Precautions to be taken for the avoidance of mutual disturbance in the case of power circuits running in close proximity to telegraph and telephone lines.

(4) Telephony between places at great distances from each other. Construction of cables for long-distance use, relays, combination of aerial lines with cables.

(5) Wooden poles—new process for impregnation and preservation—and procedure described from actual practice as to staying and strutting.

(6) Party lines and selective calling upon telegraph and telephone lines.

(7) Telegraph systems for heavy traffic. Multiple type-printing telegraphs and the Mercadier system.

GERMAN NOTES.

BERLIN.

Some interesting experiments have recently been brought to a successful issue with the high voltage microphone system devised by the Swedish engineers, Egner & Holmstrom. The wires connected the royal palace at Stockholm with the Grand Ducal Palace at Carlsruche, and the King of Sweden conversed with the Grand Duke of Baden over the telephone, as did other only slightly less illustrious personages. The distance is nearly a thousand miles as the crow flies, and the enunciation was as perfect at one end as it was at the other. The new system is already in operation between Stockholm and Hamburg, and will soon be extended to Berlin and Paris.

Hydraulic Engineering Investigations.

My Vienna correspondent sends me two interesting items. First of all he tells me that a highly important body, which cannot fail to contribute largely to the development of electrical industries and to scientific education, as well as to interesting the general public in electrical questions, has been formed in Austria. The Bund Oesterreichischer Industriellen, the Oesterreicnische Ingenieur und Architektenverein, the Elekrotechnischer Verein, and the Zentrawerein fur Fluss und Kanalschifffahrt have combined to constitute a central office for considering all questions concerning hydraulic engineering. The regulations for its management have already received official sanction, and many corporations and chambers of commerce have signified their intention to co-operate actively with the new project. Experts will preside over every branch of the industrial use of water. As regards the matter of effluents, chemical and bacteriological investigations will be undertaken and various courses of instruction will be gradually instituted. An exhibition is also planned. It will be seen that the whole project is sufficiently ambitious, but it deserves our heartiest wishes for its success. Perhaps some day we shall have something of the kind on this side of the Channel.

Agram (Croatia).

The latest project of the municipailty of Agram, to erect a new central power station, has assumed tangible shape. The cost will be about a quarter of a million sterling, and it is expected that the turbines, which will be driven by an artificial waterfall on the river Save, are expected to supply from 5,000 to 6,000 h.p.

Company Notices.

The Elektrizitatswerk Berggelst A. G., Brühl, near Cologne, made a gross profit of 311,335 marks for 1908–9, and is paying a 4% dividend. The interesting point is the increase in the output, which rose from 6,900,000 kw. hours in 1907–8 to 10,300,000 in 1908–9. So far this rate of increase has been maintained during the current financial year.

PHASES OF TRANSFORMER REGULATION.*

By W. A. HILLEBRAND and S. B. CHARTERS, JR.

The following paper is based upon experiments conducted at Stanford University during the past two years upon the regulation of transformers under varying conditions. The first test was made upon a single phase, 200 watt, 11,000-110 volt meter-transformer. Owing to the importance of voltage and phase regulation in such a transformer, particularly when applied to the measurement of a large amount of power, a knowledge of its behaviour in this regard is extremely desirable.

The remaining tests were made upon power transformers variously connected to polyphase networks, for the purpose of determining the cause and probable extent of the unbalancing in polyphase connections that occur under certain conditions.

The connections investigated were:

Three-wire, two-phase system of distribution.

Open delta.

Scott two-phase to three-phase transformation.

Insamuch as any transformer in a group feeding into a polyphase network behaves precisely as it would when operated from a single-phase circuit under similar conditions of load and power-factor, the performance of the group of transformers is to be explained on the basis of the performance of their individual units as single-phase apparatus.

The impedance of the transformer causes not only a variation in the amount of secondary voltages but also a displacement in phase. With leading current the secondary electromotive force is displaced more than if the power-factor were unity, and still more than if the current were lagging.

Meter-transformer.

Since in most installations special transformers are inserted between the power mains and the instruments, the accuracy with which the power is measured depends not only upon the inherent accuracy of the instruments but also upon the regulation, both voltage and phase, of the transformers. Thus, if the secondary pressure of the meter-transformer is lower than it should be, due to loading, the power recorded will be less than the real value. Also, if the phase-angle between the currents in the pressure and field coils of the meter differs from that between line pressure and current, a second error is introduced.

It is well known that meter pressure transformers are provided additional secondary turns to compensate for the drop due to loading, so that when used at their specified load they give their rated voltage ratio; and to give this ratio the load should be as nearly as possible that for which the transformer is compensated. It is comparatively easy in this way to compensate for voltage-drop at any given power-factor, but this will not compensate fully for the drop at a different phase relation between current and electromotive force.

Theoretically it should be possible, by making the resistance very large in proportion to the reactance, to design a transformer of perhaps poor voltage regulation at unity power-factor but one which would give nearly the same drop over a range of power-factors much less than unity. An effort to accomplish this end might have been made in the transformer tested, in which the dimensions are as follows:

Ratio of turns—100; 1 approximately.
Primary resistance = 5,900 ohms.

Primary resistance in secondary terms =	0.59	ohms.
Secondary resistance	0.306	„
Equivalent resistance	= 0.898	„
Impedance, in primary terms	0.9824	„
Impedance, in secondary terms	0.9824	„
Equivalent reactance	= 0.406	„

Voltages—11,000 to 110.
Capacity—200 watts.
Full-load secondary current = 1,82 amp.

This shows an equivalent resistance of somewhat over twice the equivalent reactance, proportions entirely different

* Paper presented at a meeting of the San Francisco Section of the American Institute of Electrical Engineers, San Francisco, Cal., October, 1909.

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from those in the ordinary power transformer, but in spite of this fact the voltage-drop varies widely with the power-factor.

For full-load current between unity and 75% power-factor there is a difference of 1.6% in the voltage-drop, the total drop being for the first case 2.7% and for the second 4.3%, quantities so large where the measurement of any considerable amount of power is concerned as to necessitate, for accurate results, that the transformer be compensated at the factory not only for its specified load but also at the power-factor at which that load operates. Otherwise the meters should be calibrated with the transformers to which they are connected.

A thorough investigation of the extent of the phase displacement of secondary voltage in pressure and current transformers has been undertaken by the National Bureau of Standards, and will be published entire in one of the *Bulletins* issued by the Bureau. In the only report as yet printed no figures are given, but the statement is made that "the shunt transformer is a device of high precision and that the same is true of the current transformer, but to a less degree."

Three-Wire, Two-phase Connections.

Turning now from the meter-transformer to the subject of polyphase connections, we will take up the question of distributing two-phase power over three wires. This connection was investigated because it is largely used in the distribution of power, and the belief has been expressed that the throwing of quarter-phased currents together into a common conductor will cause voltage unbalancing and phase distortion.

Two 4-kw. 2,200/220 or 110-volt transformers were connected to a receiver through a line 95 ft. long, consisting of three wires spaced 65 in. apart, the outer wire being No. 12 B. & S. and the middle of the same wire doubled for 41% of the distance to give the same drop as either of the outer wires.

Resistance of each outer wire = 0·148 ohms.
Resistance of middle wire = 0·117 ,,
Reactance of each wire = 0·01 ,, (about).

The line gave, with full load on the transformers at 110 volts, about 12% drop, and about 6% drop with full load at 220 volts.

The results of a run on non-inductive load are given in Table I.

TABLE I.

	Volts		Amperes		Angle phase difference	Per cent. unbalance
	Phase A	Phase B	Phase A	Phaes B		
No load	110.4	110.5	0.	0.	90° 48′	.09
Load ..	97.4	96.1	34.15	34.05	94° 57′	1.34

These figures, showing an unbalance of 1·25% and phase distortion of 4° 9′, are of interest to the extent that they support the theoretical conclusion that there should be unbalance and phase distortion as a result of this connection.

When furnishing power to an induction motor at 220 volts the figures were, Table II.

TABLE II.

	Volts		Amperes		Angle phase difference.	Per cent. unbalance
	Phase A	Phase B	Phase A	Phase B		
No load	2220.8	220.1			89° 46′	0.3
Load ..	195.2	198.0	18.23	19.8	92° 4′	1.414

Here there was an unbalancing of only 1.11% and a shift in phase of 2° 18′.

The same reason that led us to investigate the subject of three-wire, two-phase distribution, also prompted the experiments on the open delta and Scott T, to determine to what extent these unsymmetrical connections may lead to unbalancing or phase distortion.

In Table III. are shown the results of loading two 10 kw. transformers in this manner.

TABLE III.

	Electromotive force			Per cent. unbalance.	Angle 'C' Fig. 8.
	Phase 1	Phase 2	Phase 3		
No load	254.4	253.2	253.4	0.472	59° 58′
Load	246.6	240.3	236.6	4.05	58° 13′

Balanced non-inductive load, 50 amperes per phase. Phase is the open phase.

With these particular transformers carrying approximately full-load current, there was an unbalancing of 3·58% and a change of 1° 45′ in the phase-angle between their pressures. A convincing demonstration of the fact that the current in one transformer is leading was obtained by inserting a choke-coil in series, which caused an immediate increase in wattmeter reading, the current and voltage remaining practically the same.

The regulation on non-inductive load is chiefly of theoretical interest. The induction motor when operated from such a system exerts its customary regulating effect so that unbalancing and phase distortion are by no means so pronounced. Unfortunately, we had but one three-phase motor, which could load the transformers to only about half of their capacity so that regulating effects were not very marked. In Table IV. are presented, however, comparative readings on non-inductive and induction motor loads of approximately equal value, which show relatively a greatly improved performance on inductive load over that on non-inductive load, although the unbalancing in either case was slight.

TABLE IV.

	Electromotive force			Per cent. unbalance	Angle.	
	Phase 1	Phase 2	Phase 3			
Non-inductive Load	232.1 229.2	230.3 224.4	231.7 223.9	0.776 2.31	60° 12′ 59° 11′	no load load
Inductive .. load	233.6 226.0	230.2 224.3	232.1 222.5	1.45 1.55	60° 3′ 59° 21′	no load load

Phase 3 is the open phase. The currents were 27·9 and 27·2 amperes per phase for the non-inductive and the inductive loads respectively.

For the non-inductive load the unbalance and phase distortion were 1·53% and 1° 0′. For inductive load they were 0·1% and 0° 42′ respectively.

The above results are of value only as a check upon the theory that explains the regulation of V-connected transformers. In the most unfavourable case, when full-load current was drawn by a non-inductive receiving circuit, the unbalance was between 3 and 4%. On inductive load the unbalancing would doubtless be considerably less, so that, judging from the performance of these two 10 kw. transformers, which are representative of modern apparatus the unbalancing resulting from the V-connection or open delta is not likely to be serious, a conclusion doubtless in accord with practical experience.

When supplying induction motors with power-factors of from 85% to 90%, one transformer operates at about unity power-factor and the other operates at a power-factor of from 50% to 55% lagging.

With initially unbalanced primary circuits, the transformer with the high voltage draws a heavier current, which, however, if the power-factor of that circuit is the high one, will on that account exert a correspondingly less regulating effect; whereas the low power-factor current in the other transformer will exert a relatively greater effect, so that there may be no improvement in line conditions with load, a particular case in which induction motors fail to balance up the line. This is brought out in Table V.

TABLE V.

	Electromotive force			Currents			Per cent unbalance.
	Phase 1	Phase 2	Phase 3	1	2	3	
No load ..	230.1	216.8	223.8	0	0 .	0	5.8
Load	225.0	212.2	218.6	24.0	19.4	26.15	5.7

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Theoretically, then, the V-connection of transformers will cause unbalancing, due to the different power-factors at which the two operate; but with well designed apparatu supplying induction motors, this unbalancing should be small. With initially unbalanced circuits conditions may be such that the induction motors fail to exert any regulating effect.

These conclusions are based upon experiments in which the electromotive force was nearly sine wave in form. Where a pronounced third harmonic is present, the pressure across the open side is much distorted, which might cause trouble aside from any phase distortion or unbalancing of the fundamental.

Scott T-connection.

Currents of different phase relation flow in the two halves of the transformer which constitutes the top of the T. In one half the current may be leading by 30° and in the other half lagging by the same amount. This means that the regulation in the two halves will be different. One side of the delta electromotive forces will tend to hold up its voltage and the other to drop off.

These transformers are of the core type, with a primary and a secondary coil on each leg, wound for 2,200 to 1,100 to 220 or 110 volts.

In single-phase operation the draught of load current draws current from the primary whose ampere-turns neutralise the secondary load ampere-turns. In this case, however, with primary coils in series, but one load current can flow, which can only neutralise the vector sum of the two secondary currents.

With primaries in series as before, but secondaries in parallel, furnishing 110 volts, instead of 220, the regulation is greatly improved.

The unbalancing from no load to full load is 2·3% as against 22·7% for the series connection.

When secondaries are connected in parallel the result is a greatly reduced leakage flux with consequent improvement in regulation.

As a further experiment, the two halves of the primary winding of transformer were each excited by means of separate transformers at 1,100 volts, equivalent to placing the two primary coils in parallel across an 1,100 volt circuit. With secondaries connected in series, the secondary current in one leg is leading and in the other lagging, but with each primary coil supplied independently of the other, it could draw a load current whose ampere turns would at all times equal those of its corresponding secondary, as in the single-phase transformer. The result was small leakage flux and good regulation.

TABLE VI.

	Electromotive forces			Per cent. unbalance	Average amperes per phase.
	Phase 1	Phase 2	Phase 3		
No load	221.8	220	0.82	220	
Load	200	194.6	192.0	4.0	38.9

With this connection the unbalance from no load to full load was only 3·2% as against 22·7% for both primaries and secondaries in series. The currents were 41·9 and 47·1 amperes per phase for the parallel and series connection of primaries respectively.

As a final experiment three transformers were used, each consisting of half of an independent transformer. This does away with complications due to leading and lagging currents in the same transformer, and gives good regulation whether primaries are connected in series or in parallel.

Using three transformers, the unbalancing from no load to full load, secondaries in series, was 85%. With secondaries in parallel the unbalancing was 63%. These were for non-inductive loads. When operating induction motors the unbalancing was less, or even an improvement over no-load conditions; for, not having a tap on the transformer used as the stem of the T that was approximately 86·6% of the base, the secondary voltages were initially unbalanced between 1 and 2%.

Our tests were all based on transformation from two to three phases. When transforming from three to two phase, it is the primary of one transformer that carries different power-factor currents in its two coils, but the effect would be the same as with similar currents of equal ampere-turns in the secondary coils, so that any conclusions drawn from these experiments should apply equally well to both cases.

Wherever serious unbalancing is caused by T-connected transformers transforming from two to three phase, or the reverse, it is probably due to excessive leakage flux caused by different power-factor currents that circulate in the two halves of the transformer comprising the top of the T. This leakage flux may be greatly reduced and regulation correspondingly improved:

1. By proper interlacing of the transformer windings, secondaries, if transformation is from two to three-phase; primaries, if the reverse.
2. By joining in multiple the two halves of the transformer used as the top of the T, on the side that connects to one of the two-phase circuits.
3. By using three transformers, where available.

NATAL GOVERNMENT RAILWAYS.

THE ELECTRICAL DEPARTMENT.

By F. W. MILLS, M.I.E.E.

The electrical branch on these railways is one of fairly recent date (says Mr. Mills in the *South African Railway Magazine*). The railway telegraphs being maintained and worked under the control of the Government Telegraph Department, there existed no railway electrical branch till May, 1896, when the first experiments in the electric lighting of trains took place.

The initial experiments were quite successful, and all passenger vehicles were gradually equipped. At first, accumulators were employed, fixed in the vans for lighting the whole train, and "charging depots" were installed at Durban, Pietermaritzburg, Charlestown, and Ladysmith This method was a cumbersome one from the Traffic Department point of view, and the "Stones System" was later introduced for all corridor and special vehicles.

As the "Stones System" was so uniformly successful, it was adopted for the whole of the train lighting, but, instead of having a complete equipment for each vehicle, "Stones" dynamos were installed in the vans, keeping the old van batteries in use for lighting the trains. This final change took place some 14 months ago, and train lighting has since been reduced considerably in cost, the system being much more convenient to the Traffic Department, as no charging depôts are now necessary, involving shunting of vans, etc.

In all local trains, therefore, the lighting is supplied from one "Stones" equipment, fixed in the van, and only the through mail service has separate equipments for each of the larger corridor stock.

This adaptation of the "Stones" system was only rendered possible by the introduction of the high efficiency metallic filament lamp. Both the "Tungsten" and "Tantallum" type of lamp are used, and are found most satisfactory for train lighting.

During 1908 our costs per vehicle per annum only totalled £13 3s. 3d., and at the rate of ·36d. per coach hour. During the first six months of the present year this figure has been reduced to 25d. per coach hour.

When the electrical branch was first started, in May, 1896, the Durban yards, sheds, and offices were installed with electric light, and a small generating plant of 12·5 kw. capacity was put down for that purpose, and from this small beginning the Durban Power House has developed to its present capacity of 2,770 kw.

In the early part of 1901 the General Manager had before him the question of re-building the Railway Workshops. I, therefore, seized the opportunity of introducing to his notice the claims of electrical driving, and in the end he decided to adopt electric driving. Plans and general specifications were, therefore, made out, and tenders called for, and contracts placed in England for the whole of the power house plant. The power house was erected, and the plant ready to operate in July, 1904, since which date it has run continuously. The railway workshops were erected

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in the meantime, and all the machines are operated by electric motors, of which there are in the Durban shops no less a number than 431, equalling an aggregate of 2,473 h.p. The electrification of the workshops has been very successful, and only minor troubles are experienced. In any month the reported failures rarely exceed 1 %, and these are often quite trifling, chiefly referring to rheostats.

So soon as the electrification of the workshops was accomplished, a covetous eye was turned toward the Harbour Department, and in November, 1904, I submitted to the General Manager a proposal to amalgamate with that department for power supply purposes. In designing the Durban Power House, space was left for extension, as the Harbour load was always at the back of my mind, and we were, therefore, in a position to press for this development.

At this time the Harbour Department had one power station in the Point area, and were preparing to erect another power house at the Bluff, the funds having already been voted for that purpose.

The "case for amalgamation" having been fully proved, the Government accepted same, and instructions were given to that effect, whereby the two electrical branches were merged into one.

Plans and specifications for the new scheme were made out, tenders were called for, and the plant installed.

In July, 1907, the turbines started work, and since then the electrical supply to the harbour has been generated at the railway power station.

Electricity at 6,600 volts pressure is transmitted to No. 1 sub-station at the Point, and to No. 2 sub-station at the Bluff, and there converted to 550 volts direct current for power purposes, in each area, and to 115 volts alternating current for incandescent lighting.

There are duplicate lead covered and armoured feeders laid along the railway line from the power house to the harbour, looping into No. 1 sub-station and thence to the harbour entrance channel, where they are laid across at a depth of 50 ft. from low water level, to the Bluff sub-station for the coaling appliance power supply.

The annual saving, due to the amalgamation of the electrical interests, amounts to a very large sum, and the scheme has been a complete success.

The following statement shows the scope and capacity of our department, apart from train lighting:—

At Durban, for railways, 210 v. D.C., 2,770 kw.; for harbours, 6,000 v. 50 cycle three-phase current, 500 kw. At the various stations and sub-stations there are 491 motors of a capacity of 4,067 h.p. and 3,114 kw.; 487 arc lamps, 279·3 kw.; and 11,385 incandescent lamps, 779·5 kw. The total capacity is 4,680 kw.

At Maritzburg an up-to-date comprehensive electrical scheme has been installed for the power supply to the Railway and Public Works Department's workshops, the lighting of yards, offices, sheds, and Government buildings generally.

At Ladysmith we have also a fairly extensive plant for the same purpose.

At Charlestown, Mooi River, and Inchanga we have small plants installed for yard and station lighting.

At Hill Crest there is an important pumping plant, dealing with a problem that would have been a very difficult one without making use of electrically driven pumps. This plant has the distinction of being the first three-phase electric plant erected in Natal.

The electrical branch is young compared to other branches of the service, but it is very vigorous and full of life, and is prepared to tackle greater problems, even to the "Electrification of Railways," should the traffic conditions ever warrant same.

NON-RETURNABLE SPECIFICATION FEES.—We are informed that the Municipality of one of our largest towns issued an advertisement asking for tenders for certain electrical goods, a fee having to be paid for the specification, which fee was not to be refunded. The matter was taken up with the Town Clerk by the National Electrical Manufacturers' Association (incorporated), with the satisfactory result that he has informed me that the amounts will be refunded to all firms who have sent in *bona-fide* tenders.

TRAMWAYS USER.

In the Chancery Division, before Mr. Justice Eve, the case of the Eccles Corporation *v.* South Lancashire Tramways Co. was heard. The plaintiffs sought a declaration that the Salford Corporation were not entitled to authorize the defendant company to use the plaintiffs' tramways and for an injunction to restrain the defendant company from running cars over their lines.

Eccles is bounded on the east by Salford, and on the west by Worsley, and the defendant company work tramways in the Worsley urban district and up to the western boundary of the borough of Eccles, but possess no powers to work tramways within that borough. In virtue of the Eccles Corporation Act, 1901, Section 24, the plaintiffs entered into agreements of April 11, 1902, and July 31, 1907, whereby tramways within the borough of Eccles have been constructed and worked by the Salford Corporation, the plaintiffs supplying the electrical energy. The first agreement provided for the granting by the plaintiffs to the Salford Corporation of a lease for 35 years to run cars with flanged wheels upon the tramways within Eccles borough, subject to the terms mentioned in the fourth schedule of that agreement, which provided for the licensing by the plaintiffs of the Salford tramcars plying within the borough of Eccles, that they should work the tramways to the best of their ability, and should not assign, sub-let, or part with the benefit of that agreement or the lease except by licence under the seal of the plaintiffs. The Salford Corporation worked the tramways, and on June 2, 1908, they granted a licence to the defendant company to run cars over a portion of the tramway. The defendant company did not apply for or obtain any licence from the plaintiffs, the Salford Corporation claiming the right under the agreements to authorize the defendant company to run cars within the borough without any such licence. The plaintiffs alleged that the defendants by wrongfully running cars within the borough were trespassing on the tramways and causing damage to the plaintiffs.

In delivering judgment, Mr. Justice Eve said: The plaintiffs allege that the granting of the licence is a breach of the agreement of April 11, 1902, and is an act *ultra vires* of the defendant corporation. The defendants maintain that there is no branch of the agreement, and that the transaction is one entirely within the statutory powers of the defendant corporation. It will be convenient to deal with the latter question first. The point may be stated thus: Could the defendant corporation as lessees of the plaintiffs' tramways, in the absence of any special terms in the lease prohibiting them from so doing, grant to the defendant company permission or licence to use the tramways or any part of them? The plaintiffs say no, that the subject-matter of the demise is a Parliamentary franchise—the statutory monopoly to use on the authorized tramways carriages with flanged wheels or other wheels suitable only to run thereon (see Section 34 of the Tramways Act, 1870)—and that it is for those who assert the power of lessees of such a subject-matter to license others to use the tramway to demonstrate clearly where such power is to be found. They point to Section 35 of the Tramways Act, 1870, as indicating the only circumstances in which the Legislature has contemplated the joint user of a tramway by licensees and promoters or the lessees of promoters.

The defendants do not dispute that the burden of establishing statutory authority to do what they have done lies upon them, and they contend that so far as the corporation are concerned the authority is to be found in Section 28 of the Salford Corporation Act, 1899, and so far as their licensees are concerned, power to accept the licence is conferred upon them by Section 41 of the South Lancashire Tramways Act, 1903. Section 28 of the Act of 1899, read with the assistance of the definitions in Section 4 of the same Act and in the light of the facts of this case, empowers the defendant corporation to enter into and carry into effect contracts and agreements with the owner of any tramways in any adjacent district which can be worked with the tramways demised to the corporation by the plaintiffs. Pausing there, I think in construing this part of the section, I am bound to treat the defendant company as the owner of tramways in an adjacent district, having regard to the object of the section and to the fact that the expression "corporation tramways" includes tramways

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demised to the corporation. The contracts and agreements contemplated by the section are contracts with respect to (*inter alia*) the working and use by the contracting parties of all or any of their respective tramways and works or any part or parts thereof respectively, to the supply for all or any of the respective tramways of the contracting parties being worked by the other of them of rolling stock, plant, and electrical energy, and to the other matters therein mentioned, which include the "interchange, accommodation, conveyance, transmission, and delivery of traffic coming from or destined for the respective undertakings of the contracting parties." The section confers, in wide terms, powers which enable the undertakings of the various promoters to be worked in the manner best calculated to meet the public convenience and to secure traffic—that is, as one continuous undertaking and not as a series of disjointed undertakings, each managed, worked, and controlled by a separate authority with no power outside the limits of its administrative area.

The terms of the section are sufficiently wide to confer upon the defendant corporation authority to make the arrangement which is embodied in the licence of June 2, 1908, and the mere fact that the arrangement assumes the form of a revocable licence is not, in my view, material. So long as the licence remains in force and the licensees take the benefit of it, they are under contractual liability to pay the mileage charges thereby established, and I think I should be adopting an altogether too narrow construction were I to decide that the arrangement brought about by the document is not within the scope of the section. For similar reasons I think the terms of Section 41 of the South Lancashire Tramways Act, 1903, authorize the arrangement on the part of the defendant company. So I come to the conclusion that the plaintiffs cannot succeed on the ground that the impeached transaction is one *ultra vires* of the defendants or either of them.

The question remains whether its validity can be successfully assailed on the ground that it is a breach of the agreement of April 11, 1902. The plaintiffs contend that the whole agreement is so framed as to impose on the defendant corporation the obligation to work the demised tramways themselves and to exclude a construction which would confer upon them any right to transfer this obligation. The defendants, on the other hand, point to the schedule as negativing the argument founded on any inherent non-assignability of the contract. I think the contention of the defendants ought to prevail. The expressed intention of the parties is that, except as therein provided, the defendant corporation are to have assured to them the plaintiffs' statutory right to the exclusive use of the tramways; that is to say, that, as between the contracting parties, the defendant corporation is to step into the place of the plaintiff corporation except so far as the contract otherwise provides. In the absence of any express stipulation controlling the free exercise by the defendant corporation of the statutory power of granting the licence, which I have held them to possess, I do not think I ought to imply or infer any such restrictive stipulation merely because an examination of the agreement leaves upon one's mind the impression that the parties entered into it contemplating that the tramways would, in fact, be worked by the defendant corporation, and that neither of them at the time appreciated that an arrangement such as has been come to between the defendants was practicable, and if come to would not be contrary to any express term of the agreement. I hold, therefore, that there has been no breach of the agreement by the defendant corporation, and the result is, that I must dismiss the action with costs.

Electrical Engineers Territorials (London Division).—Orders for week ending February 12, 1910: Monday, February 7, "A" Company, Technical Drill, 7 to 9.30 p.m.: Recruits' Infantry Drill, 6 to 7 p.m.; Tuesday, February 8, "B" Company, Technical Drill, 7 to 9.30 p.m.; Wednesday, February 9, Gymnasium, 6.30 to 9.30 p.m.; Thursday, February 10, "C" Company, Technical Drill, 7 to 9.30 p.m.; Friday, February 11, "D" Company, Technical Drill, 7 to 8.45 p.m.; Infantry Drill, 8.45 to 9.45 p.m.; Saturday, February 12, "D" Company, Week-end run at Coalhouse Fort, Parade at Fenchurch-street Station, 3.15 p.m.: Dress—Service Dress with putties, greatcoat, and haversack. (Signed) P. H. Campbell, Capt. R.E., Adjutant.

LEEDS ELECTRICAL ENGINEERS' DINNER.

The Leeds Local Section of the Institution of Electrical Engineers' annual dinner took place on the 28th ult, at the *Hotel Metropole*, Leeds. A company of nearly a hundred sat down. The chair was occupied by Mr. W. M. Rogerson, of Halifax, and among those present were the Lord Mayor, Mr. Robert Hammond, Mr. A. G. Lupton (Pro-Chancellor of the University of Leeds), Dr. G. Kapp (President of the Institution of Electrical Engineers), Mr. Percy Robinson (President of the Leeds and Yorkshire Architectural Society), and Mr. H. Dickenson.

Mr. Robert Hammond proposed "The Corporation of Leeds." He said Leeds must prosper, because the city had thoroughly grasped the idea that, given its fine position, its water power, its supply of coal, and its sterling citizens, it had got a supply of electricity which was not excelled by any in the kingdom.

The Lord Mayor, in replying, pointed to the development of the Corporation's electrical undertaking, the capital involved having risen from some £60,000 to almost a million sterling. He would like the committee to encourage the supply of electricity for power purposes. His Lordship pointed out that a million and a half sterling was sunk in the tramways undertaking, and alluded with gratification to the fact that the concern was not only worked at a profit, but yielded a handsome surplus in relief of the rates.

Dr. G. Kapp pointed out that the reason why electrical engineers were so numerous was because they were the handmaidens of every other engineering profession. If a railway company wanted to push a train through a tunnel without asphyxiating its passengers under the Mersey, the St. Gothard, or the Simplon, it must use electricity. If rolling mills wanted to turn out quickly billets of the highest quality they used electricity also. The steel-maker found that by using electric smelting he could produce a higher grade of steel with certainty than with the old methods. That was the reason why steel smelting furnaces had been erected in many parts of the country. The Lord Mayor had asked for cheaper electricity. From the experience gained during the last few years, they might confidently predict that electricity was going to be cheap. In the Leeds district he thought they might be proud of what had already been achieved. In the heavy trades there were works which used electricity to a great extent, but he was astonished that in a great textile district like Yorkshire he saw so very few electrically-driven textile mills. He was surprised when Professor Barker, of Bradford, told him that they had "a commission which is investigating the subject." He (Dr. Kapp) thought it was rather late in the day to begin investigating when the utility of electricity had been proved by every other country on the Continent. He considered that the electrical industry had been injured by the report of the commission which had been issued. He did not think it redounded to the credit of the industry that at this time of day the usefulness of electrical driving should be questioned. In one shop on the Continent he had seen hundreds of motors studding the floor for the electric driving of cotton goods which were wanted, not for England, but for a country which he would not mention. About the report of the commission, there was one redeeming feature—they had not shut the door against electric driving altogether. He thought it would be to the benefit of spinners and weavers if they introduced electric driving, and in this connection he thought the Leeds Section of the Institution could do some useful work. He suggested that they should get some association of experts in the manufacture of spinning and weaving machinery, and form a committee to decide the question. He had no fear of the verdict in that case.

Mr. A. G. Lupton proposed "The Leeds Local Section," and as one connected with the Yorkshire Electric Power Co., said that in the year 1908 more than half the company's revenue came from the textile trade. Manufacturers were now very much alive to the benefits they enjoyed from electrically-driven machinery.

The Calcutta Electric Supply Corporation, Ltd., announce that the number of units delivered to consumers during the five weeks ended December 31, 1909, were 598,714, compared with 483,259 units in the corresponding five weeks of 1908.

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THE "X" SYNDICATE.

Under a compulsory winding-up order against the "X" Syndicate, Ltd., the first meetings of the creditors and shareholders were held at the Carey-street offices of the Board of Trade, Lincoln's-inn, W.C., before Mr. W. J. Warley (Official Receiver). The accounts filed under the liquidation showed liabilities £5,301, against assets valued at £4,425, and a deficiency of £1,882 to the shareholders. The syndicate was formed in March, 1908, with a nominal capital of £2,000, to acquire and carry on the business of manufacturers of electrical secondary batteries, formerly carried on by the "X" Electrical Accumulator Co., Ltd. The result of the syndicate's trading to June, 1909, was a loss of £1,395, and the working capital was exhausted by October, 1908. The directors attribute the failure of the syndicate to the breakdown of the negotiations with the Admiralty and with prospective purchasers of some of the syndicate's foreign patents. In the absence of a quorum, the meetings were formally adjourned.

ELECTRICAL DRIVING OF PRINTING MACHINERY.

PATENT INFRINGEMENT CASE.

The case of J. H. Holmes & Co. *v.* the Associated Newspapers, Ltd., came on in the Court of Appeal on the 7th ult., before the Master of the Rolls and Lords Justices Fletcher Moulton and Buckley. It was an appeal against the decision of Mr. Justice Neville (see ELECTRICAL ENGINEER, Vol. XLIV., page 650), against the plaintiffs, who are patentees and registered owners of Patent No. 9802, 0898, granted for an invention of "an improved system and means for driving newspaper printing or like machines at variable speeds by electric motors," and alleged infringements by the defendants. The defendants pleaded invalidity, anticipation, and prior user: they alleged that the invention had been used in England before the date of the Letters Patent by *The Times*, the *Standard*, the *Daily Telegraph*, the *Daily Mail*, and other newspapers. Mr. Justice Neville came to the conclusion that claim 1 of the plaintiff's patent claimed the use of mechanism the use of which for the same purpose had been already publicly described in this country before the date of the plaintiffs' patent. It followed that the plaintiffs' patent was bad and that the action for infringement failed.

Thereupon the plaintiffs appealed.

The Master of the Rolls said that in his opinion the judgment of Mr. Justice Neville was quite right. The appeal really turned upon the true construction of the specification. It appeared to his Lordship that it was plain that the invention had been anticipated, and for the reasons given by Mr. Justice Neville the appeal failed and must be dismissed with costs.

The Lords Justices also delivered judgments to the effect that the plaintiffs' patent was bad on the ground of anticipation, and that the appeal must be dismissed.

VILLAGE LIGHTING.

Glais, a part of the parish of Llansamlet, in the Rural District of Swansea, is now lit by electricity. It appears that Mr. Evan Lewis, a local colliery owner, had for some time past lit his private residence, Graig-y-Pal, with electric light, generated by a small plant he had set up Arising out of suggestions made, he offered to instal a larger and more up-to-date electrical plant, and to provide the current for the lighting of the village, if the Council were prepared to join with him. This they did with enthusiasm, with the result that in a very short time a power house had been erected and a modern generating plant installed.

The engineer in charge of the work was Mr. Higgs, Swansea, and the contractor was Mr. D. O. Williams, Morriston. The consulting engineer to the Council was Mr. Blake. The plant includes a suction gas engine, by Messrs. Hornby, Stockport; a dynamo, by Messrs. Crompton, Chelmsford; and a marble switchboard, by Messrs. Veritz, London. The accumulators consist of 120 cells of 40 amperes. The plant supplies 220 volts for street and private lighting, and provision has been made so that in event of a breakdown, the district lighting can be maintained for a fortnight from the accumulators. The cost to private consumers works out at about one penny for six hours, with one lamp of 32 c.p. The streets are lit with 34 lamps of 32 c.p., and two lamps of 50 c.p. All the outside works were constructed by Mr. D. O. Williams.

It is confidently expected that the Swansea Valley may soon see considerable industrial development, and this will be assisted by enterprise in the matter of electricity generating.

THE HISTORY AND MANUFACTURE OF ELECTRIC GLOW LAMPS.*

By MR. L. WALLIS.

The history of electric glow lamps does not date back so far as that of electric arc lamps. The very earliest attempt at the production of an incandescent glow lamp being by Jobart in Brussels in 1835; whilst an arc lamp was invented in 1801 or 1803.

Jobart's lamp consisted of a small piece of carbon heated in a partial vacuum. In 1841 De Molyens, of Cheltenham, produced a lamp in which Platinum wire instead of carbon was used for a filament. In 1845 Starr, of Cincinatti, invented a lamp which was contained in an enlargement at the top of a barometer tube; this, of course, was useless outside the laboratory, but showed the right course for improvement, namely, a complete vacuum. Several lamps, some simple, and some very complicated, were produced between 1870 and 1879, all founded on the use of carbon in a vacuum.

The production of the vacuum and the supply of current for the lamps were the chief difficulties with which these early experimenters had to deal; but when these were overcome by Sprengel producing his mercury pump, and the development of the shunt dynamo several other inventors entered the field, the chief of whom were Edison, Swan and Weston. These all produced more or less satisfactory lamps between the years 1880 to 1889. These lamps all used carbon filaments made by carbonising various vegetable substances such as bamboo and cotton.

These lamps led up to the production of the well-known Robertson's lamp in 1893. This is practically the same as the modern carbon filament lamp used on nearly every British supply company's mains. The manufacture of this lamp is described in some detail in a later portion of the paper.

In 1898 the metal Osmium was discovered, and this, together with the discovery of Tungsten and other rare metals, caused several serious rivals of the carbon filament lamp to come on the market, the most important of which is the Osram, produced in about 1906.

Two other important lamps, namely, the Nernst and Mercury vapour lamps, are mentioned, but space only allows of a brief mention of these.

THE MANUFACTURE OF A MODERN LAMP.

The filament of a modern lamp is usually made by squirting a solution of artificial cellulose, made by dissolving cotton wool in a solution of zinc chloride. This filament is carbonised by baking, after having been wound on to formers to give it the required shape. It is then "flashed" and mounted on to platinum "leading in" wires, which are first sealed into a short piece of glass tube. This glass tube is then sealed into the bulb, which is then exhausted from a small glass tube which has previously been melted on to the top of the lamp for this purpose.

The exhaustion is done either by a Sprengel mercury pump or a good mechanical pump helped by chemical means. The cap is next cemented on, and the lamp is then ready for testing, and having been marked with its candle-power and voltage, it is ready for the market.

Metal filaments are made by a great many methods, of which three are shortly described in the paper. The makers of these filaments keep their processes so secret that it is somewhat difficult to obtain much information about them.

The paper concluded with an account of a few lamps made for special purposes, such as the Bernstein series lamp, the Linolite tube lamp, and lamps made with the filament so arranged as to increase the vertical candle-power.

* Abstract of paper to be read before the Northampton Institute Engineering Society, on Feb. 4, at 5.45 p.m. Dr. C. V. Drysdale in the chair.

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BUSINESS NOTES AND NEWS.

LIGHTING AND GENERAL—Home.

BEXHILL-ON-SEA.—Application has been made to the Local Government Board for sanction to a loan of £3,058 for extension of the electricity mains.

BRIDLINGTON.—A proposal is under consideration to appoint Mr. A. J. Barrett, the Corporation's Electrical Engineer, as consulting engineer for all work over £200, at a commission of 1%.

DUNDEE.—The Electricity Committee of Dundee Corporation at its last meeting resolved that all future building constructional work in connection with the department be carried out by the City Electrical Engineer.

GLOUCESTER.—Alterations are being carried out at the Corporation electricity works to obviate the possibility of breakdowns. The department has been very active in making the result of the elections known by means of illuminated signs.

HULL.—The Hull Electrical Contractors' Association sent a deputation to the Electric Lighting Committee to protest against any move on the part of the Corporation to sell fittings. It was explained that the showroom had only been fitted up as an advertisement, to promote the use of electricity, and that goods would have to be purchased through contractors and dealers. The deputation went away satisfied. Another interesting item cropped up when, in paying their accounts for November and December, Messrs. E. E. Keighley, Ltd., informed the Hull Corporation Electric Lighting Committee that they did so under protest. They said they were only using the power passing through the half-horse-power meter, so that the quantity charged on the 35 h.p. meter was running to waste somewhere, and they were paying twice as much for it. Surely, they said, some of the Corporation experts could locate it. The Engineer explained that Messrs. Keighley were taking their units through a large meter instead of getting a small meter connected. There were two meters—a big one and a little one—and it was impossible to get them to read exactly the same. Messrs. Keighley were charged for the difference between them. The committee decided to inform Messrs. Keighley that at slight expense the difficulty could be obviated by having another small meter installed.

LONDON.—The County Council have approved the following work: Brompton and Kensington Electricity Supply Co., laying mains in Pembroke-place; County of London Electric Supply Co., laying mains in Tustin-street; London Electric Supply Corporation, laying mains in Evelyn-street, Blackhorse-road, and Waterloo-road; Metropolitan Electric Supply Co., laying mains in Gloucester-mews West, Upper Brook-mews, Gloucester-mews East, Charles-mews, Lancaster-mews, Bathurst-mews, Devonport-mews, Somers-mews and Oxford-mews; the South Metropolitan Electric Light and Power Co., laying mains in Whitfield-road, Longton-avenue, and Taylor-lane, Sydenham, and also in Charlton-road, Marlborough-lane, and Shooter's-hill-road; St. Pancras Metropolitan Borough Council, laying mains in Burghley-road, Gresse-street, and Albert-road.

LONDON, BETHNAL GREEN.—The Borough Council are considering the question of the electric supply within the borough.

PLYMOUTH.—New mains are to be laid in Hyde Park-road, May-terrace, and Victoria-road, at an estimated cost of £190. A new scale of charges is to come into force on April 1, the charge for current supplied to the Tramways Committee to be 1¾d. per unit up to 750,000 units per annum, the current supplied in excess of that quantity to be charged at the rate of 1½d. per unit. The present charge is 1¾d. per unit for any quantity, and last quarter the supply to the tramways amounted to 306,233 units, representing about 1,200,000 units per annum. The charge to private consumers for current supplied for motor purposes will be 1¾d. per unit up to 100 units per quarter, and for current in excess of that quantity 1½d. per unit. At present the charge to that class of consumers is 1¾d. per unit. The charge proposed to be made to electrical contractors for current for business purposes is a flat rate of 2d. per unit for supplies for lighting or motor purposes.

ROCHDALE.—The Town Council are applying for permission to borrow £12,690 for electric lighting purposes.

SOUTHAMPTON.—It has been decided to substitute electricity for gas for the public lighting of Anglesea-road, Shirley, the Cobden Bridge, and Priory-road, St. Denys. An application is to be made to the Local Government Board for sanction to raise a loan of £13,000 to be expended on additional electrical plant.

LIGHTING AND GENERAL—Overseas.

BOMBAY.—It is expected here that the new licence for the Tata scheme for supplying Bombay with electricity will shortly be financed. The electricity is to be generated hydraulically in the Ghaut Hills, and the new concern will be in direct competition with the existing electricity undertakings.

CALCUTTA.—The Bengal-Nagpur Railway Co. are past replacing oil for electric lighting on their passenger carriages, the work being entrusted to Messrs. J. Stone & Co., Ltd.

FOCSHANI, ROUMANIA.—The Communal authorities have obtained powers to contract a loan of 1,000,000 francs (£40,000), three-quarters of which sum is to be allocated to the provision of electric light, and the remainder to the extension of the town's waterworks.

GENERAL SARMIENTO, ARGENTINE.—The Municipality will shortly invite tenders for the erection of an electric light station.

SANTA-FE, ARGENTINE.—The Municipality have accepted the tender of Messrs. Geiger, Zublin & Co. for the supply of machinery for the electric light station, at a cost of $80,000 gold.

TRACTION—Home.

ABERDEEN.—At a meeting of the Electricity Committee the supply of electrical energy to the Aberdeen Suburban Tramway Co. was again under consideration, and it was resolved to recommend the Council to offer them without prejudice to the arbiter's award a supply for five years at 1·75d. per unit, being ¼d. less than the rate at present charged.

ABERDEEN.—As a result of the National Telephone Co running most of their lines underground, the Tramway department are now removing the guard wires, which are no longer of any use.

BELFAST.—The Cavehill and Whitewell Tramway Co., Ltd., have agreed to the sale of their undertaking to the Corporation, at a price to be fixed by an arbitrator appointed by the Board of Trade. The matter is to be considered immediately at a special meeting of the Council.

TRACTION—Overseas.

LILLOOAH, INDIA.—The East Indian Railway are laying a separate motor driven exciter set for the Lillooah Electric Power Station in order to meet with the increasing demand for power.

NIKOLAIEFF, RUSSIA.—The local imperial authorities have approved the proposal of the municipality to expend £979,000, to be raised on loan, for the establishment of a tramway system, harbour works and extension of the electric lighting system.

SANTA-FE, ARGENTINE.—The tender of Messrs. Colson, Brookhouse & Pyne, for the electrification of the Santa-Fe Municipal Tramways, has been accepted. The concession is for 60 years.

CONTRACTS OPEN.

Home.

ASTON MANOR.—The Corporation invite tenders for the supply and erection of one 250 kw. motor generator and one 350 kw. rotary converter, complete with the necessary starting and field controlling gear. Specifications from Mr. Robert Foster, Borough Electrical Engineer. February 11.

BELFAST.—Borough Council.—Annual supply of low-tension insulated V.B. cable. (Specification, £1 1s.) Also: Section 1, stores; Section 2, trolley wire and overhead material; Section 3, conduits, pipes, cable connecters, etc.; Section 4, meters, *maximum* demand indicators, switches, cut-outs. (Particulars, 10s. each section, City Electrical Engineer.) February 21.

BERMONDSEY.—Borough Council.—Annual supplies. (Samples for Electricity Works.) February 14.

BLACKBURN.—Corporation Tramways.—No. 1: General stores; No. 9: Motors, etc. (11 sections, 3s. each. Borough Electrical Engineer.) February 16.

BLACKPOOL.—Corporation Electricity Department.—2,500 yards ·5 low tension single cable (for 600 V. working pressure). (Particulars, Borough Electrical Engineer.)

BLACKBURN.—Borough Council.—Section 1, general stores; Section 2, iron, brass castings, bolts, bar, etc; Section 3, timber; Section 4, insulating material; Section 5, tools, brushes, etc.; Section 6, oils, etc.; Section 7, wrought-iron pipes; Section 8, house service fuse-boxes, switches, etc.; Section 9, motors; Section 10, motor starting switches; Section 11, screwed tubes for inside wiring. (Particulars, 3s. each, Borough Electrical Engineer.) February 16.

CARLISLE.—Corporation.—1,500 yards (six-way 3 in. cable ducts), 2,200 yards of 5 sq. in., and 800 yards of ·4 sq. in. single core paper insulated and lead covered cables. (Particulars, £1, City Electrical Engineer.) February 5.

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EDINBURGH.—Corporation Tramways.—Raising existing car sheds, roofs, etc. (Specification, £2 2s., Borough Engineer.) February 22.

HAMMERSMITH.—Borough Electricity Department.—Annual supplies. (Particulars, Borough Electrical Engineer, 85, Fulham Palace-road, W.) February 16.

KETTERING.—Urban District Council.—1,440 positive battery plates (360 amp. hour cells). (Specification, £1 1s., Electrical Engineer, Rockingham-road.) February 14.

LEEDS.—Corporation.—Annual supplies. Section N, cables, mains, boxes, lamps, insulating material, fittings, etc. (Particulars, Manager, Electric Lighting Department, 1, Whitehall-road.) February 28.

LONDON, INDIA OFFICE.—The Secretary of State invites tenders for the supply of (1) electric cranes; (2) wheels and axles. Conditions of contracts from the Director of Stores, India Office. Feb. 15.

LONDON.—The London County Council Tramways invites tenders for (*a*) the supply and delivery of about 3,000 tons of steel girder tramway track rails and fastenings; (*b*) about 1,500 tons of slot-rails and conductor tees, required in connection with the construction or reconstruction of the Council's tramways for electrical traction. The supply and delivery of the track rails, etc., and the supply and delivery of the slot-rails and conductor tees will be under two separate contracts. No tender received after 11 a.m. on Tuesday, Feb. 8, 1910, will be considered.

OLDHAM.—Corporation Tramways.—A. Electric lighting installation; B. Switchboard and accessories; C. Testing board and accessories; D. Workshop motors with starting panels, pulleys, and slide rails, etc. (Specification, £1 1s., General Manager, Wallshaw.) February 16.

PORTSMOUTH.—Corporation.—Annual supply of electrica goods. February 7.

SALFORD.—Corporation Tramways Department.—Car accessories, overhead material, etc. February 14.

STOCKTON-ON-TEES.—The District Fund: Gas and Electricity Committees invite tenders for the several articles and stores required by them for the year ending March 31, 1911. Particulars from Mr. A. B. Crosby, Town Clerk. February 15.

ST. PANCRAS.—Borough Council.—Arc lamp carbons. (Specification, £2, Electricity Department, 57, Pratt-street, Camden Town.) February 28.

WOLVERHAMPTON.—Corporation Tramways.—Two years' supplies of general stores. (Particulars, General Manager, Cleveland-road.) February 12.

WEST HAM.—Borough Council.—Cables, Watt meters, fillings, cut-outs, stores, etc. (Specification, £1, Borough Electrical Engineer, 84, Romford-road, Stratford, E.) February 17.

OVERSEAS.

CONSTANTINOPLE.—Public Works Department.—Electric tramway between Niausta town and railway station. (Salonika-Monastir line.) February 28.

MADRID.—Public Works Department.—Electric Tramway in Madrid. February 18.

MADRID.—Public Works Department.—Electric tramway at Bilbao. Deposit, £60. February 28.

MADRID.—Public Works Department.—Electric tramway in Santander. March 29.

MADRID.—Public Works Department.—Construction and exploitation of electric tramways in the north-east of Barcelona. Deposit, 6,030 pesetas. (Particulars, Direccion General de Obras Publicas.) March 14.

MADRID.—The official *Gaceta* contains an announcement inviting for a 60 years' concession for the construction and working of an electric tramway in the north-east district of Barcelona. The line will run from the Calle de Caspe to Vallcarca by way of the Calle de la Irdustria. Tenders must be enclosed in sealed envelopes, and addressed to the "Direccion General de Obras Publicas, Ministerio de Fomento," Madrid, where they will be opened at noon on March 14. To qualify any tender a deposit of 6,030 pesetas (about £216) will be required, to be increased by the successful tenderer to 30,151 pesetas (about (£1,077). Work must be commenced within three months after the signing of the contract. An application in respect of this concession has already been lodged by the "Sociedad de Tranvias de Barcelona a San Andrés y Extensiones," which will have preferential rights in the competition. The *Gaceta* of January 20 notifies that an application has been submitted by the "Sociedad Tranvia del Este de Madrid" to the Direccion General de Obras Publicas, Madrid, for a concession for the construction and working of an electric tramway to run from the Calle Mayor to the Calle de Atocha in Madrid, and that a period of one month from the date of the *Gaceta* is allowed for the presentation of competing offers at the above-mentioned Direccion.—The *Gaceta* of January 21 announces that an application has been lodged by the Nueva Montaña Iron and Steel Co., Ltd., of Santander, with the Direccion General de Obras Publicas, Madrid, for a concession for the construction and working of an electric tramway designed to join the Santander-Astillero line with the Santander urban tramway in Peña Castillo. Tenders, which should be enclosed in sealed envelopes and addressed to the above-mentioned "Direccion," will be opened at midday on March 29. A deposit of 781 pesetas (about £28) will be required to qualify any tender. The Nueva Montaña Co. will have certain preferential rights in the competition. In all these cases local representation is necessary.

MONTEVIDEO.—Anglo-Argentine Tramway Co.—Permanent way material and rolling stock. (Particulars (L.), Commercial Intelligence Department, Board of Trade, 73, Basinghall-street, E.C.)

SMYRNA.—Provincial Government.—One or more electric power station cables, mains, etc. (Particulars, Conseil d'Administration du Villayet.) March 15.

TENDERS ACCEPTED.

LONDON.—The London County Council Highways Committee have recommended the acceptance of the tender of Messrs. J. A. Brenner & Co. for the supply of machinery oil to Greenwich generating station; Edison & Swan United Electric Light Co., Ltd., for the supply of electrical wiring material for Abbey-wood and Hammersmith car-sheds and Woolwich sub-station for the sum of £281 11s. 5d.

COMPANIES' MEETINGS AND REPORTS.

ST. JAMES' AND PALL MALL ELECTRIC LIGHT.

The directors recommend a balance dividend on the 7% preference shares for the half-year ended December 31, 1909, of 3s. 6d. per share and 5s. per share on the ordinary shares, making, with the interim dividend paid thereon, a total distribution of 10%.

LIVERPOOL OVERHEAD RAILWAY CO.

The report of the above company to be presented at the general meeting to be held on the 8th has been issued. The gross revenue receipts for the half-year ending December 31 last amount to £36,911 15s. 10d., and the working expenses to £28,313 2s.

There has been an increase in the number of passengers carried during the past half-year, but there has been a decrease in the revenue of £380. This is the result of the reduction made in the price of workmen's special return tickets necessary to meet competition. The working expenses show a gratifying reduction of £1,345, after providing £873 towards the final settlement of claims arising out of the accident at Seaforth Sands station in December, 1903.

The revenue account shows that the receipts from passenger traffic amount to £35,861 2s. 8d.; miscellaneous receipts and interest, £1,050 13s. 2d.; making £36,911 15s. 10d., less working expenses and transfer to renewal fund, £28,313 2s.; leaving a total of £8,598 13s. 10d. From this there has to be deducted interest on mortgage debentures, and on calls paid in advance, £4,329 8s. 2d.; thus giving £4,269 5s. 8d. To which has to be added balance brought forward June 30, 1909, £4,696 4s. 8d; leaving available for dividend, £8,965 10s. 4d.

Out of this balance your directors recommend the declaration of dividends at the rate of 5% per annum (less Income Tax) on the (1892) preference shares, and 5% for the year (less Income Tax) on the (1900) preference shares, payable on and after February 10 next, leaving a balance of £4,613 16s. 4d., to be carried forward to next half-year.

YORKSHIRE ELECTRIC POWER CO.

The directors have issued their report, to be submitted to the shareholders at the half-yearly meeting, to be held at the *Hotel Metropole*, Leeds, on February 15.

The receipts fom the sale of energy and for work charged out to consumers, etc., amount for the year 1909 to £25,762 17s. 1d.; against for the year 1908, £18,643 2s. 7d.; and for the year 1907, £11,994 2s. 6d. The gross profit on the revenue account is for the year 1909, £6,087 9s. 11d.; against a gross profit for the year 1908 of £2,819 4s. 11d.; and for the year 1907, £433 6s. 2d. After payment of mortgage interest the net revenue account shows a profit on the year 1909 of £2,664 13s. 6d.; against for the year 1908, £717 12s. 8d.; and for the year 1907 a loss of £1,350 6s. 8d. The net profit of £2,664 13s. 6d. with £717 12s. 8d. brought forward from 1908 makes a total disposable balance of £3,382 6s. 2d., and the directors recommend that this amount should be carried forward. A call of 5s. in the £ has been made on those holders of second mortgages in the undertaking of the company who have not already paid in full. Owing to demands from large users of power an overhead main is being carried through Scothill Nether, Soothill Upper, East and West Ardsley, Stanley, Whitwood, Methley, Rothwell, and Castleford to Allerton Bywater; this will be completed and begin to bring in revenue in the course of the next few weeks.

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in addition to a steady growth of the number of connections to the mains of the company, there have, as in previous years, been continuous extensions of the use of electric power by existing customers, a most satisfactory evidence of their appreciation of the company's supply. In consequence of these extensions, and in view of further negotiations, now in progress the directors have considered it necessary to place on order a fourth turbine of the same type but of double the capacity of the present ones, together with an additional boiler. These will be erected during the present year in the space provided in the existing buildings. As further capital will be required for these extensions, and to cope with the continuous progress of the company, it is proposed that powers shall be obtained to issue as preference shares a portion of the unissued shares of the company. This requires the authority of Parliament, and a Bill has been prepared and will be submitted to the shareholders at a special meeting to be called at the conclusion of the shareholders' meeting. The clauses asked for are non-contentious, are almost entirely confined to the internal finance of the company, and afford no ground for opposition by any of the authorities in the company's area. As already reported in September last, Mr. Walter Geoffrey Jackson, chairman of Henry Briggs, Son, & Co., Ltd., has accepted a seat on the Board. The directors regret to have to report the resignation, in consequence of his departure for the United States, of Mr. Ernest Alfred Carolan, who has been on the Board since the inception of the company. They have pleasure in reporting that Mr. Howard C. Levis, managing director of the British Thomson-Houston Co., Ltd., has consented to fill the vacancy thus created. Messrs. Robert Armitage, Henry Barran, Thomas Octavius Callender, and Howard C. Levis are the directors who retire by rotation, and being eligible, they offer themselves for re-election.

PERSONAL.

We learn from Toronto that Mr. J. J. Wright, General Manager of the Toronto Electric Light Co., is resigning that post to become second vice-president of the company and its consulting engineer. Mr. Hubert H. Macrae succeeds him, having resigned the general managership of the Toronto Electrical Development Co. for that purpose. Mr. Wright had held his former post for 27 years.

M. de Marchena, sub-manager of the French Thomson-Houston Co., has been decorated with the cross of the Legion of Honour.

DIARY.

SATURDAY, FEBRUARY 5.

NORTHAMPTON INSTITUTE ENGINEERING SOCIETY.—At the Institute, Mr. L. Wallis, "History and Manufacture of Electric Glow Lamps."

MONDAY, FEBRUARY 7.

BATTI-WALLAH'S SOCIETY.—At the Holborn Restaurant, at 8 p.m., smoking concert.

TUESDAY, FEBRUARY 8.

INSTITUTION OF ELECTRICAL ENGINEERS (Glasgow Section).—At Bath-street, Glasgow, at 8 p.m., "Equitable Charges for Tramway Supply," by Mr. H. E. Yerbury.

INSTITUTION OF ELECTRICAL ENGINEERS (Manchester Section).—At the University, Manchester, at 7.30 p.m., "Three-Wire Balancers," by Mr. A. S. Cooper.

WEDNESDAY, FEBRUARY 9.

ASSOCIATION OF ENGINEERS-IN-CHARGE.—At the St. Bride's Institute, at 7.30 p.m., "Modern Arc Lamps and their Application," by M. A. Angold.

THURSDAY, FEBRUARY 10.

INSTITUTION OF ELECTRICAL ENGINEERS.—At the Institution of Civil Engineers, at 8 p.m., "Losses off Transmission Lines due to Brush Discharge, with Special Reference to the Case of Direct Currents," by Mr. E. A. Watson.

FRIDAY, FEBRUARY 11.

PHYSICAL SOCIETY OF LONDON.—At the Imperial College of Science, Imperial Institute, South Kensington, at 7.30 p.m., President's address.

JUNIOR INSTITUTION OF ENGINEERS.—At 7.30 p.m., meeting of the Junior Institution of Engineers with the Architectural Association Debating Society at 18, Tufton-street, Westminster. Papers, "Architectural and Engineering Considerations in Town Planning," by Mr. Stanley Hamp (Mem.A.A.D.S.) and Mr. Frank R. Durham (M.J.I.E.).

TUESDAY, FEBRUARY 15.

INSTITUTION OF ELECTRICAL ENGINEERS (Manchester Students' Section) AND MANCHESTER AND DISTRICT JUNIOR GAS ASSOCIATION.—Debate on "Gas *versus* Electricity for Heating and Power Purposes."

WEDNESDAY, FEBRUARY 16.

INSTITUTION OF ELECTRICAL ENGINEERS (Birmingham Section).—At the Chemical Theatre of the Birmingham University, at 7.30 p.m., paper on "The Influence of Various Cooling Media upon the Rise in Temperature of Soft Iron Stampings," by R. D. Gifford, to be read in abstract; and discussion on Mr. Yerbury's paper on "Equitable Charges for Tramway Supply."

PATENTS.

Electric Circuit Closer.

18500.—1909. A. H. JOHNSON, Epsom. This is a mechanical escapement adapted for use as a circuit closer. One member of the escapement is attached to and moved by the switch point. The escape action either closes or opens an electric circuit, and the member which escapes is capable of a secondary movement in a different plane to the escape movement when acted on by the other member, and is so connected to a circuit closer that a circuit is either opened or closed by the secondary movement of the escaping member.

Transmission of Power from a Prime Mover to a Load.

19431.—1909. A. C. & J. KINH & F. HAMER, Southgate. The transmission system comprises pinions which may be used alternately as an ordinary train of gearing or as an epicyclic gear train by the operation of suitable brakes in combination with a dynamo electric element comprising a rotatable field magnet structure driven by the prime mover and made up of a plurality of pairs of poles the armatures of which have a compound rotary movement, and are connected through sun and planet gearing with the pinions. The arrangement is such that according to the excitation of the poles of the field magnet structure and the operation of the brakes the load is driven directly or at an intermediate speed forwardly, or is driven in a reverse direction.

Electric Meters.

19277.—1909. COMPAGNIE POUR LE FABRICATION DES COMPTEURS ET MATERIEL D'USINES A GAZ, Paris. In electricity meters of the induction type a bi-metallic adjusting screw is provided whereby the meter can be regulated for lagging or leading currents, and whereby the same constant can be given to the meter for inductive or non-inductive loads.

Electricity Meters.

17138.—1909. COMPAGNIE POUR LE FABRICATION DES COMPTEURS ET MATERIEL D'USINES A GAZ, Paris. The meter has a maximum current or energy indicating arrangement comprising an ammeter or wattmeter in which the indicator moves a loose maximum indicator in the forward direction only, in combination with mechanism actuated by a wheel of the meter counter whereby the indicator may be retained or retarded.

Electric Telegraphy.

27867.—1908. A. MUIRHEAD, Shortlands. In systems of submarine cable telegraphy an overflow circuit is applied to the end of a retardation circuit. Means are provided for establishing current in the overflow circuit, when the main coil of the cable relay is deflected by a signal current.

Dynamo Electric Machine.

28049.—1908. T. FERGUSON, Altrincham. The driving force is utilised for driving the armature to rotate the machine shaft and to produce the endwise displacement of a sleeve when the normal speed is exceeded. This displacement is utilised to regulate the excitation field of the dynamo.

Electric Alternating Current Distributing Systems.

28186.—1908. C. H. MERZ & B. PRICE, Westminster, S.W. This is an improvement in alternating current distributing systems wherein provision is made for automatically opening a circuit whenever leakage occurs sufficient to disturb the balance of forces which are normally in opposition, and so cause a circuit breaker to operate. The object is to provide arrangements of a simple character for the purpose of protecting individual circuits in which the inductive windings for producing balanced forces in each case are arranged adjacent to one another in the same circuit and pilot wires dispensed with. The required balance may be created between instantaneous values of electromotive forces or magnetising forces or currents, or it may be created between some integrated effects of currents which, though differing in phase are generally similar as regards magnitude and wave form.

Electric Lighting and Heating of Vehicles.

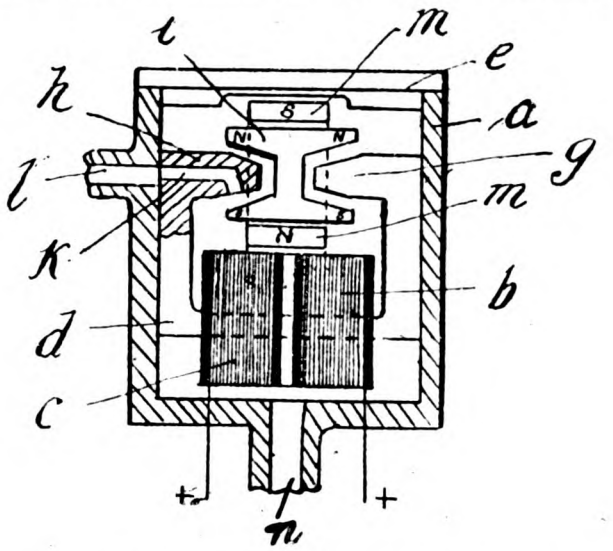
28120.—1908. H. GROB, Zurich. In the electric lighting of vehicles by means of a dynamo and two batteries independent of each other it is frequently desirable to exchange the functions of these batteries after each stopping of the vehicle. The invention provides a controlling apparatus which at a given speed of the vehicle connects the dynamo driven by a car axle with the lamps and two batteries, and simultaneously causes an exchange of the functions of the two batteries which they had performed during the preceding run.

Alternating Current Meter.

129.—1909. G. C. FRICKER & W. M. MORDEY, Westminster. In this alternating current meter of the induction motor type an iron frame forming part of the magnetic system is constructed to conduct magnetic flux from one side of the rotor to the other. The shunt portion of the motor stator system is excited by a single coil, and has opposing sets of polar faces, each set forming a gap for the rotor.

Electrically Operated Valves.

2740.—1909. E. A. Fagerlund, Stockholm. This electrically operated valve is especially suitable for use in lighting and extinguishing gas flames at a distance by means of an electric current. The valve is of soft iron rotated between electro-magnetic poles and influenced by a permanent magnet; hitherto the valve itself has been formed as a permanent magnet. The consequence of this latter construction is that the magnet in a short time becomes demagnetised and incapable of action. If the valve body is of soft iron and influenced by a permanent magnet, it can be arranged in such a manner that the magnetic lines of force do not flow through the permanent magnet, and accordingly no demagnetisation is caused. In a valve casing *a* of iron, two electro-magnet coils *b* and *c* are located around the pole core *d*, which is in the form of a horse-shoe magnet, the poles of the core forming the projections *g* and *h*. *e* is the cover of the valve casing. Between the projections *g* and *h* a piece of soft iron *i* of H form is rotatably arranged and constitutes the valve body. This iron piece is influenced by a permanent magnet *m* shown in the drawings as a horse-shoe magnet with its poles disposed above and below the valve body *i*, so that the upper part becomes of positive polarity and the lower part of negative polarity. The projection *h* is provided with a channel *k* which communicates with the gas outlet pipe *l*, *n* indicates a supply pipe for the gas. When electric current passes through the coil *b*, the magnetic lines of force will flow through the core *d*, projection *g*, valve body *i*, and projection *h* back to the core *d*. The projection *g* thus becomes of positive polarity and projection *h* of negative polarity. The valve body is thus caused to occupy a position to open the channel *k*. The gas can then pass freely from supply pipe *n* through the interior of the valve casing *a* to the outlet *l* so long as the valve body *i* magnetised by the magnet *m* occupies this position. If current now flows through the coil *c* or *b* in an opposite direction, the magnetic lines of force will pass in a direction opposite to their former course, and the polarity of the projections *g* and *h* will also be reversed. The magnetised valve body *i* is thus repelled by *q* and attracted by *h*, and will be caused to abut against the projection *h* and remain against the same by magnetic attraction, thereby closing the mouth of the channel *k* so that the gas supply to the pipe *l* is cut off.



Voltage Regulation of Alternators.

416.—1909. Morris & Lister, Coventry. The object is to provide for the more convenient regulation of electric alternators by an inductive load. Fig. 1 is a diagram illustrating one application of the invention. Fig. 2 illustrates magnetisation curves. Fig. 3 is a diagram illustrating a modified application of the invention. A choking coil is employed for producing the inductive load. Fig. 1 shows a three-phase alternator *a*, mains *b*, and choking coils *c*. The coils must be so proportioned that their magnetisation currents shall vary greatly with a comparatively small variation of potential difference at the terminals; and this variation must be small compared with the regulation of the "alternator"; that is, the rise in terminal volts occurring when the full load is switched off. This condition can be conveniently obtained by the use of a choking coil, wound on an iron core forming a continuous magnetic circuit which is worked at high flux densities. For the maximum and minimum voltages between which the alternator operates in service, the flux density produced in the core is in excess of that required for magnetic saturation.

In Fig. 2, A and B represent the magnetisation curves of an alternator and a choking coil respectively, voltages being denoted by the ordinates and ampere-turns by the abscissæ. The point C represents the normal working voltage of the alternator at full load. This must correspond with saturation of the choking coil a little above the knee of its curve. The coil is of such a size that its ampere-turns corresponding to the raised alternator voltage is comparable with those required to excite the alternator itself. A coil is provided across each of the phases to be regulated, the connection of the coils being either star or mesh as required. Star connection is shown in Fig. 1. In operation the effect of the coil is to counteract a great part of that excitation of the alternator which would cause the usual rise in voltage

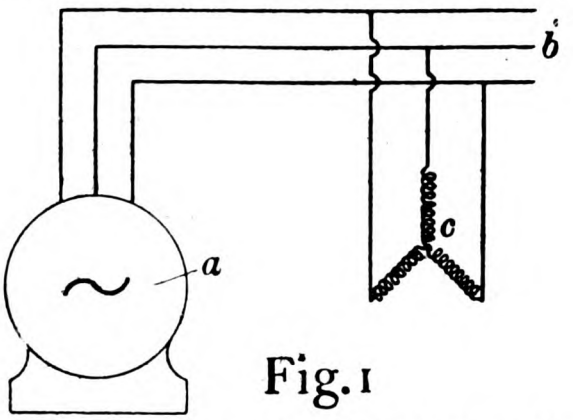


Fig. 1

when the machine is working under little or no load. As the load increases, and a consequent slight drop of potential is produced, a large diminution of the magnetisation current taken by the coil is experienced, with the result that the counteraction of the coil on the exciting field is greatly diminished. This is equivalent to an automatic strengthening of the exciting field, so that the usual voltage drop is greatly reduced and the regulation of the generator correspondingly improved. An inductive load has the peculiarity that the counteraction on the excitation of the alternator is a maximum when the load is nil, and diminishes rapidly as the load increases, so that at full load the coil is practically inoperative. The improved regulation thus afforded is consequently automatic, and capable of self-adjustment to the load. Choking coils employed for the purpose of this invention being constructed with closed cores and worked at high flux density, require artificial cooling. For the cooling of either the core or the winding any ordinary method may be adopted. As an alternative method of cooling, the winding is formed of copper tube adapted at its extremities to permit the circulation of cooling water. To avoid electrolytic action on the water, the inside of the tube may be coated with an insulating varnish, whilst to avoid conduction along the water stream at the ends of the winding a suitable length of rubber or other insulating tube may be employed. With an inductive regulating load, a small drop in the main circuit voltage is necessary in order to make

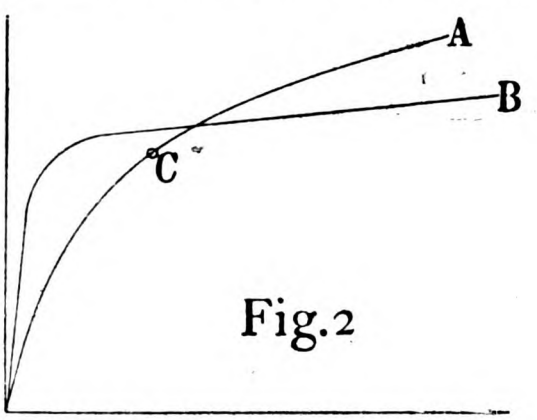


Fig. 2

the coils operative. In order that a constant voltage may be maintained, in conjunction with each choking coil, auxiliary or transformer coils are provided, the primary of each of which carries one of the load currents which is, when working at unit power factor, approximately in phase with the idle current taken by one of the choking coils, that is, approximately, in quadrature with the voltage across the terminals of the choking coil. The secondary winding of this transformer is coupled in series with that choking coil. The core of the transformer may either be separate from the choking coil or form a magnetic shunt on the unwound part of the core of the coil. It is essential that the auxiliary core shall be worked at relatively low flux density, even when the full load current is passing

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through its primary. The secondary voltage of the transformer is approximately in phase with that across the choking coil, and it increases proportionately with the main load. Thus, since the choking coil only receives a difference between the generator phase voltage and that induced in the transformer secondary, it is seen that at the load increases, the voltage, and therefore the demagnetising current which it takes from the generator, diminishes rapidly. In this case the load and not the drop in the alternator volts is the cause of the reduced demagnetising action, so that the terminal voltage may be constant, or may even rise with increasing load. For two or three phase generators an arrangement as above described is provided for each phase. With the choking coil connected across any two of the generator terminals, the series winding of the transformer carries the main current from the other terminal.

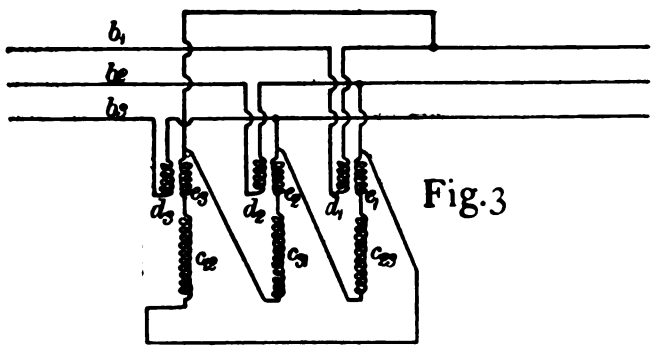

Fig.3

Fig. 3 shows the application o. the above arrangement to a three-phase system; the mains are denoted by b_1, b^2, b^3, and the choking coils by c^{12}, c^{31}, c^{23}, in mesh connection. The auxiliary primaries in the mains are indicated by d^1, d^2, d^3, whilst the secondaries in series with the choking coils are indicated by e^1, e^2, e^3. It will be seen that the auxiliary coils e^1, d^1 are associated with the coil c^{23}, and that the other transformers are correspondingly arranged. If the actual alternator load be itself inductive, either of the apparatus above described is rendered the more effective, since the tendency to drop voltage is increased. Also the devices may be used either on the alternator terminals direct, or on the low tension side of a transformer, or if desired, at the distant end of a feeder.

Distributing Electric Current.

10456.—1909. L. E. Pralon, Paris. This is an apparatus for distributing electric current in two directions. The operation of a switch causes an electric current to pass to one or the other of two sets of electro-magnets so as to attract an armature carrying a movable stop in one or the other direction. The armature has a contact piece.

Filament for Electric Incandescent Lamps.

16328—1909. C. H. Weber, Berlin. The filaments are produced from low stage oxides of wolfram, with a pyridine coating. The pyridine passes from the centre to the surface of the filaments during the heating operation and forms a protective covering.

Electric Furnace.

17342—1909. Aktiebolaget Elektrometall, Stockholm. The smelting chamber is so formed as to leave free spaces between the inside surfaces of the furnace and the material. The electrodes enter into the smelting chamber through the spaces. The lower portion of the shaft communicating with the smelting chamber, expands upwards and the pressure of the material in the shaft is lessened.

Jack Springs of Telephone Exchanges.

17994—1909. Siemens Bros. & Co., Westminster. A stop, in the form of a metal loop fixed into the strip which carries the brushes, is provided for each of the jack springs in order to limit their movement and prevent contact between them and the tip of the plug inserted into the bush.

Magnetic Separator.

27020—1908. F. Powell, Doncaster. The separator has a magnetic drum from the outer curved surface, of which the operative magnetic field emanates, formed of magnets with the axes radial with respect to the axis of the drum, there being projections from the outer ends of the magnets extending in staggered form on the curved surface of the drum so as to leave gaps between the adjacent poles of the zig-zag form.

Electric Circuits.

27168—1908. O. Baker, London. The switch for opening and closing the circuits comprises a base plate and case which carries the two terminals of the circuit, a bridge carrying piece of insulating material so mounted within the case as to be adapted to undergo angular and axial displacement relatively thereto. A conducting bridge piece is so secured to the bridge carrying piece as to connect the two terminals when in one extreme position. A pin secured to the bridge carrying piece, protrudes through the case and through the medium of the pin a cam displaces the bridge piece angularly and axially so as to make the connection between the two terminals.

Electric Pocket Lamps.

22032.—1909. J. Lewy, Zeitz. The slide, which is guided by the contact spring and the press button connected to it, are movable at an angle to the direction in which the contact spring is moved in and out of contact by the press button.

Governing Electric Motors.

23619.—1909. H. C. E. Jacoby, London. The governor consists primarily of two elements, the one fixed and the other free to slide. Both or only one may revolve. The one element is cup-shaped, and the other a flat disc or cone, or cup-shaped. Between the two elements are balls which are free to move in any direction. When the governor revolves, the balls fly out by centrifugal force and separate the two elements. The expansion of the balls forces the brush rocker forward in a longitudinal direction, and this motion is transmitted into a rotatory motion by making the brush rocker engage with a suitable cam or by means of a link motion.

Arrangements of Circuits for Magneto Ignition.

24602.—1909. L. J. Milton, Chicago. The invention consists in the use of an inductive or non-inductive resistance across the primary of a transformer fed by a magneto generator, so that the resistance is closed on the magneto generator before the primary of the transformer is connected in circuit.

Telephone Exchange.

24615.—1909. E. E. Clement, Washington. The connection of a particular line to a trunk is effected through a series of relay selector sets. Each set consists of tens and units relays. The tens and units relay of a particular group associated with the trunk circuit is effected automatically, and the actuation of the tens relay and units relay conjointly effects the desired connection.

Telephone Exchange.

24616.—1909. E. E. Clement, Washington. An auxiliary ringing switching device composed of relays arranged in pairs is provided for each set of automatic switching apparatus. The auxiliary ringing switching device controls the generator leads and is actuated by impulses through the main switch circuits.

Telephone Receivers.

25112.—1909. E. A. Graham, Brockley, S.E. In order to secure increased loudness and clearness of tone in receivers of the kind in which one extremity of a pivoted lever is rigidly attached to a diaphragm and the other extremity is acted upon at one side by a pole piece carrying the currents, the lever and diaphragm system is given an initial mechanical stress so that the diaphragm responds to the resultant of the mechanically applied stress and the stresses set up the action of the magnetic pole piece of the receiver.

Electric Signalling.

26425.—1909. Siemens & Halske, A.G., Berlin. The movable coils of a receiver turn in a magnetic field produced by an alternating current. The circuit of the movable coils contains ohmic resistance of such magnitude that the currents induced in the coils by their motion differ so much less in phase from the induced voltage than they would if the resistance were almost entirely inductive, that increase in the amplitude of the oscillations or an automatic rotation of the receiver armatures is prevented.

Electro-Magnetic Friction Brake.

20845.—1909. R. Braun, Friednau. This is an electro-magnetic friction brake with an interchangeable brake shoe. The magnet is so shaped that the magnetic induction at the point where it makes contact with the shoe is greater than that at any other cross section of the magnet.

Electrical Brakes.

19098.—1909. R. Braun, Friednau. The brake consists of single electro-magnets connected together like the links of a chain. This construction results in a certain mobility of the brake magnets relatively to each other which makes it possible for the chain element to adapt themselves to the peculiarities of the wheels.

Electric Signals.

19684.—1909. Siemens & Halske, A.G., Berlin. A mechanical coupling between the transmitter instruments operates to cause the first instrument to move all the others at the required periods, but otherwise leaves all the instruments free for independent movement.

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NOTES.

THE RISING BOOM.

Reports from all over the country bear witness to a revival of industrial activity, and, what is very pleasant for us to record, an inclination on the part of manufacturers to turn to electricity for assistance. Everywhere the demand for motors is on the increase, while there is a considerable sprinkling of orders for the electrification of big factories. Turning in another direction, we find that the greater number of people using electric light has in most cases quite, and others almost entirely, absorbed the reduction in consumption of current which followed on the adoption of the metal filament lamp. Now, in a great many places the question of increasing the output will have to be faced. An interesting corroboration of this comes from a large manufacturer of metal filament lamps, who has to work overtime in order to fill orders, and is now in such a position that he cannot guarantee time delivery, supplying customers in rotation as their orders are booked, and so sure of his market, that he books all orders with the proviso that customers may countermand whenever they choose. That certainly indicates a healthy state of the industry and a bright future.

ELECTRIFYING INDIAN FACTORIES.

We print elsewhere an abstract of an interesting lecture delivered by Mr. C. H. Douglas at Calcutta on the electrical operation of textile factories. Although avowedly based on the lecture Mr. H. W. Wilson delivered at Liverpool some six months ago, there are many interesting points which Mr. Douglas brings forward showing the peculiar demands existing in India. It is evident that the Near and Far East offer many opportunities for electrical engineers, and not the least promising ground for cultivation is our own splendid Empire of India, where, in spite of the drawbacks to which we recently drew attention in these columns, electrical development is being proceeded with steadily, if not quite so fast as many desire.

REGULATING ELECTRICITY AT THE CAPE.

Additional regulations have recently been issued in Cape Colony under the Electric Lighting and Power Act, 1905. Passing over the rules laid down concerning tramway drivers, we come to important changes in the regulations issued in 1907, the tendency being to give the Government greater control. Among these alterations we find a rule laying down that "an extra high-pressure supply shall not be given to any consumer's premises other than a factory, a workshop, a mine, a quarry, electric traction works, waterworks, or sewerage or drainage works. And no such supply shall be given except with the consent of the Government and subject to such regulations as the Governor may prescribe."

OVERHEAD WIRES.

Supports for an overhead line must be of durable material and be properly staged against forces due to wind pressure, change of direction of the line, or unequal lengths of span. The factor of safety is fixed at for overhead lines at least 5 and for iron or steel structures at least 6, taking the maximum possible wind pressure at 30 lbs. per sq. ft. Other safeguards are that application for permission to employ any overhead line for high pressure or extra high pressure must be made to the Government, that substations should be provided, and that "where the pressure of a supply between the adjacent conductors of a three wire system of mains exceeds 125 volts, the intermediate conductor shall be connected with earth," in accordance with certain conditions.

SUPPLIER AND CONSUMER.

A point of great moment is embodied in the following regulation: "If any consumer is dissatisfied with the action of the undertakers in refusing to give, or in discontinuing, or in not recommencing the supply of energy to his premises, the wires and fittings of the consumer shall, on his application, and on payment of the prescribed fee, be tested for the existence of leakage by the Government electrical inspector; and if the inspector's report is favourable, the supply shall not be withheld by the undertakers by reason of supposed leakage."

HYDRO-ELECTRICS IN JAPAN.

Success is now practically assured to the Kinu-gawa Hydro-Electric Co. Its capital is 20,000,000 yen, divided into 400,000 shares. Of these, 340,000 have been taken up by the British syndicate and 60,000 by the Japanese concessionaires. The work of installation is to be carried out by Messrs. Alexander W. Clayton, London, with Mr. A. E. Jackson as local representative. It is expected that the work will be completed by October, 1913. The great incentive to activity is the signing of a contract whereby the Kinu-gawa Hydro-Electric Co. undertakes to supply the Tokyo Electric Railway Co. with electric power, the minimum being placed at 25,000 kw. A fine of 300,000 yen is to be paid in the event of failure to carry out the contract. Other hydro-electric projects are in a more or less forward state of preparation.

BALANCERS FOR THREE-WIRE SYSTEMS.

Mr. A. G. Cooper's paper on "Balancers for Three-wire Systems" contained many useful hints. He pointed out that cinematographs are often a serious cause of out-of-balancing in comparatively small networks, and to overcome this disturbing element he adopts the rule of refusing to supply current for these except through motor-generators. Speaking of the common practice in continuous current balancing of using two shunt machines mechanically coupled together, and with their shunts cross-connected, he said the variation of voltage could be reduced by putting on some series turns to compensate for the armature drop, and to cross-connect them, which also avoided complications in the event of a heavy short. He said that then the motoring current passes round the dynamo fields in the same direction as the shunt current, producing a strong field. The dynamo current also flows round the motoring side field, but in opposition to the shunt, speeding up the armature and raising the voltage on the out-of-balance side. He stated that by over-compensating the armature drop by additional series turns, the out-of-balance side could even be raised above the opposite side.

"C. M. B."

Speaking of the "C.M.B." (Crompton, Macfarlane & Burge) continuous current balancer, Mr. Cooper pointed out that it had only one armature, one commutator, and one set of brush-gear. The ring-wound armature is divided into two equal parts by the short-circuited brushes, the polar limbs are all of equal dimensions, the series com-

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pounding coils are arranged on all the poles (thus regulating the voltage and balancing the circulating current across the short-circuited brushes), and the shunt coils are cross-connected. In his opinion this machine has many advantages, such as high efficiency (4 to 5% higher than he obtained with two machines coupled together), close regulation, small weight, small floor space occupied, and little waste from wear and tear, the machine being run on ball-bearings.

STATIC BALANCERS.

As regards static balancers, Mr. Cooper strongly favours the three-phase type. Dr. Garrard had showed that the greater the number of phases used, the better the regulation. Mr. Cooper, however, was of opinion that anything more than three-phase was inadvisable, as this necessitates the slip-rings being brought outside the bearings, and that meant increasing the length of the armature shaft, and, consequently, its diameter, as well as having a larger bearing, all of which was undesirable. He said that if a static balancer was used with a compound-wound machine, and one with commutating poles, the series windings had to be split, one half being connected with the negative side and the other with the positive side of a generator, then the balancer would give the true middle.. When a heavy out-of-balance current in proportion to the static balancer and generator has to be dealt with, it is good practice to have a middle wire booster attached to the machine to boost the out-of-balance side.

LOSSES OFF TRANSMISSION LINES.

In dealing with losses off transmission lines due to brush discharges, especially in connection with direct current, Mr. E. A. Watson argued that of the three factors said to limit the voltage which may be transmitted over a line, the generating or transforming apparatus and the line insulators were capable of great improvement, and so admitted of considerable elasticity, but it was otherwise as regards the brush discharge off the line itself, for this depended upon the insulating properties of air. He, therefore, confined his experiments to this factor. He put forward the following general conclusions, which it will be seen have very direct bearing on practical problems: (1) That there is a definite critical stress for which loss occurs from a direct current line just as for an alternating current one; (2) that the direct current stress required to produce this loss is the same as the maximum alternating current one; (3) that this stress is substantially the same whether the wire is positive or negative provided that it is clean; (4) that for dirty wires the electric stress is lowered much more for negative than for positive charges; (5) that the critical stress is greater the smaller the wire diameter; (6) that the critical stress is reduced by reduction of the air pressure but not proportionately; (7) that the presence of water vapour in the air does not affect the loss or critical stress for a clean wire; (8) that an actual transmission line does not behave exactly like a perfectly clean wire, but that a factor of safety varying from 1·5 to 2 should be allowed. This factor probably depends somewhat on the conditions of the district in which the wire is situated, and is probably less for a line in a clean mountainous region than for one in an industrial district. The loss is also affected by the presence of water vapour in the atmosphere, especially for low values of the electric stress, and a considerable loss takes place before the wire is uniformly enveloped in a corona or becomes noticeably luminous. (9) that the loss which occurs with direct current when the critical stress is exceeded is due to the production of gaseous ions at the surface of the wire; (10) that the actual current lost depends partly upon the amount by which the stress at the wire exceeds the critical value and partly upon the disposition of the wires; (11) that with alternating current lines part of the loss may be due to the energy stored in the layers of air surrounding the wire, and which upon breakdown becomes converted into heat, but that is insufficient to account for the whole loss which is observed, and that part of the loss is probably due to the same cause as that for direct currents.

POLARIZATION OF GUTTA-PERCHA.

Professor Thorton, in a paper on "The Polarization of Dielectrics in a steady Field of Force," read before the Physical Society of London, gave a very large polarization for gutta-percha, but Mr. A. Campbell pointed out that the result could not be safely applied to telephone work, owing to the high frequencies employed. He instanced a case where a coil of gutta-percha covered wire gave an apparent insulation of 200,000 meghoms with direct current, and one minute electrification, but instantly fell to a fraction of a meghom when tested at 1,000 $\sim$ per sec. This variation of the insulation of rubber under different conditions was commented upon by several speakers in the course of the discussion on Dr. Schwatz's paper dealing with the "Testing of Rubber," recently read before the Institution of Electrical Engineers.

CAPITAL INVESTMENTS.

According to a return of new company registrations, compiled by the *Investors' Guardian*, the capital invested in new electrical undertakings amounted to £2,200,635 in 1907, to £1,791,025 in 1908, and to £3,253,920 last year, which bears out the statement that we are witnessing a healthy renewal of activity.

THE I.E.E. AND ITS MISSION.

The following correspondence, resulting from a letter of Mr. E. Garcke, M.I.E.E., which was fully dealt with in the leading article of our issue of December 24 last, has been forwarded to us by Mr. Garcke for publication:—

To E. Garcke, Esq.,
Electrical Federation Offices, Kingsway, W.C.

Dear Sir,—In reply to your letter of December 10 last, I am instructed by the Council to inform you that their administration of the affairs of the Institution of Electrical Engineers is governed by its Memorandum of Association.

The main object of the Institution is to promote the general advancement of electrical and telegraphic science and its applications. The Council have always given, and will continue to give, as broad an interpretation to the Memorandum of Association as is consistent with the avoidance of matters which, while possibly affecting one section of the industry beneficially, might be injurious to the interests of another section, or contrary to the public interest.

The Council are constantly engaged in the consideration of matters affecting the industry which come within the proper scope of the objects of the Institution, and in regard to legislation they have always welcomed applications from Government Departments for advice or assistance, and have repeatedly taken the initiative in putting before such Departments the views which they may have formed on questions connected with the general advancement of the industry.

Accounts of the Council's action in regard to these matters appear in due course in the annual reports of the Institution. The particular matter to which you refer in your letter will be dealt with in the next report.

I am,
Yours faithfully,
(Signed) P. F. ROWELL, Secretary.

The Institution of Electrical Engineers,
92, Victoria-street, London, W.C.,
January 28, 1910.

To P. F. Rowell, Esq.,
Secretary, Institution of Electrical Engineers,
92, Victoria-street, S.W.

Dear Sir,—I have received your esteemed letter of January 28, for which I am much obliged. I am aware that the administration of the affairs of the Institution of Electrical Engineers is governed by the Memorandum of Association of the Institution, and it was because of the irreconcilable statements which had been made as to the province of the Institution in regard to legislative and commercial matters, that I ventured to ask the Council to make a pronouncement on the subject.

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You refer me to the annual reports of the Council for information as to the action of the Council in regard to these matters, and an examination of these reports for the past 22 years (since I have had the honour of being a member of the Institution) clearly shows that the Council have, as you state, given a broad interpretation to the Memorandum of Association. During this period the Council have given their attention to such purely legislative and industrial matters as the London Building Acts (Amendment) Bill, 1905; the Workmen's Compensation Bill, 1906; the Factory and Workshops' Act, 1901; and to other kindred questions.

In regard to some of these matters the Council, it appears from the reports, have taken the initiative.

In March, 1901, the Council appointed a Committee on electrical legislation—

> "To determine whether they can recommend the Council to take any action, and if so, what action, that would assist the industry in connection with the matters dealt with in Mr. Madgen's paper on the Electrical Power Bills of 1900."

According to the report issued by the Institution, the Committee found—

> "That the essential difference between the electrical industry as it exists in the United Kingdom and as it exists abroad is largely due to the exceptional legislative enactments, official regulations and powers of local authorities existing in this country."

and the report adds—

> "Thus British electrical engineers, capitalists and others concerned have been hampered by enactments and rules which other Governments have regarded as either unnecessary or opposed to public interests."
>
> "The Committee considers that the Acts restricting the electric industry should be revised in order that there may be that development which is necessary to the commercial progress of the nation."

As a result of the finding of this Special Committee of the Institution, the Council arranged for a deputation to wait on the President of the Board of Trade with a view to obtaining amelioration of the legislative conditions surrounding the electrical industry.

Moreover, in 1903, the Council appointed a Parliamentary and Industrial Committee—

> "To collect information, consider, and report to the Council on proposed legislation, regulations, enactments and policy, so far as they may be expected to affect electrical industries generally from the engineering point of view, and to make recommendations to the Council as to the advisability of taking action thereon or otherwise."

It cannot, therefore, be said that the Council of the Institution have felt that their action in regard to legislative or commercial matters has in any way been circumscribed by the Memorandum of Association, or that it was not in the view of the Council the province of the Institution to undertake the protection of the industry in legislative and commercial matters.

With regard to the necessity or expediency of discriminating between conflicting interests of the various sections of the electrical industry, I do not believe that any member of the Institution entertains the slightest doubt that the Institution possesses the ability and the means of equitably safeguarding these sectional interests while promoting the general legislative and commercial welfare of the entire industry, provided the Council act in their representative character and avail themselves of the exceptional facilities at their command for forming impartial judgments on the position and requirements of the industry from commercial as well as technical aspects.

The points I desire to emphasise are :—

1. That no industry of the magnitude and importance which the electrical industry has now attained can permanently subsist in this country with adequate advantage to British capital and labour unless it possesses an authoritative, representative and efficient organization for the promotion and protection of its general legislative, industrial and commercial interests.

2. That the electrical industry in this country does not possess such an organization. It possesses several most praiseworthy societies for the furtherance of sectional interests, but apart from the Institution of Electrical Engineers there is no organization in the country which is able to represent the industry as a whole, and this correspondence, although it has brought out the fact that the Institution has the power to meet this much felt want and that the Council has occasionally exercised this power, still leaves it open whether the Institution may be relied on to provide an organization as above defined.

3. The Council of the Institution having from time to time given their attention to certain legislative and commercial questions, many members have formed the belief that the Institution does, in fact, in all cases protect the legislative and commercial interests of the industry in a manner rendering any other efforts with this view unnecessary.

4. At the same time, many members (including myself) are of opinion that the Council have not dealt with legislative and commercial matters in such a manner as to offer reasonable hope of preventing the industry from being very seriously prejudiced relatively to other industries and interests in this country.

In support of this expression of opinion, I would point out that in 1902 the then President of the Board of Trade informed the deputation from the Institution that a Bill would be introduced to give effect to the recommendations of the Joint Select Committee of both Houses of Parliament which sat in 1898, but the subsequent annual reports of the Council contain no reference to any efforts that may have been made by the Council to get this official promise realised. I have in my previous letter referred also to what I most respectfully consider the neglect to deal properly with the Electric Lighting Bill of last Session, and you are good enough to inform me that this matter will be dealt with in the next annual report; but may I be permitted to point out that the Bill was passed substantially in its objectionable form by the House of Lords in May last before the presentation of the last annual report of the Council, which, however, contained no reference whatever to the Bill. If it had not been for the efforts subsequently made by a few members without the benefit of the great influence of the Institution, the Bill would, it is believed, have become law in a form which would undoubtedly have put an end to the profitable investment of capital in many provincial electric lighting undertakings.

There can be no doubt that the commercial applications of electricity have, in quite an exceptional degree, been made the subject in this country of misguided and empirical legislation greatly to the detriment of those who are engaged in the industry, and that a very large proportion of the capital which is employed in the industry is consequently less remunerative than similar investments in other countries. If any support were needed for this statement, I would only refer you to the full and authoritative report of the influential and representative committee appointed by the Council in 1901.

While I have felt constrained to express myself strongly and unequivocally in regard to the attitude of the Institution in commercial matters, I hope I have done so without in any way detracting from the feelings of respect for the governing body of the Institution which I share with all its members, nor without failing to recognise and gratefully appreciate the considerable, the excellent and the beneficial work which the Institution has done for the industry in engineering and technical matters, and, incidentally, also the important services which have consequently been rendered to many other industries and interests in the country. But no one who feels any responsibility for any part of the capital invested or for the material welfare of those who are engaged in the industry can avoid the conclusion that it is regrettable that an Institution which is capable of such excellent work and which enjoys a thoroughly representative character and possesses the requisite influence and means, has not devoted a larger portion of its energies to the promotion and protection of the commercial prosperity of the industries which it represents, and I am quite sure that I am but expressing the feelings of a large number of the members of the Institution in saying that the Council would render the industry an inestimable service if they would at this juncture provide for the electrical industries in this country the much needed organization to be constituted either entirely

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within the Institution or partly within and partly outside the Institution, so that steps may be taken with a view to improving the general industrial conditions under which electrical undertakers, manufacturers and contractors are working.

May I, in conclusion, express the hope that the Council will announce their views on this all-important and pressing matter at as early a date as they can conveniently do so.

I am,

Yours faithfully,

(Signed) E. GARCKE.

February 3, 1910.

ELECTRICAL SAFETY SYSTEM FOR USE IN MINES.*

By H. J. FISHER.

Although stringent rules have been issued by the Home Office to safeguard persons from shock through contact with metallic sheathings of cables, the framework of motors, and other appliances at times when faults exist on them, it is to be regretted that there have been many fatal accidents, severe shocks, and burns, due to inefficient earthing or due to an earth wire being broken or detached by accident. The majority of accidents of this kind have occurred on portable machinery such as coal-cutters, conveyors, etc., these machines and the cables connected to them having to stand an exceptional amount of wear and tear and rough usage. In fact, it may be said that the conditions are more adverse to safety than on any other class of machinery.

As will be seen from the following rule extracted from the "Special Rules for the Installation and Use of Electricity in Mines," at present the Home Office do not enforce the earthing of coal-cutters, portable motors, and trailing cables :—

> "All metallic coverings, armouring of cables, *other than trailing cables*, and the frames and bed-plates of generators, transformers, and motors *other than portable motors* shall, as far as is reasonably practicable, be efficiently earthed where the pressure at the terminals where the electricity is used exceeds the limits of low pressure.

In many cases, however, the framework is earthed through the metallic sheathing of the trailing cable or, better still, a special core is sometimes inserted in the trailing cable as an earth wire. The earth conductor thus provided, however, is very liable to be damaged, and it has to be admitted that, in many cases, the connections have been made so crude and dependent upon the exercising of such care on the part of the attendant, that the use of an earth wire is no guarantee of safety. This has unfortunately been proved by the occurrence of several accidents. In the cases which have come under the author's notice the coal-cutter machines jammed the trailing cables against a prop, causing one of the cores of the cables to make contact with the framework of the machines, and so in both cases the earth circuit was not intact and fatal accidents occurred.

A type of plug has been commonly used for connecting the trailing cable to the machine at one end and the gate-end panel at the other, consisting of a wooden block having a brass plate on one side connected to the earth wire and joining on to the framework by means of screwing a pin through the block into a tapped hole on the machine. When it is required to reverse the motor the plug is withdrawn and reversed (see Fig. 7). There have been four fatal accidents with this type of plug within the author's knowledge.

Such arrangements have proved to be entirely unsatisfactory and have indicated the necessity for making the earth connections automatic and secure.

The danger of shock is increased on coal-cutters which are working on a fairly wet coal face.

At least one case has occurred where a man has been fatally injured when setting the cutting tools on a coal-cutter at a time when the motor has been accidentally restarted after a stoppage.

Attention is drawn to a recent experience at Clifton Colliery, Nottingham, in which two men lost their lives (see report of Mr. R. Nelson, H.M.'s Electrical Inspector of Mines).

The author has devised and put into commission a system to reduce such risks. The object has been to provide a gate-end switch-box having automatic features which ensure cutting off the supply to the coal-cutter motor and trailing cable under any of the following fault conditions :—

1. Persistent overload (time-limit setting).
2. Short circuit between phases (time-limit setting).
3. A fault between any phase and earth (instantaneous release).
4. No-voltage, or failure of supply (instantaneous release).
5. A break or a bad contact in the earth circuit (instantaneous release).

The other conditions which have been studied in the design of the gate-end box are as follows :—

6. Suitable connections for incoming and trailing cables.
7. Joints to be made in a place where the use of a blow lamp would not be permissible.
8. The assurance of sound earth connections between the armouring of the cable and the case.
9. Earth connections automatically made on plugs at both ends of the trailing cable.
10. The system to be as simple as possible and negative in action, *i.e.*, if any part of the system is faulty it is to be impossible to make the coal-cutter motor alive.
11. No live parts to be accessible to the miner.
12. The case to be made so that there is no risk of an internal explosion permitting flame to be emitted therefrom.
13. The arrangement of the plug and sockets to be made so that it is impossible to draw out an arc in operating them. Provisions to be provided whereby a man at the coal-cutter frame can conveniently open the gate-end switch and is assured that the gate-end switch cannot be closed without his consent.

    It is to be impossible to close the main switch if either of the plugs are out of position and lying on the ground in order that it should be impossible to get a shock off the plug when in this position, the switch being made so that it is impossible to close the circuit or hold the switch in on a fault.
14. It is to be impossible to lock off the automatic gear to render it inoperative.
15. There is to be an absence of fuses. It was considered that numerous cases of shock and burns to workmen have been brought about by unskilled men replacing blown fuses with a dim light available from the safety lamp.

    Moreover, a great deal of time is wasted in replacing fuses which have blown. The majority of men working on coal-cutting machinery are paid by the number of yards or ton of mineral cut, and experience has shown that they will, rather than be delayed in any way, overfuse the machine in order to get a heavier feed on the cutter, thus overloading the motor and endangering the operation of coal-cutting.

    It was therefore considered necessary to dispense with fuses altogether and, in preference to the fuses, an automatic switch arranged in such a way that it is practically impossible for unauthorised persons to alter the setting.

The system involves the use of a trailing cable having a pilot or subsiding wire in addition to an earth conductor (Fig. 5).

The gate-end switch (Fig. 7) is controlled by a solenoid in circuit with the pilot and earth conductor, so that, if the earth circuit is not complete, current cannot pass through the solenoid, and it is impossible to close the switch.

Fig. 2 shows the arrangement for a three-phase supply having an earthed neutral, and Fig. 1 illustrates corresponding connections when used on a direct-current supply with an earthed neutral-point obtained by the addition of an extra brush on the commutator of the generator in the power station.

* Paper before the Newcastle Local Section, Institution of Electrical Engineers.

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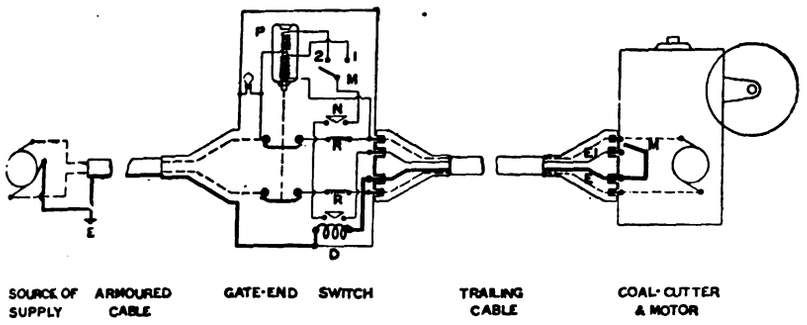


FIG. 1.

Reverting again to Figs. 1 and 2, it will be seen that when the operating switch M is closed, and provided the pilot circuit E_1 and the earth conductor E are complete through the framework of the machine, then the solenoid P is energised and the main switch is closed. On releasing the handle of the control switch M the switch springs automatically on to the contact No. 1, which puts a high-resistance solenoid in circuit and also affects a change-over by which the connection through the solenoid is taken from the outgoing side of the switch. It will be seen that the main switch cannot be held in the closed position unless current passes through the solenoid, and there will be no circuit through the solenoid unless the earth circuit is complete through E and E_1, or if the supply voltage fails. By this means the switch opens automatically under the required fault conditions enumerated above.

Figs. 3 and 4 show the details of the gate-end box. S is a three-pole oil-break switch fitted with three overload release coils R, R, R, having a time-lagging device of the oil dash-pot type. A scale Y is provided for adjusting the setting of this overload arrangement.

P is the controlling solenoid and has two windings, one of which is used to give a maximum pull at the moment of closing the switch, and the other is a coil of high resistance consuming only the small amount of energy sufficient to hold up the armature when the switch is in the "on"

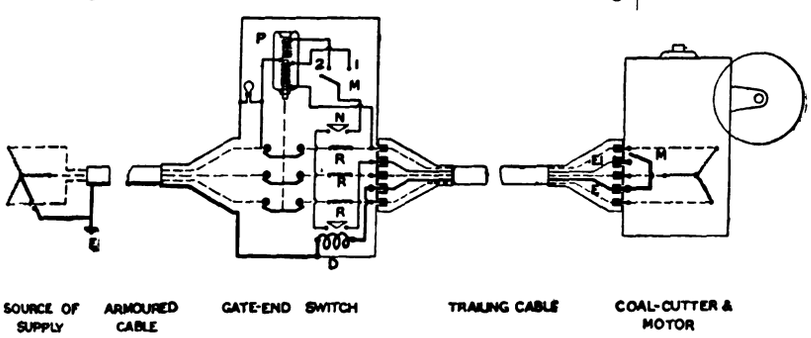
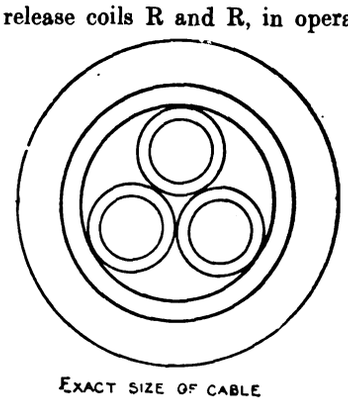


FIG. 2.



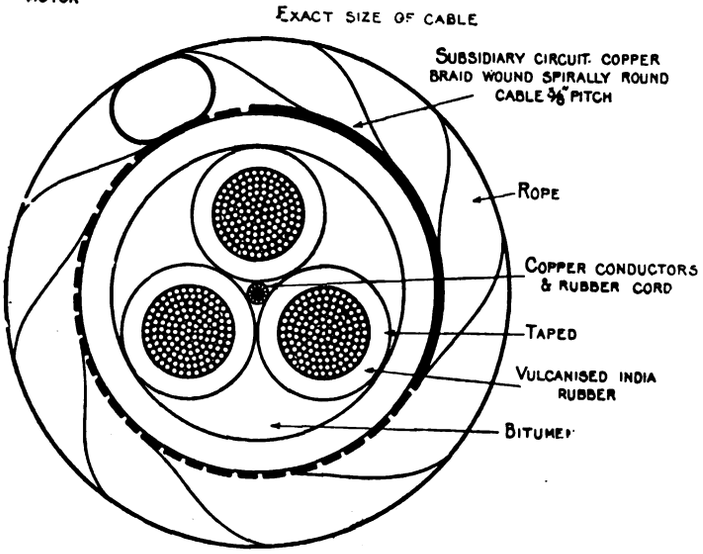


FIG. 5.

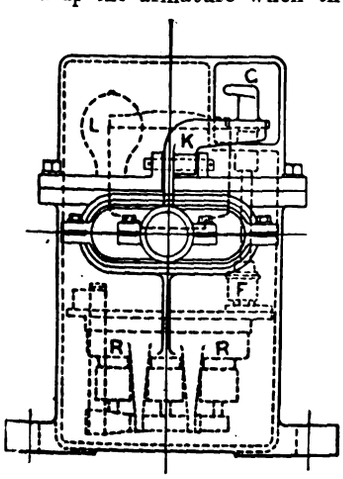


FIG. 3.

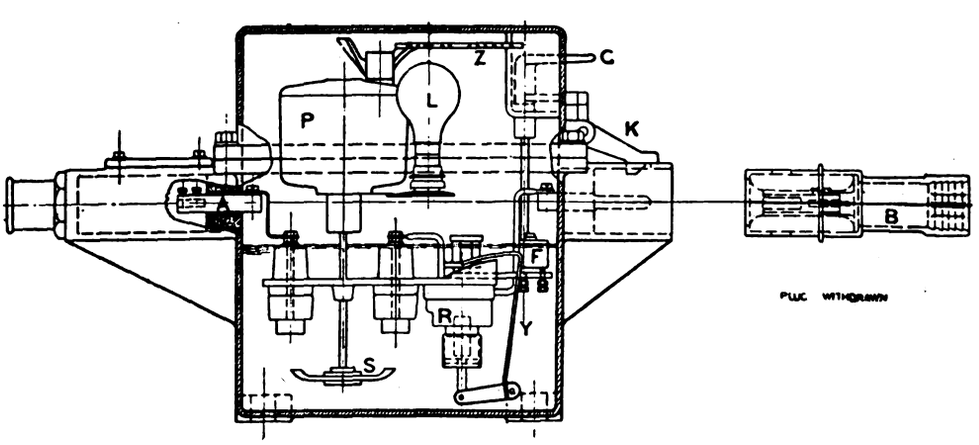


FIG. 4.

position, but the switch is knocked out by means of simple mechanism, when the weight of the armature is released by the solenoid.

F is a small control switch operated from the outside of the box at the handle G. This arrangement of control is on a free handle principle—*i.e.*, in the event of a fault occurring the main switch was bound to trip out even though the control switch is held by the operator's hand, or even if an attempt is made by a dauntless operator to tamper with the device. The argument has been raised against automatic gear in collieries that automatic switches can be locked out of action. It will be seen that this danger cannot exist with the method shown on the above illustrations.

L is an indicating lamp which, by the aid of a simple shutter device, shows a light through a strong glass window and gives a clear indication so that it can be seen from the outside whether the switch is "on" or "off." The lamp is connected to the incoming cable, and so, when no light is shown, it indicates that the supply is cut off from this source.

The overload release coils R and R, in operating, open the control circuit and so release the main switch. The complete mechanism is enclosed in a strong iron case. The current-breaking parts are immersed in oil. The case and lid have wide machined joints to avoid the possibility of an omission of flame. Mechanical terminals are provided throughout so that joints can be made without soldering. Those at A take the incoming cable, the insulated ends

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of which are situated in a box which can be run in solid with compound for the purpose of sealing the ends. Suitable glands are provided for earthing the armour thoroughly to the box. The trailing cable is attached to the plug B. The plug is enclosed in a strong cast-iron case, and it is so interlocked with the control switch that it is impossible to withdraw the plug when the main switch is closed. This interlocking is effected by a simple pawl at K, and it is obvious that it is impossible to draw out an arc in manipulating the plug for the reason that the plug cannot be withdrawn when the circuit is alive. A corresponding plug is used at the coal-cutter end of the trailing cable, and a socket is made, as shown on Fig. 6, suitable for

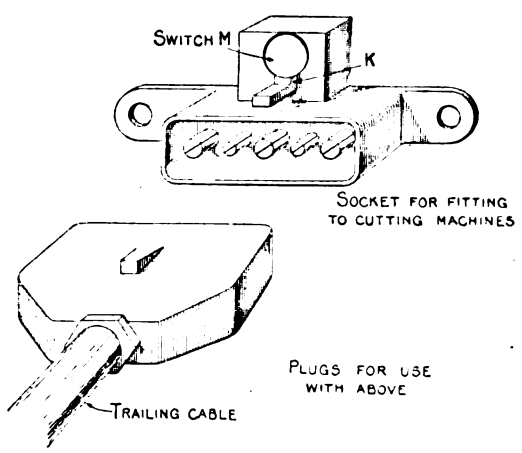

FIG 6.

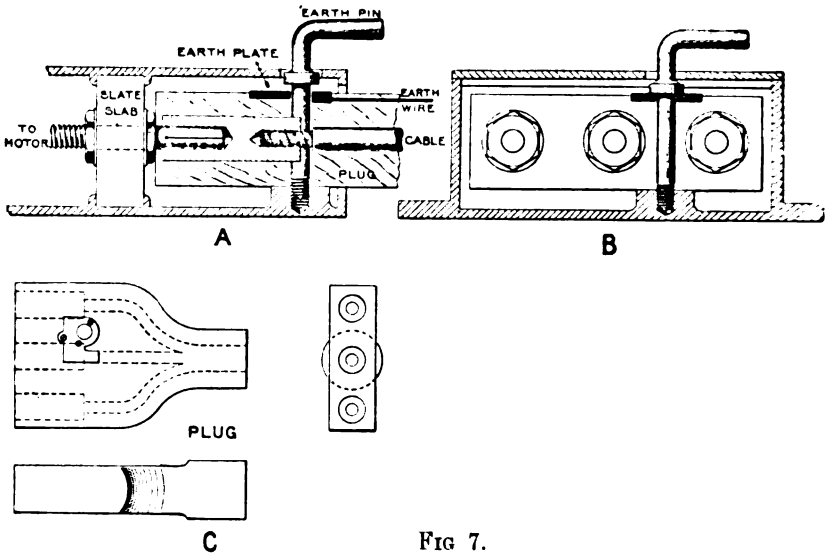

FIG 7.

fixing to any existing coal-cutter frame. Like the corresponding socket on the gate-end box, it carries a locking pawl K, inter-connected with a small switch by which the men working the coal-cutter can open the control circuit, and so make the trailer and the motor dead, and ensure that they cannot be made alive until the switch is closed at the coal-cutter end. This is an important factor in the safe working of coal-cutters, and has not been provided for in any previous system. It is true that arrangements have been made which cut off the current to the motor at the coal-cutter end, but the author's system enables a supply to be cut off right back to the gate-end box, and not only disconnects the motor, but the trailing cable as well, and at the same time prevents any one accidentally closing this circuit if the men at the coal-cutter are carrying out any work on the machine.

The plug is made reversible so that the motor can be reversed, if necessary, by simply withdrawing the plug and reinserting it the other way round.

It is obvious that, if the plug is not in the socket, the control circuit is incomplete, and so it is impossible to close the main switch with the plug lying on the ground.

It may be argued that there are an excessive number of parts to maintain on the switch. Appreciating this it has been the endeavour in the design to reduce these parts to a minimum, and to so completely enclose the apparatus that nothing can be tampered with by inexperienced men in bye. In the event of any part requiring skilled attention it is a simple matter to remove the complete interior working parts from the case and, if necessary, to get the circuit going again quickly, to replace them by another set whilst the first set is taken to the pit-head, or to a convenient place where there is plenty of light and room available for proper inspection.

In the objects enumerated above, it has been mentioned that the switch was to open instantaneously in the event of a fault or leakage to earth occurring on the coal-cutter motor or on the trailing cable. This object has been attained in a very simple manner. Mr. McFie and Mr. Georgi have both proposed a system for branch feeders in which a relay is inserted in the earth conductor. The relay operates when any current passes through the earth conductor, such as would be the case in the event of a leakage. This idea, as shown by letter D as applied to the gate-end box (Figs. 1 and 2), represents the coil which is connected between the earth conductor in the trailer and the switch case. This electromagnet operates on a current well above that required through the solenoid of the main switch, in order to discriminate between the normal current in this earth circuit and the current which is there on account of a fault. It will be seen from the diagram that the electromagnet in operating opens the control circuit in a manner similar to the overload release. The distinction between the overload release and the leakage release is that the overload operates on a heavy persistent overload or fault between phases, whilst the leakage protection trips the switch instantly with a current which forms a small proportion of the normal full load.

It is suggested that the system described above may be of service on other electrical installations. It may be used with advantage to protect odd numbers of sections between main switchboards at bank and distribution centres in bye, in such cases where it is required to embody a system for remote control, and to ensure against accidents due to incomplete earth circuits. Moreover, it may be applied to portable machinery in factories, shipyards, ironworks, etc. For example, wharf-cranes and other portable apparatus where, to be strictly in accordance with Home Office regulations, and in order to avoid danger, it is essential to have efficient earth connections.

It should be said in conclusion that the system under discussion has had extended trial underground. Several times the earth wire was broken accidentally, and in every case the gate-end switch was opened and could not be closed again until a new trailing cable had been inserted.*

EDISON'S LATEST BATTERY.

By OUR NEW YORK CORRESPONDENT.

The Edison Storage Battery, which, according to some of the inventor's critics, has for nine and a half years been hanging between myth and mystery, is at length an accomplished fact, and a public trial of its powers has this week convinced even the most sceptical that the nickel-iron battery, if not fulfilling everything that Mr. Edison suggested in 1901, is, at any rate, enormously in advance of anything of the kind which has hitherto been perfected. The new cell does not differ much in outward appearance from the original cell brought out in 1901, but the structure of the positive plate has been radically modified and other improvements embodied to increase the capacity and durability. At present the battery is made in two sizes; one size having four positive and five negative plates, and the other possessing six positive and seven negative plates. The active material in the positive plate consists of nickel oxide and iron oxide is used in the negative electrode. The electrolyte consists of potassium hydrate (21% solution) to which has been added a small amount of lithium hydrate. The function of the lithium hydrate is not clearly defined, but it has been found to improve the working of the positive electrode. The normal specific gravity of the solution is 1·210, which does not change during charge or discharge. The efficiency and capacity of the cell, however, are not affected to any extent if the specific gravity of the solution

* The system installed is Patent No. 12452/09, Fisher. The switch-box for ditto, App. No. 20590, Fisher, Reyville & Co., and others.

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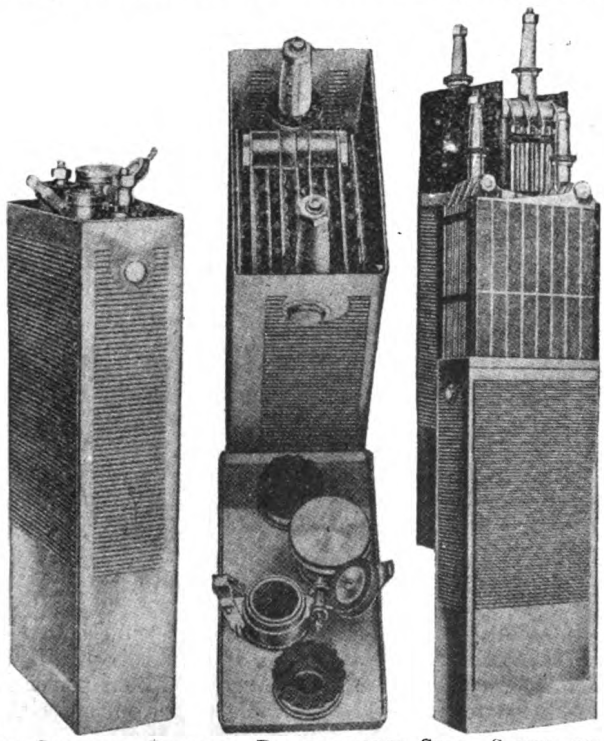
is as low as 1·160. Below this a temporary effect is noticeable in the output of the cell.

The New Principle.

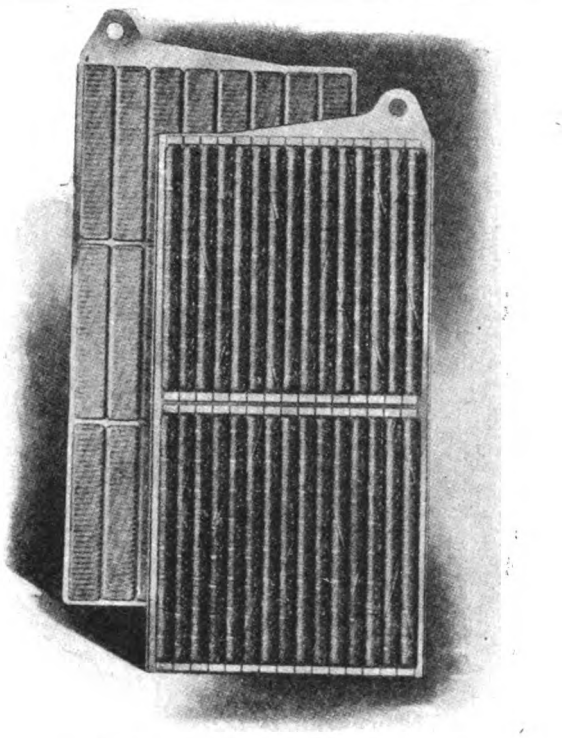
The cans or containers are made of electroplated steel welded at the seams by the application of the oxyacetylenic blow-pipe. The walls of the can are corrugated so as to obtain the greatest amount of strength with minimum weight. The iron element has an excess capacity over the nickel element. Much time has been spent in perfecting the latter. The original positive plate was made up of flat rectangular pockets containing nickel oxide and graphite. It was found that the graphite oxidized and that mechanically the structure could not resist the swelling action of the nickel oxide. In the new plate round tubes 4 in. long and about the diameter of an ordinary pencil are used to retain the nickel oxide. The tube is made of thin perforated steel, which when filled with the active material and properly bound by eight steel rings, makes expansion of the active material impossible and insures perfect internal contact. Instead of the graphite formerly employed, electrochemically prepared flakes of pure nickel are interspersed in the oxide to increase the conductivity of the active mass, because nickel oxide of itself is a poor conductor. Each positive plate consists of a grid of nickel-plated steel holding 30 of these tubes. The negative plate comprises 24 flat rectangular pockets supported in three horizontal rows in a nickel-plated grid. The pockets are made of thin nickel-plated steel perforated with fine holes, each pocket being filled with an oxide of iron and afterward subjected to very heavy pressure.

Details of Construction.

The plates of each group are hung on a connecting rod perpendicular to, but integral, with the pole. They are held apart by nickel-plated steel washers and held in contact by nuts screwed on both ends. The two outside plates are negative and are insulated from the retaining can by sheets of hard rubber. Hard-rubber pieces are also fixed between the can and the side and bottom edges of the plates, and these, together with the hard-rubber rods inserted between the plates, maintain correct spacing and insure permanent insulation. The cover of the cell, which is also welded in place, has four mountings. Two of these are for stuffing boxes through which the positive and negative poles extend; one is a separator which prevents the loss of electrolyte while allowing the gases to escape, and the other is an opening for water and electrolyte. This opening is fitted with a water-tight cage held in place by a catch. Fastened to the cage is a spring so arranged that the cage will fly open unless properly fastened. In an assembled battery each individual cell is held securely in place and



THE COMPLETE BATTERY—BATTERY WITH CELL COVER OFF—CELL SHOWING ELECTRODE PROTRUDING.



POSITIVE AND NEGATIVE PLATES.

from contact with adjacent cells by means of a small hard rubber button which extends through the slot on each side of the tray and fits over an emboss pressed out on the side of the can. The bottoms of the cells are held in position by small buttons protruding from a wooden block fastened to the bottom slots of the tray. The indentations in the bottom of the cell fit over these buttons. A rubber apron insulates the cell from the block. The separator through which the gases escape while the battery is charging is so designed that the gases escape in substantially a dry condition, the globules coalescing with a liquid film which forms at the base of the casing and seat of the ball valve with which the battery is fitted, and in this way falling back into the cell. The electrolyte, therefore, need only be replenished with distilled water until completely changed every eight or ten months.

Data of the Cells.

Electrical connection between the cells is made by means of heavy copper connectors, well plated with nickel. The lugs at the end fit over taper-joint binding posts and are held in place with a nut. A socket wrench for removing the nuts which hold down the connectors and a specially designed jack for lifting the lugs from the binding posts when disconnecting the cells are sent with each battery. The trays in which the cells are assembled are very light, and where formerly the ends and the bottom were dovetailed together, the trays are now made of continuous strips, the corners being bent. The data of the cells are given herewith:

	Type A-4.	Type A-6.
Rated ampere-hour output	150	225
Average discharge voltage per cell	1·2	1·2
Normal rates of charge and discharge in amperes	30	45
Weights (in pounds) of cell complete	13·5	19·2
Width of can	$2\frac{9}{16}$	$3\frac{3}{4}$
Breadth of can	5	5
Height of can	$13\frac{3}{8}$	$12\frac{3}{8}$
Height of cell to top of pole (not assembled)	$13\frac{3}{8}$	$13\frac{3}{8}$
Required height of battery compartment	15	15

While the normal rate of charge of the smaller cell, for instance, is 30 amp., charging may be done at double this rate for a one-hour boost if the temperature is kept from rising much above 100° Fahr. It is also permissible, though not recommended, to discharge a battery continuously at rates up to 25% above normal, and for occasional short intervals of time as in hill climbing or starting on heavy roads, no harm is said to result if the rate be increased to three or four times normal.

Capacity Increases with Use.

The capacity of the battery increases after it has been placed in service so that after working some time the

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efficiency is increased and greater output obtains also. This process of self-forming continues over a period of from one to three months of regular service and it is partly to assist in this forming up that the overcharges are recommended at intervals. The curves also show that the battery possesses reserve capacity. The highest practical limit of output is reached when a battery is charged 10 hours at the normal rate, and its value will be, for a fully formed battery, perhaps 30% more than the rated output. Efficiency is sacrificed somewhat, of course, when the highest available capacity of the battery is utilised. A seven-hour charge at normal rate is considered a normal charge.

Behaviour under Tests.

It has been found in testing the battery under severe conditions that with a rated discharge three times normal the voltage drops 0·03 volt for every 10 amp. increase. On returning to normal discharge the voltage comes up to a value a trifle higher than normal owing to the heat generated at the heavy discharge rate. Heat on discharge increases the output while heat on charge diminishes it; but excessive heating at all times impairs the life of the battery and should be avoided. The watt-hour efficiency of the cell is given in various curves and ranges from 60% to 65%. The smaller battery gives about 14 watt-hours per pound of cell, and the larger cell 16 watt-hours. The manufacturer lays stress on the claims that the battery cannot be injured by overcharging; it does not deteriorate when left discharged; any cell can be removed by simply detaching the connections from the poles, and the battery has nearly twice the output or mileage of other batteries weight for weight. The purity of the chemicals used and the structure of the cell insure great durability and long life.

THE ELECTRICAL OPERATION OF INDIAN TEXTILE FACTORIES.*

By C. H. DOUGLAS.

It was originally intended that Mr. Wilson's paper should be presented to you intact, but I have ventured to depart from this course, because here in Bengal we have a textile industry of great importance in which the conditions of commercial efficiency are somewhat different to those which govern the Lancashire mills.

For this reason it has seemed desirable to make the scope of this paper a little wider than that of Mr. Wilson's.

So far as I am aware the first case of electrically driven textile machinery occurs in Switzerland, where in 1884 the Preparation Room of a cotton mill was driven by four 20 h.p. direct current motors taking their power from a turbine driven dynamo.

This installation, now 25 years old, is still, I believe, running satisfactorily.

The United States, however, developed the drive and adapted the polyphase motor, the use of which is now general, and the first completely electrically operated textile mill was started there in 1894. So immediate was its success that since then over 16 million out of approximately 22 million spindles, and 380,000 out of 640,000 looms in America are electrically driven.

On the Continent of Europe not less than 47% of the spindles installed are run electrically, and well over 90% of all fresh mills are arranged for this drive.

It is frequently stated that the reason for this may be found in the cheap water power of these countries, but it is a fact that only about 17% of the above-mentioned machinery derives its energy from water power.

In India one firm alone has equipped one jute mill and nine cotton mills completely with machinery for this system, all of which are steam, oil or gas driven.

The foregoing figures without being exhaustive, should serve to prove the existence of definite experience of this method of operation.

Great Britain has been particularly backward in adopting electric drive, but a good deal of leeway has been made up, and both Lancashire and Dundee are adopting the new system rapidly.

A point on which Mr. Wilson touches is the question of power supply from an outside station. Now this is a much more complicated question than it seems, and local conditions have a most important bearing on it, but I may say that a new 400 loom jute mill on the Hooghly would find it advantageous to take power at ·45d. per unit, and a cotton mill in Bombay at ·5d.

In any well laid out textile mill, the following advantages can always be claimed for electric drive:—

(1) The best possible utilisation of the land available for buildings.
(2) A quieter, cleaner and cooler mill.
(3) Greater production.
(4) Better product.
(5) Lower maintenance and depreciation.
(6) Better facilities for accurate cost keeping.

In an old and badly laid out mill there are many problems of transmission for which electric drive is the only solution, but these are special cases.

In connection with production, a curious point has arisen with one of the mills in India with which I am familiar.

As you are aware, it is usual in calculating power required to drive a definite number of looms to assume that a percentage of these will always be stopped. In the mill in question, which has what would have been considered a phenomenal, if not impossible production some years ago it was found that the usual allowance is quite inadmissible with electric drive, and in consequence the power taken is above that which ordinarily would be allowed for such a shed. The owners were a little worried over this until the financial results of one year's working showed that the extra production completely accounted for, and extinguished many times over, the value of this extra power.

When jute manufacturers have consulted me with regard to the advantages of electric transmission, almost invariably the first question they have asked is—can we turn out a ton of fabric for so many cwts. less coal?

Now this is an entire misconception of the object to be attained. Electricity is only a transmission agent, and it is not probable that much better than 83% over-all efficiency can be attained by its means in this case, from engine to shaft, and on the whole this is about equal to rope driving. But owing to its superior steadiness, it enables the productive machinery to be driven at a higher rate.

Now, rotary textile machinery takes energy somewhere in proportion to the one-fifth power of the speed, within ordinary limits, therefore, if the production is high, the coal per unit of production is also high. But the total power costs are only about 2½% of the manufacturing costs in a cotton mill, so that 3-4% extra production would wipe out *all* the fuel costs. Put this way, the supreme importance of production and the comparative insignificance of fuel is self-evident.

It is frequently urged by persons to whom the problem is not familiar that it is quite impossible that electric drive can make such a difference as is claimed in production when the modern mill engine will govern within 1½%.

While it is quite true that such governing can be obtained, it is not realised that this is no guarantee of cyclic regularity, and it is this which governs the maximum speed at which the machines run.

Again, with even the best mechanical transmission systems long lines of shafting are inevitable, and no one who has not witnessed tests on such lines of shafting can realise the amount of torsional swing which they can develop.

The use of electricity permits the employment of practically all forms of prime mover, such as, for instance, a combination of the familiar Corliss or drop valve engine with an exhaust steam turbine. This combination offers a steam economy which is quite unequalled. In a case which came before my notice during this last summer a reciprocating engine of 1,250 h.p., which consumed about 14 lbs. steam per i.h.p., had a 625 h.p. turbine added to it. Their combined output was 1,625 b.h.p., with the same steam as before, consequently the consumption per i.h.p. was reduced to about 11 lbs., while the output with the same coal consumption was increased by 30%.

The modern gas engine is again highly suitable for

* Abstract of a paper read before the Calcutta and District Section of the Institution of Mechanical Engineers on December 15, 1909.

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driving electric plant, but not so suitable for mechanical transmission. Its fuel economy is, of course, greater than even the combination referred to above, and its use is consequently increasing rapidly.

In the design of a textile mill to be driven electrically several somewhat conflicting conditions have to be met. If first cost is no object, it is probable that small motors on each ring frame are the most satisfactory arrangement, and small groups of roving frames may also be driven without much shafting.

For looms, however, it seems necessary to retain the cross shafts, each shaft being driven through spur gear by a motor of about 15 h.p. in the case of a cotton mill, and perhaps 45 or 50 h.p. in the case of a jute mill.

It is in details of design such as these that the secret of really successful electric driving lies, and it is probably owing to ignorance of the millwrights' craft that one or two installations have not fulfilled all the promises made for them.

A local advantage which I think will appeal to everyone here is the centralisation of machinery, which can be obtained by electric transmission. The work of the European staft is unquestionably lightened by this means, and by suitable instruments on the power station switchboard it is possible to state almost with complete accuracy what is occurring inside the mill.

In conclusion, I append a table of costs and results for a gas engine electric drive as compared with steam engine and rope transmission :—

COMPARATIVE COSTS

OF GAS-ELECTRIC *versus* STEAM ROPE DRIVES, 800 LOAM JUTE MILL.

CAPITAL.

STEAM ROPE.			GAS ELECTRIC.		
1—2,200 i.h.p. steam engine 1—1,000 i.h.p. steam engine	Rs.	1,68,000	3,000 b.h.p. tandem gas engines complete connected to 3 generators and excitors ..	Rs.	3,35,000
12—8′ 0″ × 30′0″ Lancashire boilers ..	,,	1,44,000	Switchgear ..	,,	10,000
Steam piping, including economiser and feed pumps ..	,,	65,000	4—Mond gas producers 3,000 h.p. capacity for above engines complete	,,	1,60,000
Engine room ..	,,	90,000	Shafting complete for mill as before, all motors starting gear, cables and accessories ..	,,	1,83,000
Boiler house ..	,,	60,000	Engine room and foundations ..	,,	50,000
Chimney ..	,,	25,000	Producer house	,,	25,000
Rope alley ..	,,	21,600			
Shafting, gearing, etc.	,,	2,00,000			
Cooling pond, including land	,,	35,000			
Total	Rs.	8,08,000	Total	Rs.	7,63,000

RUNNING COSTS.

Engine duty 13 lbs. i.h.p. hour.	Engine duty 10,000 B.T.U. per b.h.p. hour.
55 tons coal per diem at Rs. 9-0 .. Rs. 495	24·5 tons coke at Rs. 12-0 Rs. 294
Labour 24 men and Sirdar.	Labour 10 men and Sirdar.

Oil, waste, stores, say, equal.

REVENUE ACCOUNT.

Say 76 tons fabric (average of weights) at Rs. 450	Rs.	34,200	81 tons (6% increase) fabric at Rs. 450 ..	Rs.	36,500

SUMMARY.

(300 days).

Cost of fuel saved Rs. 201300 ×	Rs.	60,300
Value of 5 tons extra production, say, Rs. 750 × 300 ..	,,	2,25,000
Total	Rs.	2,85,300

USE OF MUTUAL INDUCTOMETERS.

By MR. A. CAMPBELL.

Speaking before the Physical Society of London, the author said that in the use of mutual inductometers (or variable inductances), already described by him, the use of a balancing coil in one arm of the bridge causes considerable loss of sensitivity. With an equal-arm bridge this difficulty is overcome by putting the two halves of the secondary circuit in adjacent arms of the bridge. The auxiliary balancing coil is thus dispensed with and the usual formula is still applicable.

He next discussed the measurement of effective resistance, which is in general much more troublesome than that of self-inductance. As the effective resistance determines the total power spent by a given alternating current in a conductor, it is a most important quantity in telephonic and other high-frequency work. When it is measured by an ordinary self-inductance bridge, Giebe has shown that large errors may be introduced by the small residual inductances of the ratio arms. The author worked out the analogous formulas for mutual inductance bridges, which indicate that the inductances of the ratio arms must be accurately proportional to their resistance, if errors are to be avoided.

He next described a null method in iron testing analogous to Max Wien's self-inductance method. The ring to be tested is wound with primary and secondary coils. The magnetizing current I_1 is passed through the primary coil, the primary circuit of a mutual inductometer, and a slide-wire resistance. The detecting instrument, a vibration galvanometer or a tuned telephone, is put across a circuit consisting of the secondaries of the ring and the inductometer in opposition and a part Q of the slide-wire resistance. By adjusting Q and the reading M of the inductometer, a balance is obtained, in which case the power lost in the ring (due to hysteresis and eddy currents) is equal to $QI_1^2 \times N_1/N_2$, where N_1 and N_2 are the numbers of turns in the windings of the ring. In certain cases the permeability can also be directly found. The method is immediately applicable to the testing of current transformers. If the instrument usually in the secondary circuit of the transformer be replaced by a suitable low resistance S, then when a balance is obtained

$$\tan \phi = 2\pi n M/Q \quad \text{and} \quad I_1/I_2 \doteqdot S/Q,$$

where ϕ is the angle of lag between the primary and the reversed secondary currents, and n is the frequency. The primary current should have a sine wave form. The method gives directly the two quantities wanted in practice, but, owing to considerations of wave form, the results must be interpreted with caution.

DISCUSSION.

Mr. W. Duddell remarked with regard to the self-inductance of the ratio arms, that the time constants of the two should be the same and suggested, the use of woven resistances.

Mr. Campbell, in reply to Mr. Duddell, stated that when the ratio arms of the bridge could be of high resistance, the employment of woven resistances could ensure that their time constants were equal. The main difficulty, however, arose with ratio arms of relatively low resistance (*e.g.*, 10 : 1,000 ohms.) ; for such values woven resistances did not appear quite applicable.

AN ITALIAN CABLE.

On January 11, the laying of a new cable between the Italian Mainland and the Island of Sardinia was completed by Messrs. Pirelli & Co., of Milan. The first cable between Italy and Sardinia was laid in 1875, and its upkeep entrusted to the Eastern Telegraph Co. until 1905, after which date, it passed into the care of Messrs. Pirelli & Co. For the new cable, the contract for supplying, laying and upkeep of 5 years was allotted to this firm. The core of the new cable is completely armoured with a brass tape as a protection against teredo. A peculiar condition of the specification was, that the sag was to be not less than 5% in depths up to 55 fathoms, nor less than 10% in depths of more than 55 fathoms. The maximum depth reached by the cable is about 700 fathoms.

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WIRELESS FOR THE PACIFIC.

An abstract of the report of the Conference recently held in Melbourne to deal with the proposal to establish a wireless telegraphy scheme for the purpose of linking up the British possessions in the South Pacific, has been given by the *Electrical Record* supplement of the *Australian Mining Standard*. The recommendations of the Conference are as follows :—

1. That high-power wireless stations be established at or near the following places :—
Sydney, in Australia ;
Doubtless Bay, in New Zealand ;
Suva, in Fiji ;
Ocean Island ;
the Sydney station to be capable of communicating with Doubtless Bay, that at Doubtless Bay with Sydney and Suva, that at Suva with Doubtless Bay and Ocean Island, and that at Ocean Island with Suva ; and that such stations be capable of receiving and transmitting waves up to 6,000 ft., in addition to ordinary commercial waves.

2. That medium-power stations be established at Tulagi (Solomon Islands), and Vila (New Hebrides).

3. That the proposals of the Pacific Radio-Telegraph Co. be not adopted.

4. That the proposed system be established and maintained under State control, or through a State agency.

5. That costs of construction be apportioned as follow :—

Fiji—Imperial Government	One-third
Commonwealth	One-fourth
New Zealand	One-sixth
Fiji	One-fourth
Ocean Island—	
Tulagi, Solomon Islands (Imperial Government)	Two-thirds
Vila, New Hebrides (Commonwealth)	One-third

6. That any deficiency in regard to the annual charges be met, in the case of—
Fiji—By the Governments contributing to its construction, and in the same proportions, with the proviso that, if the station be used in connection with any local system of radio-telegraphy established by the Fijian Government, that colony shall bear an increased proportion of the charges, to be determined :—
Ocean Island—By the Pacific Phosphates Co.
Tulagi, Vila—By the Governments contributing to the construction in the same proportions.

7. That the Governments concerned embody their arrangements for carrying out any scheme approved by them in an agreement, which shall provide for the executive control and management by the High Commissioner for the Western Pacific and the Government of Fiji.

It is estimated that the cost of construction will be about £70,000, to which the Imperial Government would contribute £23,334, the New Zealand Government £16,333, the Government of Fiji £3,500, and the Commonwealth Government £26,833. The cost of constructing, maintaining and operating the high-power stations at Sydney and Doubtless Bay to be borne by the Australian and New Zealand Governments respectively, is included in the above figures, thus swelling the amounts to be contributed by those two Governments by £14,000 in each case. In estimating cost of maintenance it has been presumed that wherever skilled labour is not required native labour will be made use of, and it is expected that for a continuous service the gross maintenance charges will amount to about £24,820 per annum, Great Britain contributing £7,716, New Zealand £6,248, Fiji £1,122, and the Commonwealth £9,734, while for a restricted service the total would be £17,170, of which Great Britain would pay £5,586, New Zealand £4,130, Fiji £795, and the Commonwealth £6,659. In all these estimates provision has been made for a high-power station at Ocean Island, but that portion of the scheme will be dropped unless the Pacific Phosphates Co. guarantees any loss on the working expenses.

The Conference expressed the opinion that the effect upon the trade of the existing Pacific cable would be very beneficial, and that about £1,125 per annum would be added to its earnings ; and on this the report says :—
"If satisfactory wireless communication is established between Australia and New Zealand and Fiji, it is, of course, possible for the system to compete with the existing cables for ordinary telegraph business between these places, but it is understood that the installations of Sydney and Doubtless Bay will only be used for communicating with ships, and for defence purposes." It is further suggested that both Germany and France would be likely to avail themselves of the opportunity which the scheme would afford for bringing about closer communication between their dependencies in the Pacific.

"A station in the New Hebrides would doubtless induce the French Government to create means for direct communication with their nationals on that group. Tahiti is at present far removed from the paths of ordinary traffic, but the opening of the Panama Canal is expected to materially enhance its importance. The Society Islands form the easternmost of the groups of the South Pacific, in which there is safe harbourage, and include some valuable guano islands. There will, therefore, be strong reasons why, if the proposed system is extended eastward to Tonga and Raratonga, the French should establish a station at Papeete, and thus come into immediate touch with the world."

CANADIAN DEVELOPMENTS.

The three following important Bills are to be promoted in the Dominion Parliament :—

(1) For an Act to incorporate a company, under the name of the Morrisburg Ferry and Dock Co., with powers establish a ferry service on the St. Lawrence river to build docks, wharves, and slips, and to construct a line of railway.

(2) For an Act to incorporate a company, under the name of the Pacific and North-Western Railway Co., with powers to construct a line of railway from a point on the international boundary between British Columbia and Alaska to a point on the boundary between Yukon Territory and Alaska, and to construct and acquire steam and other vessels.

(3) For an Act to incorporate a company, under the name of the Ottawa and Montreal Transmission Co., Ltd., having a capital of $500,000 (about £103,000), with powers to generate and transmit electrical energy, and to construct telegraph and telephone lines.

Meanwhile, the Minister of the Interior has recommended the granting of the application of the Vancouver Power Co., Ltd., for permission to buy land and to erect a hydraulic earth and rock-filled dam in the Coquitlam Lake, in order to raise the water of the lake, for the purpose of generating electrical energy.

From Toronto it is announced that the Hon. Adam Beck states that the Ontario Government's Hydro-Electric Commission has arranged to supply 15 municipal corporations with approximately 27,000 h.p. over transmission lines now under construction. These municipalities, with the number of horse-power each proposes to take, are : Toronto, 10,000 ; London, 5,000 ; Guelph, 2,500 ; St. Thomas, 1,500 ; Woodstock, 1,200 ; Galt, 1,200 ; Hamilton, 1,000 ; Stratford, 1,000 ; Berlin, 1,000 ; Waterloo, 685 ; Preston, 600 ; St. Mary's, 500 ; Ingersoll, 500 ; Hespeler, 400 ; and New Hamburg, 250.

In the official Blue Book just issued by the Department of Railways at Ottawa, for the year ended last June, the total mileage of electric railways is given as 988 miles of main track. The paid-up capital of these lines was $91,604,989, and the gross earnings $14,824,936, an increase of $817,887 over the previous year. The net income of the various roads aggregated $4,716,308, or 5% on the capitalisation. The electric railways carried 314,026,671 fare passengers and 81,670,945 transfer passengers on their 3,544 cars.

The total car mileage was 60,152,846, of which 737,720 was in the carrying of mails, freight and express traffic. There were in 1909 10,557 employés of electric railways, 603 more than 1908, and their wages amounted to $6,761,281. The official figures for the last six months of last year are not available, but the figures given in this report have been considerably added to.

During the year 11 passengers, 7 employés, and 50 other persons were killed, and 1,303 passengers, 218 employés, and 618 others were injured in accidents on electric railways.

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Secretaries and Managers of Companies are asked to furnish Notices of Meetings, Issues of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers.

Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

Contractors can make use of our columns to obtain the names of the makers of any specialities they require in their business.

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DIVERGENT VIEWS.

In another column our readers will find a continuation of the correspondence which has been carried on between Mr. E. Garcke and the Institution of Electrical Engineers. It will be remembered that in December Mr. Garcke wrote complaining that, while the Institution was the most representative body of electricians in the United Kingdom, and did excellent work in many directions, it did not take a sufficiently active part in protecting the commercial interests of those engaged or financially interested in the electrical industry. As we pointed out at the time, the views of one who has taken so prominent and successful a part in the electrical development of the country are naturally entitled to the most serious and sympathetic consideration. Yet it is obvious that if the views of Mr. Garcke prevailed, the Institution would necessarily derogate from its present enviable position and take rank as a trade protection society. Of course, all recognise that the functions of the Institution are far higher than that, as we see by the increasing numbers eager to take on the responsibilities of membership. Because, after all, membership, while conferring very decided benefits, also imposes some sacrifices, the professional etiquette being more stringent for those inside than for those outside the ranks. That is as it should be, and emphasises the difference existing between a body merely formed to protect an industry, and one established to promote the development of a science. The official reply practically takes this point of view, while recalling the fact that the industrial side of electricity is by no means neglected, or legislative activities overlooked. While agreeing with Mr. Garcke that an industry of the magnitude and importance of the electrical industry does require some organisation for the promotion and protection of the general legislative, industrial, and commercial interests of both capital and labour engaged therein, we doubt that it would be good policy for the Institution to take the active part in the narrow

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groove he desires. The Institution should be, as far as possible, scientific and professional, and be in a position to offer legislators and Government departments advice and evidence that could be taken unreservedly as the expression of the best opinions in matters concerning not only the interests of the profession, but of the community. That, so far, has been the guiding principle of the Institution. It would be a vast pity if the wise reserve were departed from, and that the public should look upon it in the same light as a deputation of cobblers placing their views before the Board of Trade, or of great financiers conferring with the Treasury. It is notorious that Mr. Garcke and a large body of eminent electrical engineers hold views on certain questions which are diametrically opposed to the general trend of public opinion and national policy. That these views should be expressed is good; that they occasionally prevail we know; but it would be a thousand pities that the expression of such views, necessarily based on narrow industrial and "high finance" needs, should be voiced by the Institution, and made to prevail through its activities. It is, indeed, well to bear in mind that "the main object of the Institution is to promote the general advancement of electrical and telegraphic Science and its application." That, surely, can be best accomplished by taking broad views, leaving the narrower industrial considerations to other organisations.

CORRESPONDENCE.

TO CORRESPONDENTS.

All communications intended for the Editor should be addressed "THE EDITOR, 149, Fleet Street, London, E.C." Anonymous communications will not be noticed. Letters should reach the Editor not later than Tuesday afternoon to be included in that week's issue of the Journal.

The Editor is not responsible for, nor does he necessarily endorse opinions advanced by correspondents.

SEARCHLIGHTS WANTED.

Sir,—Is it not time that the exceedingly useful searchlights supplied to the Army, and so easily moved about from one place to another, were supplied to signal boxes and breakdown gangs on railways and to coastguards? I fancy that the work of breakdown gangs working at night to rescue victims of railway accidents, and of coastguards rescuing souls from wrecks, should not be obstructed by the absence of portable and ultra-powerful searchlights. What do your readers think?

Yours, etc.,

HENRY JAMES SAINT BENNO CUNLIFFE.
(M.A. Oxon.)

New University Club, London,
February 3, 1910.

SUTTON COLLIERY FATALITY.

An inquest was held last week at Stanton Hill on the body of Willis P. Silkstone, aged 26, an assistant electrician at the Sutton Colliery of the Blackwell Colliery Co., who was electrocuted at the colliery on Wednesday morning. The inquiry was attended by Mr. Walker (inspector of mines), and Mr. W. H. Mascall (manager of the Sutton Colliery).

The father of deceased, J. Silkstone, gave evidence of identification, and said that his son had been working in the electrical department at the colliery for eight years. Asked if he blamed anyone in relation to the death, witness said he blamed Slaney, the man in charge, for not carrying out definite instructions given by himself to cut off the current before commencing to disconnect the wires at the pump-house. He understood there was no disconnection until after the accident. If the current were not cut off before starting a job, it would be contrary to rule.

In reply to Mr. Walker, witness said that he and his men were working at the removal of the pump and motor from No. 15 in the top hard seam to another place in the mine. On Tuesday last Mr. Mascall gave witness instructions for all current to be cut off and the place made "dead," and he conveyed those instructions to Mr. Edwards, the chief electrician.

Arthur Slaney, assistant electrician, who appeared with his head and hands in bandages, said he was working with the deceased on the previous day removing the motor starter. They were both struck by the current, witness receiving a severe shock and burns on the hands, arms, feet, and face. He was rendered unconscious, and afterwards had to be helped out of the pit.

In reply to Mr. Walker, witness said that he was in charge of the work of removing the motor starter, his instructions from Mr. Edwards on Tuesday night being to see that the motor and the switchgear were taken away. He had no special instructions to cut off the current, the work being left to his discretion. He had had ten years' experience of electrical work with various firms in Halifax, and he had been at the Sutton Colliery for five years. He made disconnections before taking off the motor starter. He only left the lighting circuit on, and then as deceased and witness were taking the motor starter off the frame they got a shock. The current was on on the live side of the switch, and to make this absolutely dead it was necessary to cut off at No. 5 switch, 110 yards away. The lighting wire came into contact with the frame, and the shock came from the lighting agency. Deceased was standing on wet planks, and witness was standing upon iron, but was wearing clogs. He believed that the wood in his clogs saved him.

Mr. Walker: Was it common sense to go on working while this current was on? Something went wrong, the starter switch became alive, and when you broke the contact you had the whole of the 500 volts. You were probably saved by the wood in your clogs. To my mind, you did a very foolish thing.

Mr. Hy. B. Edwards, chief electrician, said he had been at the colliery for five years. The instructions that he gave Slaney and deceased were to make the place safe and to shut the current off. There was no special instruction as to making the place "dead," but he particularly said to Slaney: "Make it safe." He thought the cause of the accident was an inferior contact between the starter box and the frame, one of which became alive. The probability was that the lighting wire came into contact with the starter box and made it alive.

Robert B. Barker, under manager, said Slaney had instructions to make everything safe. He was assisting Slaney, and in reply to a question he said that everything was all right. As to the lights he said he would want them to work with. Witness thought the lighting was separate from the main.

The jury returned a verdict of "Accidental death."

READING CORPORATION TRAMWAYS CHILDREN'S TREAT.

On the 28th ult., the wives and children of the employees of the Reading Corporation Tramways, to the number of about 250, were given a substantial tea, followed by an entertainment in the Town Hall. During the assembling of the children an organ recital was given by Mr. Stuart Roseveare, A.M.I.E.E. (on the engineering staff of the Tramways Department), and most of the items on the programme were contributed by various members of the Tramways staff. Alderman C. G. Field, J.P., Chairman of the Tramways Committee, welcomed the children and their parents, and Mr. W. Binns, the General Manager, expressed his thanks to all those who had worked so hard in connection with the treat, and who had sacrificed not only their time, but in many cases their wages also, in order to make the entertainment a success. The Mayor and Mayoress were present, with several members of the Corporation, and took a great interest in the proceedings. Christmas presents were distributed to the children, after which they were conveyed home by special cars to various parts of the town.

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COMPANIES' MEETINGS AND REPORTS.

SOUTH LONDON ELECTRIC SUPPLY.

The directors recommend, subject to final audit, a dividend on the Ordinary shares for the year 1909 at the rate of 5% per annum.

CHELSEA ELECTRICITY SUPPLY CO., LTD.

The directors of the Chelsea Electricity Supply Co., Ltd., have declared a dividend for the half-year to December 31 at the rate of 5% per annum on the Ordinary shares, making 4½% for the year, after paying debenture interest and placing £12,530 to depreciation fund, £704 to debenture premium redemption fund, and writing off £1,089 from the cost of extinction of founders' shares, carrying forward £1,362.

DUBLIN AND LUCAN ELECTRIC RAILWAY CO.

The directors, in submitting the company's accounts to December 31, 1909, state that the gross receipts for the half-year are £3,767 0s. 4d., being £33 2s. 8d. in excess of those of the corresponding period of last year. After providing for debenture interest, there is available balance of £1,240 11s. 6d., out of which the directors recommend the payment of the usual half-yearly dividend on the 5% Preference shares; that £350 be placed to the reduction of electrical equipment account, that sum clearing off the balance of the debt due to the contractors; and that the balance of £415 11s. 6d. be carried forward to next half-year, as against £496 16s. 4d. carried forward from the corresponding period of the previous year.

CITY OF LONDON ELECTRIC LIGHTING CO., LTD.

The directors have decided, subject to the completion of the audit, to place £45,000 to reserve, and to recommend to the shareholders the payment of the following dividends:—On the company's Preference shares, 12s. per share, being at the full rate of 6% per annum; on the company's Ordinary shares, 14s. per share, being at the rate of 7% per annum. On account of these dividends, 6s. per Preference share and 5s. per Ordinary share was paid in August, 1909, and the balance remains to be paid. After payment of the dividends and other appropriations there will remain a sum of about £24,000 to be carried forward.

The directors in submitting their report for 1909, state that energy has been supplied to the Westminster Electric Supply Corporation, Ltd., and the St. James' and Pall Mall Electric Light Co., Ltd., throughout the year, to an amount of 17,282,370 units. After making a full allowance for sinking fund and depreciation, the net balance for the year 1909 is £5,012 15s. 11d., to which is added the balance brought forward from 1908, £23 10s. 1d., leaving an amount now to be dealt with of £5,036 6s. The directors propose to divide this amount as follows: (*a*) By payment of a dividend at the rate of 5% on the Ordinary shares for the year, £5,000; (*b*) amount to be carried forward, £36 6s. The extension of the buildings and plant of the Grove-road Works has been completed, and they now have an effective capacity of 12,830 kw. The chairman, Mr. Walter Leaf, and Mr. Roger W. Wallace, K.C., retire by rotation under Clause 94 of the Articles of Association, and, being eligible, offer themselves for re-election.

ST. JAMES' AND PALL MALL ELECTRIC LIGHT CO., LTD.

The report of the directors and statement of accounts for the year ending December 31, 1909, to be submitted at the general meeting to be held on February 15, states that the supply has been distributed from the Carnaby-street and Mason's-yard Works of this company on a total connection of 11,865 kw., being an increase of 136 kw. For this purpose 5,587,351 units were generated at these works, and 5,764,690 units were purchased from the Central Electric Supply Co., Ltd. A dividend of 5% on the Ordinary shares has been declared, in respect of which a sum of £2,500 will in due course be payable to this company. Having regard to the desirability of reconstructing the boiler plant at the Carnaby-street Works and employing those at Mason's-yard for the future, as a transformer sub-station for high pressure supply instead of for generating, the directors have materially increased the amount written off to depreciation for 1909, and have transferred from the net revenue of the year a further sum of £3,500 to credit of the contingency fund. The net profits for the year 1909, applicable to dividends on shares, amount to £25,320 7s. 5d., amounting with balance brought forward from 1908, £3,705 5s. 9d., to £29,025 13s. 2d.; less interim dividend paid in August last for half-year ending June 30, at the rate of: 7% on Preference shares, £3,500; 10% on Ordinary shares, £10,000; total, £13,500, leaving an amount now to be dealt with of £15,525 13s. 2d. The directors propose to divide this amount as follows:—(*a*) By payment of a dividend at the rate of 7% on the Preference shares for the second half-year, £3,500; (*b*) by payment of a dividend on the Ordinary shares for the second half-year of 5s. per share, making, with the interim dividend paid in August last, a total distribution of 10% for the year, £10,000; (*c*) amount to be carried forward, £2,025 13s. 2d.; total, £15,525 13s. 2d.

MEXICAN LIGHT AND POWER CO.

At the special meeting of shareholders of the Mexican Light and Power Co., Ltd., held in Toronto, on January 20, resolutions were unanimously passed increasing the capital stock of the company by the creation of 36,000 additional Preference shares and 54,000 Ordinary shares of $100 each. The chairman of the meeting announced that the company had recently purchased the entire capital stock of the Compania Electrica e Irrigadora del Estado de Hidalgo, S.A. Pachuca, and that the transmission lines of the Mexican Light & Power Co., Ltd., would be extended to Pachuca, a distance of about 30 miles, for the purpose of supplying the further demands for power in that district from the Necaxa hydraulic electric plant. The Compania Electrica has a hydraulic electric plant of its own of 12,000 h.p., and at the present time is supplying about 7,000 h.p., and has additional business in sight, a large proportion of which is already under contract, amounting to at least 6,000 h.p., which will be supplied as soon as the power can be furnished. Pachuca is one of the most important mining districts in the Republic of Mexico, and in addition to the new business already assured, as above mentioned, the demand for power will undoubtedly increase very rapidly, making this section, within a short time, one of the largest power-consuming districts supplied by the company. The mines at this point consist of ore bodies of enormous extent, and there is great development in progress due to the investment of large amounts of foreign capital in the purchase of old mines and their development and exploitation by modern methods and machinery. As the cost of the operations of the Mexican Light and Power Co.'s installation will only be slightly enhanced by the addition of this new business, the acquisition of the Compania Electrica should add very materially to the net income of the company. The Mexican Light and Power Co., Ltd., has now under construction an addition to its plant of 50,000 h.p., which will be completed during the present year, and will bring the total capacity of its installation up to 100,000 h.p., thus providing ample power to satisfy all demands of the Federal district, including El Oro, and the new territory of Pachuca.

BRISTOL TRAMWAYS AND CARRIAGE CO., LTD.

The report of the directors to be presented to the shareholders at the ordinary general meeting, to be held on February 16, states that the gross receipts for the year amount to £285,564 6s. 1d., and the ordinary working expenses to £199,371 11s. 1d. The directors propose appropriations as hereafter detailed for interest and dividends amounting to £68,113 13s. 4d., the remainder of the available revenue £18,079 1s. 8d. having been allocated towards the year's outlay upon reconstruction of permanent way in addition to the ordinary repairs and maintenance. This outlay of £21,300 13s. 3d. compares with £9,876 17s. 6d. under the same head in the preceding

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year. The appropriations for interest and dividends are as follows:—Interest for the year on 4% mortgage debenture stock, 4½% mortgage debenture stock and on deposits and bankers' interest, £20,926 3s. 4d.; dividend on 4% Preference shares for the year (subject to Income Tax), £18,875; interim dividend at the rate of 6% per annum (subject to Income Tax), for the half-year ending June 30, £14,187 10s.; proposed final dividend at the rate of 6% per annum (subject to Income Tax) for the half-year ending December 31, £14,125; total, £68,113 13s. 4d. The interest on investments having been carried direct to the credit of the reserve fund, and the value of the securities adjusted to market prices at December 31, the totals of the reserve fund and of the Investments representing it both, amount to £200,832 12s. 11d. The receipts of the carriage department show an increase of £22,204 and those of the tramways department a decrease of £2,056. The total number of passengers carried during the year on the company's cars and omnibuses was 45,839,738, as compared with 46,652,389 the previous year, a decrease of 812,651. The traffic on the new Westbury extension is included in this year's figures, or the disparity would have been even larger, as the City routes without exception showed decreases, notwithstanding that every effort was made to attract traffic by maintaining the same frequent services as in previous years. The company's motor cab business is being carefully developed in Bristol and Bath, and the directors contemplate its further extension. One hundred and twenty cabs have already been put into service, and fifty more will be shortly be added.

COMPANIES REGISTERED.

ELECTRIC TIMEKEEPERS, LTD.—Capital, £1,000, in £1 shares (300 Twenty per cent. Cum. Pref.). Objects: To take over certain inventions relating to the manufacture of electric clocks, chronometers, timepieces or watches, and to adopt an agreement with C. Haunz. Private company. The first directors (to number not less than two nor more than six) are not named. Remuneration, 10% of the net profits after 1s. per share has been paid on the issued Ordinary shares.

ELLIS & WARD, LTD.—Capital, £10,000, in £1 shares. Objects: To take over the business of an electrical engineer and contractor carried on by H. W. Ellis at Edmund-street, Birmingham, as Ellis & Ward. Private company. The first directors (to number not less than two nor more than five) are H. W. Ellis and B. Davies (joint managing directors). Qualification, 100 shares. Remuneration of joint managing directors, £250 each per annum.

STAR ELECTRIC LIGHT CO., LTD.—Capital £1,000, in £1 shares. Business: To acquire the business carried on at 6, St. Swithin's-lane, E.C., as the Star Electric Light Co. Private company.

TRAFFIC INDICATORS, LTD.—Capital, £5,000, in £1 shares. Objects: To carry on the business of manufacturers of and dealers in indicating instruments and recording devices, electricians, electrical engineers, generators and storers of electricity, etc., and to adopt an agreement with H. A. Lamb and C. O'Neill Crowley. Private company. The first directors are: J. T. Bottomley and C. O'Neill Crowley. Qualification, £50. Remuneration, as fixed by the company. Registered office, 385, City-road, E.C.

ELECTRICAL DEVELOPMENT IN SPAIN.

An important 50,000 volt power transmission scheme between Bolarque and Madrid came into operation at the end of the year. The power is derived from the Tagus, the flow being 10 cubic metres per second, with a head of 100 ft. A storage reservoir holding seven million cubic metres supplies the turbines, which are four in number and yield 3,500 h.p. each at 4 8 revolutions a minute. The dynamo voltage (alternating current) is from 5,000 to 5,500, which is multiplied by 10 for the power transmitting cable by single pahse transformers. The distance traversed is about 44 miles, and the masts are about 90 yards apart.

THE BRISBANE ELECTRIC TRAMWAYS INVESTMENT CO., LTD., have heard by cable that the receipts for the month of January were as follows: £17,090, with a mileage of 278,050, as compared with £15,360 and 278,150 miles in 1909, showing an increase of £1,730 in receipts and a decrease of 100 miles.

TRADE NOTES.

The Simplex Conduits, Ltd., new registered telegraphic address for their office at 116, Charing Cross-road, is "Sicondulim."

Messrs. Everett, Edgcumbe & Co., Ltd., have moved to larger and more commodious premises at 117, Victoria-street, Westminster, S.W.

We are informed by Messrs. Siemens Bros. & Co., Ltd., Caxton House, Westminster, S.W., that the prices of the rubber tapes contained in their Lists Nos. 510 and 510A have been increased by a further 10%, making a total increase of 20% since these lists came into operation.

The Sandycroft Foundry Co., Ltd., have removed from No. 6 to No. 9, Queen-street Place, E.C.

The agency of Messrs. Meirowsky & Co., electrical insulation manufacturers, Cologne-Ehrenfeld and Urbach O.R., hitherto carried on by Messrs. George Schultz & Co., at 10, Bush-lane, E.C., has been transferred to "Excelsior Works, Ravald-street, Salford," and is under the direction of Mr. D. H. Schultz. These works have been opened by Messrs. Meirowsky & Co. for the purpose of manufacturing their patented "Pertinax" and compressed mica tubes, and other productions. A considerable stock of their mica plate and excelsior materials are kept. The removal of this branch of their business has been effected for convenience of manufacture; their other departments are carried on at 10, Bush-lane, E.C., as before.

Among the orders recently secured by the Mirrlees Watson Co., Ltd., for Independent Steam Condensing Plant are the following: P. J. Mitchell, Esq., London, for Maltby Main Colliery; Messrs. The British Thomson-Houston Co. Ltd., Rugby, for Weardale Steel Co.; Messrs. Walter Scott, Ltd., Leeds Steel Works; Messrs. The Clifton & Kersley Coal Co., Ltd., for Outwood Colliery; Las Palmas de Chaco Austrel Sociedad Anonima; Messrs. De Beers Consolidated Mines, Ltd., for Dutoitspan Mine; Messrs. J. Brown & Co., Ltd., Sheffield; Messrs. Knight, Schoolbred & Co., Buenos Aires, for Patagonia; Inhambane Sugar Estate Co., Johannesburg; Messrs. Archd. Russell, Ltd., for Polmaise Colliery, Stirling; Messrs. Jas. Howden & Co., for Govan Corporation; Messrs. The British Thomson-Houston Co., Rugby, for Dalton Main Colliery Co., Silverwood Colliery; Messrs. Jas. Howden & Co., for Scott & Sons, Dundee; Messrs. The British Thomson-Houston Co., Rugby, for Rangoon Station (fifth installation); Messrs. The British Thomson-Houston Co., Rugby, for Carrongrove Paper Works (repeat order).

PARIS DISASTER.

Our Paris correspondent informs us that the damage done to Electricity Works, Central Generating and Substations, both in the capital and suburbs, has been enormous, a great deal of the machinery and fittings having been destroyed. Vast sums will have to be spent on replacing machinery and repairs. Belgian and German firms, more especially the latter, are keenly alive to the possibilities of doing good trade, and their representatives are already in Paris, surveying the ground and approaching those who, perforce, will soon have such big orders to give out.

TRAMS AND TRAFFIC BOARD.

Sir Clifton Robinson, on relinquishing the direct control of the London United Tramways, had much that was interesting to say. Probably his most notable pronouncement was that a Traffic Board for London was imperative, both from the public point of view and from that of the development and prosperity of the Metropolitan tramway systems. He holds that without a doubt electric tramways are the key to the complicated traffic problem, but that progress is retarded owing to a want of a proper system of fares and co-ordination of general service, matters which could easily be regulated by an efficient Traffic Board. Did Sir Clifton give expression to this sentiment because he thinks the room for private enterprise in London has been snuffed out? At all events, he is now turning his energies to electric tramway work abroad, which he feels has a great future.

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PUBLICITY.

In this Section of "The Electrical Engineer" we give Publicity to New Inventions and Specialities.

Feeder Pillars for Capstan Control in India.

Apparatus designed to meet special requirements in tropical countries generally offer interesting and novel features. The feeder pillars, one of which is shown in the accompanying illustrations, which were produced at the General Electric Co.'s Witton Works for use in India, are no exception in this respect.

The problem for the designer was to arrange the complete switchgear for the control and efficient protection of direct current 15 h.p. capstan motors, consisting of double pole main switch, double pole fuses, drum type controller, starting resistance, choking coils, lightning arresters, and sealing ends for the lead covered motor cables in a cast iron pillar. Weight and dimensions had to be kept within

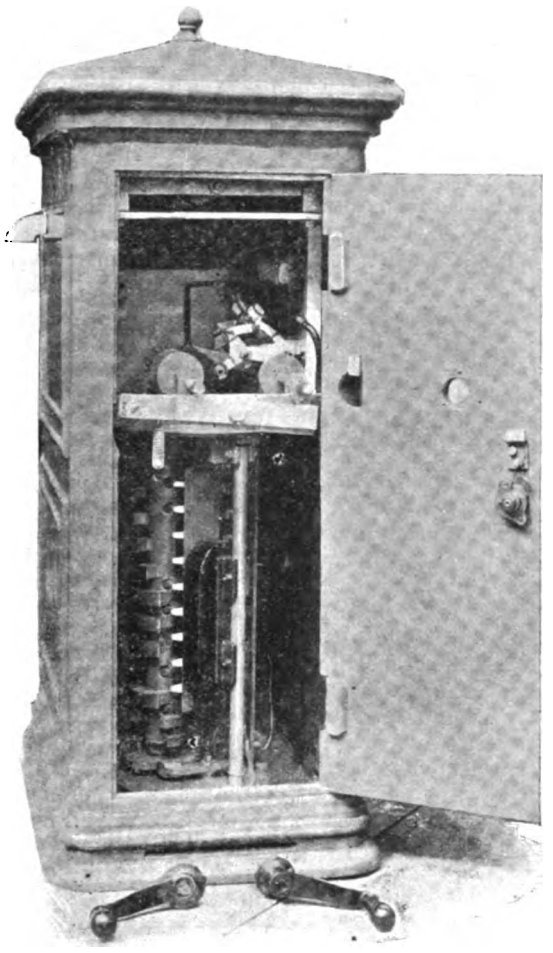

FIG. 1.

certain given limits to admit of transportation without dismantling. Only such material could be used which would stand the very trying climatical conditions, for instance, no fibre, presspahn, nor even slate could be employed. Particular care had to be taken to prevent the ground moisture from rising into the pillar, but at the same time efficient ventilation had to be provided to carry away the heat generated in the starting resistance. Furthermore, the pillars had to be absolutely safe against the torrential rains which fall periodically. As the pillars were to be operated by natives, they had to be what is generally termed "fool proof," a further difficult condition. The problem, however, has been solved in a thoroughly satisfactory manner, and to the entire satisfaction of the customer.

Reference to the illustrations will show that the pillar is provided with two doors—one at each of the short ends. One of these doors gives access to the choking coils, main fuses, and lightning arresters; the other to the controller and main switch. The choking coils and the main fuses, which are of the well-known G.E.C. porcelain bobbin type, are mounted on a white marble slab reaching across the whole width of the pillar, thus separating effectively fuses and lightning arresters from the rest of the gear. The lightning arresters are of the short gap magnetic blow-out,

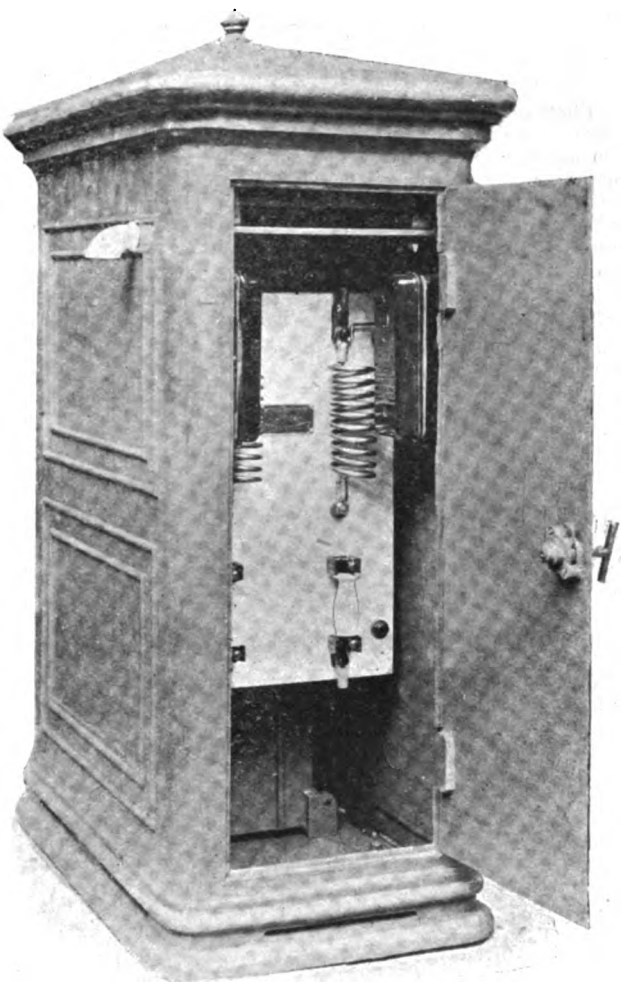

FIG. 2

serious resistance type; they are contained in boxes, and are mounted on the sides of the pillars right and left of the choking coils.

The bottom of the pillar is closed against the cable trench by a diaphragm of boiler plate, through which the lead-covered cables are brought by means of brass-screwed glands made tight with steam packing. The controller is placed on this diaphragm, and, as it stands at a right angle to its actuating shaft, bevel gearing had to be employed for its operation.

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The controlier itself offers several novel features: for instance, only micanite is employed as insulating material. The drum consists of solid iron castings, clamped on to a square steel shaft, covered with a thick coat of micanite, which makes it far superior in every respect to the drums frequently used, where sulphur is employed to fix the drum castings on to the shaft, or to the asbestonit and ambroin drums put on the market particularly by Continental makers. As one of the advantages of this new type of drum, it might be mentioned that it has the smallest possible air gap in the way of the magnetic lines, thus considerably increasing the efficiency of the magnetic blow-out. The contact fingers are arranged similarly to the drum castings, on a micanite shaft, with which they form a self-contained unit, that can be removed as a whole for inspection and overhauling. The blow-out coil is of very ample proportions, and keeps quite cool with the normal current passing permanently, giving a strong field even with the no-load current of the motor.

The double pole main switch of the magnetic blow-out, laminated brush type is mounted on a white marble base, which is bolted on one side of the pillar, near the controller, with which it is mechanically interlocked in such a way that it cannot be opened unless the controller is in the "off" position; and if the controller drum should be turned for inspection purposes while the switch is "off," it is impossible to close the switch. The actuating shafts of both the main switch and the controller penetrate the door of the pillar, and a further device is provided which securely locks this door as long as the main switch is "on." It will be seen, therefore, that to open the door of the pillar it is necessary, firstly, to switch off the controller; secondly, to open the main switch; and, thirdly, to remove the switch handles, as well as the controller handle. These handles can, of course, only be removed in the "off" position.

The starting resistance is lodged in the top part of the pillars under the cover, so that the heat generated is freely radiated by the covers. Furthermore, ventilating slots are provided in the pillars themselves near the bottom, and under the cover. The slots near the bottom are slanting upwards and inwards at a steep angle to prevent rain water drifting in, while the upper slots are securely protected by the overhanging edges of the cover.

The resistance itself is of the cast iron grid type. The individual grids are threaded on micanized steel rods, and are insulated from each other by mica washers. All connections are bolted. Finally, attention might be drawn to the easy accessibility of all parts, which will undoubtedly be appreciated by the men who have the handling and care of the gear.

THE WEAVING INDUSTRY IN LONDON.

In London there are many trades being carried on about which the general public are in complete ignorance, not the least surprising of these being that of weaving canvas hose. This is essentially a north country industry, yet for many years past the weaving of canvas hose has been carried on by Messrs. Merryweather & Sons, at their fire engine factory in Greenwich, where a considerable quantity is turned out every week.

At the invitation of the head of the firm, Mr. James Compton Merryweather, the writer was allowed an opportunity of inspecting the weaving sheds, the visit proving most interesting as well as instructive. The sheds are fitted throughout with the most up-to-date machinery operated by electricity, and produce only the very best class of hose as during the whole process of weaving, the yarn is under tension, and so great is the pull exerted upon it by the machines that a light or inferior yarn would not stand the strain.

The operations involved in the manufacture of canvas hose are many. The yarn is received into the factory in huge hanks, part of which is known as warp yarn and consists of several strands threaded together. The remainder is called weft, and contains 15 to 30 strands, according to the class of hose for which it is intended. The yarn is first taken in the hank and wound upon a ryce (a frame-work wheel, somewhat resembling the skeleton of a windmill with the sails removed) and from thence it is wound upon large reels or bobbins in the upper part of the winding machine. The weft yarns upon the reels are then placed in another machine and wound upon smaller rollers called "shuttle pirns," after which they are ready for the loom. The bobbins containing the warp, however, are placed in a large frame known as a "creel," which carries hundreds of bobbins at one time, and the ends of the yarn from the bobbins are carried through a kind of grid or comb to the beaming machine, the various threads as they converge upon one point presenting a web-like appearance. The beam is simply a large and heavy iron reel, upon which the threads, when drawn off the bobbins, lie perfectly parallel and even.

When the warp has been "made up" the beam is transferred bodily to the loom, and after certain preliminary operations have been performed by the weaver, the pirn is placed in the shuttle, and the actual process of weaving commences. The shuttle flies to and fro, threading the weft through the warp, and pulling it at the same time so as to ensure the production of a tightly woven material. As the hose is made it passes, still tightly stretched, beneath the loom to the back, where it is carried up to a beam above upon which it is automatically coiled.

After a piece of hose is completed it is taken off the loom and passed through a coiling and measuring machine, which automatically records its exact length, and here, as far as the weaving shop is concerned, its history ends, the testing being done in another department.

In many cases the hose has to be tanned, and for this purpose Messrs. Merryweather have erected a tannery, with vat and drying tower. There is also another building set apart specially for making leather hose, making up canvas hose into the required lengths, binding in couplings, etc.

There are also many other large blocks of buildings, set apart for the various trades which enter into the construction of fire engines, and the whole of the machinery in these, as well as in the hose weaving sheds, is driven throughout by electricity.

"TANTALUM" ELECTIONEERING.

We give here another striking instance of the use of electricity in electioneering, and which, incidentally, gives an illustration of the strength of "Tantalum" metal filament lamps. The unprecedented excitement which has prevailed during this fight has led many enthusiastic individuals to arrange a publicity campaign of their own in favour of their particular candidate. One of these gentlemen, who resides at Seven Kings, rigged up an impromptu Union Jack sign which was supported on a high mast, and in the evenings the sign was illuminated. This was accomplished by means of two "Tantalum" lamps, and as the sign faced the railway it attracted the notice of a good number of people. However, during a rather stormy night after its erection the mast was smashed completely in two, and the owner, on rising, found his sign considerably damaged, but the two "Tantalum" lamps were still burning. As the sign would fall with no small force, the extraordinary strength of the lamps used was demonstrated. The owner writes:—

"To Messrs. Siemens Bros. Dynamo Works, Ltd., Dalston, London, N.E.

"Gentlemen,—I have had fixed upon a mast at the back of my garden an electrically lighted Union Jack sign. Since the elections started it was lighted with a pair of 'Tantalum' lights. During the heavy wind last night the mast smashed in two and the flag fell to the ground. I found it on the ground this morning, the two lamps still burning. This seems to be a remarkable test of the durability of your 'Tantalum' lamps.—Yours faithfully."

Without doubt, English made "Tantalum" lamps are the strongest of the metal filament class now on the market, and the recent improvements have tended to considerably enhance the value of the lamps.

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ELECTRICITY IN THE LAUNDRY.

We recently gave a short note on the use of electricity both for motive power and heating in laundries in this country. Although this has been largely adopted of late it has not reached the same extent as it has in America. It is worth while giving a few brief details of probably a record equipment of this kind at the Metropolitan Laundry, San Francisco.

The steam plant supplies power for pumping 175,000 gallons daily, and also furnishes electric current for heating, light, and power in the laundry. The boiler equipment consists of three safety water-tube boilers, each of 277 b.h.p., and a low pressure boiler used as a water heater. The boilers are oil fired.

The generating plant includes four Westinghouse direct current dynamos arranged for three-wire service. The two main generators are 150 kw. 220 v. machines direct connected to tandem compound engines, 11 × 19 × 20. The hot-well, feed-water pumps and condensers are placed in a pit between the two engines. All condensation from the laundry is returned to the power plant, and by this means fully 75% of the water is saved. In addition, there are two 17½ kw. d.c. Westinghouse generators driven by engines which are used to even up the unbalanced load on the large generators and to supply current for lighting and operating the different departments when necessary to run overtime.

By means of the three-wire system, current for lighting is supplied at 110 v., and for power at 220 v. The Westinghouse three-wire system, as here installed, is so arranged that the current is supplied by one machine, so in the event of light load it is not necessary to run the two generators. The generators differ from the standard single voltage, direct current machines by the addition of auto-transformers and an arrangement of the armature lead connections somewhat like those on the alternating current side of the armatures of rotary converters, the armature lead of three-wire dynamos being connected to collector rings placed on the shaft. The connections from the armature to the collector rings are two-phase, across which a pair of auto-transformers or balancing coils are connected. These balancing coils consist of a single winding upon a laminated iron core. The assembled coils are placed in iron cases filled with oil. The middle points of the balancing coils are inter-connected, and from this connection the neutral lead of the three-wire system is led. It is obvious that the pressure between the neutral wire and either generator terminal is one-half of the 220 volt generator pressure. In this installation the coils have been placed in the wall, close to the switchboard, which arrangement has proved eminently satisfactory.

The switchboard consists of four panels, one for the two 150 kw. generators; one for the two 17½ kw. machines; one for the motors in the power plant; and one for the power and lighting circuit in the laundry.

A 30-in. centrifugal pump, single stage, is driven by a 20 h.p. motor to pump water from the sump to the top of the water softener.

The lighting circuit supplies current not only for the incandescent and arc lamps with which the plant is equipped, but also for the electric irons. These are the standard hand irons manufactured to take from 6 to 10 a. at 110 v. As there are 50 of these hand irons, the large amount of current required is readily appreciated. But considering the great amount of time that they save and the excellence of the work they do, the cost is well justified.

The power circuits furnish current for electric drive of all the machines in the laundry, including washers, hydro-extractors, mangles, and ventilating fans. These motors aggregate 62 in number, and vary in size from ¼ to 20 h.p. They are all made by the General Electric Co., and where not direct connected, are equipped with the Morse silent chain.

There are 110 washers, arranged in 10 clusters of 11 each. Each cluster is driven by a 15 h.p. motor. Hot and cold water is supplied from the power plant, and soap is made on the premises.

The hydro-extractors, or wringers, are 40 in number, being arranged in 10 lines of 4 each. Each set of four 28-in. extractors are driven by 7½ h.p. motors.

There are 8 large multiple roller ironing machines, two having four cylinder rollers, and the others are six-roller machines. Each is operated by a 3 h.p. variable speed General Electric motor with rheostat control.

There are 5 conveyor-dryer closets, (by which linen is conveyed on an endless chain through steam-heated closets) each operated by a ¾ h.p. motor. In the collar department, the collar tables, ironers, and dampeners are all operated by individual motors, connected to the machine by Morse chains. In the shirt department there are 18 body ironers, gas heated, one 3 h.p. motor operating six machines.

This is a very good example of a modern establishment equipped on labour-saving lines.

METAL FILAMENT LAMPS.

Is their Economy Over-rated?

Speaking on modern arc lamps and their application before the Association of Engineers-in-Charge, Mr. A. Angold, was all in favour of this type of lamp both for outdoor and indoor lighting. He made some remarkable statements as regards the economy effected by using metallic filaments.

"Some broad claims," said he, "have been made for high candle-power metal-filament lamps when comparing them with enclosed arc lamps, and frequently the conclusions arrived at are not correct, because certain points are not taken into consideration. For instance, the candle-powers of metal-filament lamps are usually stated in Hefner candles. If stated in British standard candles, the figures would be about 10% lower, and the figures also relate to the candle-power on the horizontal line, the mean hemispherical candle-power being another 18% lower, whilst the candle-power immediately below the lamp is only one-fifth of the figures given. Taking the consumption at 1·25 watts per horizontal Hefner candle-power, the consumption per mean hemispherical British candle works out at 1·7 watts, so that even allowing for the use of the most efficient reflector, and being kept in the cleanest condition, the consumption would remain considerably above that of the single enclosure arc lamp. Also the enclosed arc lamp gives light equally from the whole surface of the opaline globe, whilst the apparent space occupied by the metal filaments is much smaller, and therefore gives a poorer diffusion, Again, on closer observation of the filaments, the individual wires show up, and are very trying to the eyes. Frosting, even when kept clean, will absorb, say, 10 to 20%, and opaline glass makes the filaments appear red, and gives a very poor effect. It is also the practice to protect metal-filament lamps when erected outdoors with an outer globe, which means at least 10% loss.

"Now, as to the comparative costs, take a 600 hemispherical candle-power metal-filament lamp at, say, 16s. 6d. and allow for using it 1,500 hours—no conclusive figures are as yet available as to the average total life in ordinary use, but it has been shown that with current at 4d. per unit it does not pay to use metal-filament lamps over 1,500 hours. Lamp renewals, therefore, cost 1s. 1d. per 100 hours, whilst carbons for an enclosed lamp cost, say, 1d. per 100 hours.

"Assuming, for the sake of simplicity, that the consumption in watts per candle is not higher than that of the enclosed lamp, so that cost of current can be left out of the question, then there remains 1s. to cover cost of trimming the enclosed lamp once, and to cover capital charges per 100 lighting hours. On the score of expenses it will be seen that the enclosed lamp has a considerable advantage.

"Regarding the attention required, it must be remembered that metal-filament lamps will not run 1,500 hours without some cleaning. In many installations 1,500 hours means about a year's use, and the lamps will require cleaning several times during that period, and on each occasion there is some chance that the metal-filaments will be broken by careless cleaning."

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CARE OF SHIPS' ELECTRICAL INSTALLATIONS.*

By J. R. STUART.

The principal sources of danger to electric installations as given by a large insurance company. These included bad materials and workmanship, especially joints, conductors of inadequate size, perishable and inferior insulating materials, neglect of frequent test and inspection, moisture, dust and dirt, and undue heating. It was when a wire failed and was repaired hurriedly that the bad workmanship occurred. Marine engineers were, early in their career, imbued with the instinct of "keeping things going." If an important wire failed, a temporary wire was run up, the ends twisted together and roughly insulated. These temporary measures were always risky, and should only be resorted to when really necessary, and a thoroughly good job should be made as soon as possible. A bad contact speedily got worse, and the old trouble was renewed. In looking for a remedy the first thing was to discard the wood casing: it only hid the wires without protecting them. If the existing wires were open to view they could be frequently varnished and kept watertight, and any deterioration noticed at once. Armoured or lead-sheathed wires were necessary for all damp places. Fuses were the safety valves of the system, and should be respected accordingly. The frames of the fuse box would be better if metallic and watertight; these boxes were fitted in alleyways, where the paint was washed down with abundance of water, and were certainly "damp places." They should exclude vermin, and be accessible to the electrician only. The size of the fuse should be strictly limited to suit the circuit. Before renewing a fuse, the lamp and wire leading to it should be examined for intermittent breaks, partial earths, etc. If the lamp glowed for a few minutes and the fuse then melted again, it should not be renewed till the cause had been ascertained. The most frequent breakdowns occurred in that part of the installation used for portable cargo clusters. When new, everything appeared to be good and well insulated, but troubles soon developed, the wood speedily shrank or warped; and let in the water back and front. The installation should be treated seriously, and irresponsible persons not allowed to interfere. Temporary cabin lights hooked on to bared wires, amateur wire heaters, and second-hand nondescript fans. Interference with any electric fitting should be viewed as a serious offence.

DISCUSSION.

Mr. W. McLaren: He thought a more methodical arrangement of the switchboard wires might be adopted. A great deal of trouble was caused through the amateur tampering with the gear, and another source of trouble was the practice of fitting lamps of higher candle power than the engine was designed to supply.

Mr. W. E. Farenden: The motors, in his opinion, should be of the enclosed type.

Mr. R. J. Elmhurst: Trouble with bad joints was practically a thing of the past, owing to the universal adoption of junction boxes. With regard to conductors of inadequate size, it was usual to allow 1,000 amperes to the square inch, which was a perfectly safe measure. The fuse box was very seldom fitted with the slate base referred to by the author. This was invariably made of glazed porcelain, which was much stronger and more permanent. He preferred wooden to metallic cases, especially in passenger vessels, where appearance was a matter to be considered.

Mr. W. Watson: The only way to ensure continuity of supply was to make the whole system watertight. The hatchway lights, etc., should be of the twin-wire inflexible metallic type.

Mr. Jas. Adamson: A bad practice of putting in heavier fuses each time a fuse gave out. Trouble was often caused in connection with the lights used when loading or unloading cargo, through one light being taken out and a cluster substituted in its place. There was hardly a ship that did not receive a very large supplement of lights, and in many cases, owing to this cause, the dynamo was at its ultimate stress. He referred to the difficulties experienced through carrying the wires through the cargo and bunker spaces. He considered they might be carried on deck through pipes.

* Abstract of paper read before the Institute of Marine Engineers.

ADVANTAGES OF ELECTRIFICATION.

Lord Besborough, when presiding at the 128th ordinary half-yearly meeting of the London, Brighton and South Coast Railway Co., said:

The electrical train services between London Bridge and Victoria, which were commenced on December 1, met with immediate and considerable response on the part of the public, particularly in the populous districts of Denmark-hill, Peckham-rye, and Queen's-road, through which the electrically-equipped line ran. In the very first week they had an increase of over 40,000 passengers, and it was obvious that neither curiosity nor the novelty of the system had been the attraction, as after two months' experience of the working there had been a steady and continuous increase week by week. The increase in the number of passengers during the two months ending on Tuesday fortnight, as compared with the corresponding period of 1908–9, amounted to the large figure of 440,536, or just on 63%. The increase in the first month was 189,000, or 55%, and in the second month 251,000, or 71%. From the opening day the services had run with great regularity and without breakdown of any importance whatsoever.

Every credit must be given to the principal contractors, the Allgemeine Co., of Berlin, for the very thorough and careful manner in which the constructional work had been done and the equipment installed. With the exception of the motors, which were the patents of Drs. Winter and Eichberg, and not made in this country, the whole of the plant and work was English.

He believed he was right in saying that this was the first recorded instance where electrical traction established on an ordinary steam railway had worked from the commencement so smoothly and uninterruptedly, and in this connection it was only fair to acknowledge the ready co-operation and help of the London Electric Supply Corporation of Deptford, the contractors for the supply of current, and the efficiency and regularity with which their part of the task had been performed. The traffic results showed that in the first two months of electrical working they had got back nearly the whole of their lost traffic on that section, and, naturally, these results had led the board to think of the advisability of extensions, a question which was already engaging the serious and earnest attention of the board.

INDIAN ELECTRICAL IRRIGATION.

Our contemporary, *Indian Engineering*, states that it is understood that the Government of India have expressed their preparedness to consider in detail a scheme formulated by the Punjab Irrigation branch for providing electrical lift irrigation to an area of about 11,000 acres in extent in the Military "grant" at Buchiana on the Lower Chenab Canal. Briefly, the intention is to generate electric power at a canal fall and to transmit it to suitably located pumping stations where centrifugal pumps, operated by electric motors, will raise the necessary supply of water to the level required from irrigation. Within practicable distance of the land to be irrigated there are two falls whence the necessary power might be obtained, and one of these, on the Upper Gugera branch, has been selected as the source of power. We believe that the distance from the selected fall to the various pumping stations will necessitate the employment of the alternating current system with transmission at high tension. The electrical part of the scheme has been drawn up by Mr. J. Rowan Wilson, electrical adviser to the Punjab Government, and provides for three-phase current being generated at 500 volts and, for purposes of transmission, the voltage will be stepped up to 5,000 by means of transformers. The scheme is estimated to cost 1¼ lakhs and the anticipated revenue is put at a sum equal to about 20% on capital. We believe that the Government of India, while not accepting all that has been said of the scheme by its promoters from a revenue point of view, recognise that the experiment might be valuable from the experience to be derived from it, and they have accordingly approved of its being worked out in detail for their further consideration.

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Electrical Progress at Home & Abroad.

A Review by our Special Correspondents.

TYNESIDE.

NEWCASTLE-ON-TYNE.

In making mention last week of the various effects of the severe weather conditions in the North upon the electrical industry, I omitted to mention the very unfortunate results as regards mining. Reports have been received from all parts of the countryside, particularly in the uplying and outlying portions of Northumberland and Durham, that the output of the collieries has been seriously restricted on account of the heavy snowfall. In some instances it has been impossible to get the railway trucks into the colliery yards, and the men working at the surface have had to abandon their usual work to clear the railway lines. Moreover, the pitmen have experienced considerable difficulty in getting to their work. This has, of course, had a restricting influence on the working of the collieries and, in cases where these are electrically driven, of the consumption of power. In at least one case, according to local reports, where the supply of electricity for the lighting of the pit village is obtained from the colliery plant, the village has been put into darkness owing to the breakdown of the overhead lines from the colliery to the village. With the thaw, however, normal working has been to a large extent resumed, although several collieries are still contending with the difficulties of the Eight Hours' Act. This is the subject of a very serious warning by Mr. Thomas Burt, M.P., who, in his monthly letter to the miners, appears to anticipate a strike in the Northumberland coal fields unless this can be averted by co-operative effort.

The Shields Tube.

One of the great problems connected with the mouth of the Tyne is the provision of adequate communication between the north and south banks of the river mouth. At present a very efficient service of ferry boats, organised by the River Tyne Commissioners, is in commission, but it has long been felt that more extended facilities are required. In 1902 a provisional Order was given by Parliament for an electric tube railway passing under the Tyne between South Shields and Tynemouth, but no progress has yet, for various reasons, been made. During the coming Session a revival and extension of powers for this railway will probably be sought, and last week the South Shields Council agreed not to oppose such a scheme.

The "Old Siemens Units."

The engineers in the northern area who are, or were at one time, connected with the firm of Messrs. Siemens Bros. & Co., Ltd., or Messrs. Siemens Bros.' Dynamo Works, Ltd., foregather annually in order to renew old friendships and to talk over former days. The fifth annual function of this character has recently been held at Tilley's Restaurant, Newcastle-on-Tyne, and, as usual, a very pleasant evening was spent. It was hoped that Mr. Alexander Siemens would have been present this year as guest, but a telegram was received from him that illness prevented his coming. Mr. W. Brown, the late manager of the Woolwich works, was, however, present as a guest, and some 15 of the 26 old Siemens' men now resident in this district dined with him. On previous occasions, Siemens' men from places so far distant as Dundee, Leeds, Manchester, Cardiff, and Stafford have journeyed to Newcastle to be present at this gathering, but this year only one, from Rugby, was able to come. Letters of regret were received from about half-a-dozen old comrades. It says much for the good fellowship which exists among past and present members of the staff of the oldest firm of electrical engineers in the country that men are always eager to attend this dinner, often at much personal inconvenience; and it must be almost unique that so many men, many of them holding very important and responsible positions, should be resident in and near a single city some 300 miles from the works where they received their early training.

Fresh Work for Sunderland.

One of the most unfortunate events in the period of depression which overtook Sunderland during the last two years was the closing of Messrs. Sir James Laing & Sons, Ltd., of Deptford-yard, Sunderland, one of the largest shipbuilding and repairing firms in the borough. This cessation of work had a very marked effect on the electricity supply undertaking, which supplied them with a very large amount of power in bulk. It is, therefore, satisfactory to note from the local press that it is hoped to make a start again in the near future, as £50,000 6% second debentures have been subscribed, and an order for a large steamer has been obtained.

THE MIDLANDS.

BIRMINGHAM.

An important electrical problem has presented itself for solution by those responsible for the safety of the huge dams and other works of the Birmingham Welsh Water Supply. The possibility of damage by lightning may appear to be rather remote. Still, if it be a possibility, it constitutes a danger against which those responsible must provide, for these works have special features which make the possibilities of damage from lightning a consideration to be taken into account.

Lightning Protectors for Water Works.

In view of these possibilities, the committee felt bound to obtain advice as to probable sources of danger, and the means of averting it, if it should be found to exist. Accordingly, Sir Oliver Lodge, Principal of the Birmingham University, was asked to report. His investigation showed that the idea of danger from lightning was by no means fanciful. The chief danger to be apprehended, lies in the possibility that an exceptionally powerful flash might strike one of the dams or some appendage connected with the dams, or some metal work entering their interior, and thus by explosion or shock, due to sudden expansion, cause some initial crack or other disturbance of the structure which would ultimately lead to weakening. Ordinary damage by lightning to an unsubmerged part of the works, or through the dam itself when dry, would not be serious, in Sir Oliver's opinion, because it would be patent and visible. But if a flash were to be conducted by metal work into the interior of the dam, and there, by reason of inadequate means of escape, cause an explosion and perhaps a perforation, the damage, although less obtrusive, would be likely to be more serious. The damage might be much greater, if the penetrating flash should escape by metal to some point beneath the surface of the reservoir, unless the metallic surface by which it took to the water were fairly extensive. Some experiments were cited by Sir Oliver Lodge to demonstrate the violence of an explosion caused by electricity so conducted into water and entering it from a small surface. For instance, if a small spark is taken from the exposed end of a sharply cut off gutta percha covered copper wire under water inside a thick glass tumbler, the tumbler is shattered not by any electrical agency, but by the mere mechanical shock or explosion always caused when a concentrated spark occurs inside a liquid. Sir Oliver also mentions that he has taken a small spark from a square millimetre of surface inside a copper vessel filled with water and thereby strained the joints of the vessel till it leaked. Consequently, he suggested that an explosion of a copper reservoir in which sugar was being boiled under pressure at a factory near Liverpool was due to a flash of lightning entering the vessel by a pipe, and sparking from the free end of the pipe near the bottom of the vessel under the

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liquid. In all such cases, if the spark had been given off in air, instead of in liquid, there would have been nothing in the way of an explosion likely to cause damage. The conclusion come to by Sir Oliver, therefore, was that if a flash were conducted through the dam by metal, and discharged under water from a small surface, the shock so generated would be as objectionable as that caused by the explosion of a small charge of dynamite in the same position, although neither would be likely to have any visible immediate effect.

Vulnerable Points.

An examination of the structure of the several dams and auxiliary works proved that conditions existed making possible such a result, should certain parts be struck by a considerable flash. The valve tower on Craig Goch dam contains the metal hydraulic valves, which lead into the dam, and are probably quite inadequately earthed. The tower on the Pen-y-Gareg dam is less exposed. It stands in the middle of the dam, and, therefore, its protection in view of the potentialities of damage is equally important, seeing that it, too, contains metal work penetrating deep down into the masonry. The Caban Coch dam is the most important of all, though it is manifestly the least exposed and has no tower on it. Sir Oliver anticipated no particular trouble from a flash striking the dam itself, or the surface of the water. The danger here, in his opinion, is caused by the hydraulic pipes which ramify in its interior, having a multitude of joints and apparently no specially contrived earth or water connection. Though the pipes do not protrude above the ground, Sir Oliver thought that if one of the turrets at either end of the dam were struck, the lightning would probably enter this system of pipes, and so be conducted into the interior of the structure.

Precautions Taken.

The precautionary measures in regard to the various dams and works generally should, Sir Oliver advised, involve either keeping the lightning to the surface without letting it penetrate into any interior, or taking care that if it did so penetrate it should have plenty of metallic surface by which to reach the water in a quiet and unexplosive manner. In achieving either or both these ends, it would be natural and proper to take advantage of any metal work already existing for other purposes. Applying these principles in the case of the Craig Goch dam and its tower, Sir Oliver recommended that in order to keep the lightning outside as far as possible, the copper dome of the tower and the metallic ventilator surmounting it should be connected by metallic means with the water of the lake. The most obvious means would be by making the connection through what Sir Oliver describes as a kind of metallic floating hand, with fingers pointing out away from the dam, and hinged by a triangular girder frame to a horizontal line on the tower near high water level. This, however, apart from an unduly complicated adjustment, could only be efficient if the water level varied only slightly, but it may sometimes be necessary to lower the level of the lake considerably, with a range of 40 ft. The alternative suggested by Sir Oliver was the covering of the North face of the tower from a foot above high water level to some distance below with sheet copper with a connecting band of copper a foot wide, extending horizontally along the five most northerly of the octagonal faces just above high water mark. This band of copper should be put into electrical connection with the sheathing of the dome by copper ribbon. The downward continuation of the one foot copper band, Sir Oliver suggests, should be a strip of copper fringed with spikes or V-shaped serrations (as discharging points), and capable of being unrolled to suit the varying levels of the water. A similar plan, with some modifications, was suggested for the Pen-y-Gareg tower and dam. In the case of the Foel Valoe tower, it would be sufficient to make an effective electrical connection between the metal of the domes and certain girders which go a long way down, and make thorough water connection. To prevent the lighting being conducted into the interior of the Caban Coch dam by means of the hydraulic pipes, Sir Oliver suggested that it should be encouraged to take the water at some little distance above the dams. He therefore recommended that one at least of the pillars of the turrets at each end of the dam should be furnished with an arrangement of points, taking for appearance sake, the form of a copper aloe in a vase, and connected with the water by 6-in. copper tapes running down the beach some distance away.

Floating "Earth" Contrivance.

An interesting alternative "earthing" plan for the Craig Goch and Pen-y-Gareg towers was suggested by Sir Oliver, namely, that instead of the copper roll entering the water, there should be in each case a moored floating buoy. This should have a flat horizontal sharp-edged rim and points all round, on a level with the water. A copper rope connection should come up to it under water and form the connection with the protective sheathing of the tower. This alternative, as providing an automatically adjusting contact with the water and thus the "personal equation" arising from the necessity to unroll the copper strips in case of a fall in the level, has been preferred by the Water Committee and its engineers in each of the cases to which it applied. With this and one or two minor modifications, the whole of Sir Oliver's recommendations have been carried out, as well as certain more commonplace protections advised by him for other parts of the works.

LANCASHIRE.

MANCHESTER.

The demand for accessories in connection with electric lighting installations has been particularly heavy just recently. In the suburban districts, where new property is being rapidly put up, electric wiring, run in steel conduit and put in before the floors are put down and plastering done, has entirely taken the place of gas piping, wherever a main is within reach. The cost of wiring put up in this way compares very favourably with the cost of gas installations, and allows of a larger number of points being used than would be the case for gas. Better and cheaper illumination is the result. Tenants have shown a decided preference for the houses with electric light, and there is no doubt that the jerry builder (who is responsible for most of this new property) finds the installation a very good investment, quite apart from its cheapness in first cost. Although electric signs (except for a few of the largest firms) have hitherto made very little headway in Manchester, they are now being quickly taken up, and already a good number of small signs are to be seen outside, or in the windows, of small shops. The popularity of electric heating and cooking apparatus is still growing, both for domestic and commercial service. There is a considerable field for electric heating in this district, which has not yet been touched. It is the heating electrically of bakehouse ovens. This work is at present almost entirely done by gas, but that is a method which leaves much to be desired.

The Students' Section.

At the meeting last Tuesday, Mr. J. G. Travis read a very interesting paper on "Faceplate Type Controllers and Starters." He exhibited a large number of slides of various makes, including some oil-immersed types. He thought the specifying of oil-immersed D.C. starters even for mining work unnecessary and undesirable, and pointed out that the carbonising effect of a D.C. arc on the oil resulted in frequent changes of it being necessary, thus increasing the expense. It is the practice of one firm making an explosion proof type of starter for mining work underground, to make the junction between the two halves of the cast-iron case of a deep V shape, one half being concave, and the other convex, so as to fit into it. In the unlikely event of an explosion taking place within the case, the gases passing out through this deep V groove will be cooled down, and so harmless when they reach the outside air. The chairman, in discussing the paper, suggested that the word "fool-proof," usually used in describing switchgear, was somewhat unsuitable, and far from complimentary to the user. In the discussion which followed, Mr. J. S. Messent thought the condition, usually regarded as of the utmost importance, that the motor should have full field on before the first contact was reached was not of sufficient practical value to justify the complications in design entailed in the attempt to fulfil it. Another speaker, dealing with the question of

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no-voltage releases on A.C. starters, instanced a case in the district where the Corporation supply failing just before dinner-time on a Saturday, the machinery stopped, and there being no no-voltage trip, the starter handle stuck up. This was not noticed, and, consequently, when the supply came on again early in the afternoon, the motor started up, and the machinery was running all the week-end. Mr. P. C. Jones recommended the use of separate fuses in place of an overload movement on the starter. It was more trouble to replace a fuse (especially if they were only to be obtained from a stores where an account of replacements was kept), and this would cause more care in starting up, so as to avoid excessive current. In reply to Mr. Carr, Mr. Travis said for small motors 4 to 5 stops would be sufficient, while motors of about 10, 20, 30, 50, and 75 h.p., 8, 10, 12, 14, and 16 stops respectively were suitable. For a 100 h.p. starter, not less than 20 stops should be used. Now that users had come to realise the importance of the starter as a protection for the motor, there was quite a large demand for high-class control gear.

Gas Engines at Birkenhead.

Although a good deal of data is available for determining the cost of producing electricity using steam plant, there is not much yet published relating to gas engines. In this connection the working results of the gas plant at Cammell Laird & Co.'s Tranmere Works at Birkenhead, given the other day to the Liverpool Engineering Association by Mr. J. H. Collie, are worth noting. The gas generated is used for furnace work, as well as for engines. The coal, which is a mixture of Lancashire slack at 10s. 6d. per ton, is gasified in three producers, each of 2,000 h.p. capacity (150,000 cub. ft. per hr.). The makers guaranteed the coal consumption to be 1 lb. per i.h.p. Under test, this figure has been improved on somewhat. Although many of the engines used are comparatively small, Mr. Collie states the cost of generating 1 unit of electricity averaged ·32d. during last November. This he considers very reasonable. There are, however, many steam plants at work in this district which can show better results than this.

Lighting Extensions.

The Council at Macclesfield decided the other day not to proceed with their provisional order for electric lighting, as there had been no demand for a supply by the townspeople. It seems the Council instructed their gas engineer to report on the cost of the proposed electrical undertaking, and he estimated a loss running into four figures would result! What would the gas people say if an electrical engineer was asked to report on a proposed gas works? Chinley, a rapidly growing residential district on the Midland line, and much favoured by Manchester men, is to have its own gas lighting. The Matlock Gas Co. propose to erect gas works, and are at present negotiating for the sale of land for the purpose. A town's meeting to approve the scheme will shortly be held. Surely a small electric plant would be as cheap, and seeing that the residents are practically all people who appreciate comfort, should meet with distinct success. So far, I have not heard of any steps being taken to forestall the Gas. Co.

SCOTLAND.

GLASGOW.

On Wednesday of last week a public meeting was held in Glasgow to deal with the smoke problem. The Lord Provost (A. McInnes Shaw) presided, and was supported by representatives of municipalities from various parts of Scotland. A number of resolutions were put and passed. The Lord Provost referred to the number of deaths traceable to fogs, and said, in 1908, there were 1,305 deaths in Glasgow due to diseases of respiration, whereas during the heavy fogs of November and December, 1909, there were 1,225 deaths traceable to this cause. They no longer believed that where there was plenty of smoke there was plenty of money. Black smoke was a source of financial loss to the manufacturer and a loss in money and in health to the whole community. He advocated consolidation and unification of the laws against smoke, and thought that the Smoke Abatement League might do much to advise manufacturers in their choice of smokeless apparatus, as well as help to emphasise the need for the education and training of firemen. Sir John Ure Primrose, in speaking to a resolution in favour of the dissemination of information by means of lectures, leaflets, etc., said that gas would be an important factor in solving the smoke problem, but electricity, to his mind, was the "divine solvent."

Taxation of Underground Mains.

So much for the pat on the back to electricity as the "divine solvent" of the smoke problem. But, in the meantime, there is a serious discussion going on in various parts of Scotland with regard to the increased taxation of underground mains. In outlying districts, where the population is scattered and electricity mains are neither many nor very large in section as a rule, the taxation is calculated on the total value of the mains. In city areas, with one exception, the taxation is on one-fourth of the total value. With a view to reduce general city taxes, it is now being proposed that underground mains should be assessed at their full value. Even if it is conceded that the taxation of underground mains of all kinds at their full value is a sound principle on the whole, it should not be applied to electricity mains, as these form a larger proportion of the total capital value of the undertaking than is the case with either water or gas. But, apart from that, it is evident that largely increased taxation on electricity means raising the price of electricity to the consumer, and so hampering the beneficent operations of the "divine solvent" in its displacement of the coal chimney, which is the creator of the smoke nuisance. It can only be hoped that better counsels (and sounder economics) will prevail, and that if city taxes are to be lowered, they will not be lowered at the expense of the consumers of electrical energy.

Centralisation of Telephones.

In the Municipal Buildings, Glasgow, a much needed improvement in the telephone service is likely to be introduced at an early date. With some 50 lines and 118 instruments, the service has hitherto been expensive and none too efficient. It is proposed by the installation of a switchboard and a system of intercommunication within the Municipal Buildings to render the telephone service at once less expensive and more efficient. With such an arrangement, it would certainly be much easier to communicate with Corporation Departments than it is at present. The orders for the necessary apparatus have, of course, not yet been placed.

Vacuum Cleaners.

Vacuum cleaners are rapidly becoming a "household word" and "familiar friend" with the general public, and with the aid of electricity they are now within reach of all consumers of electricity. The brush, the broom, and the duster have had their day, but modern observation has awakened to the fact that they are neither efficient nor hygienic. The Electric Vacuum Cleaner is both hygienic and portable, and simplicity itself. It is already in general use in hotels, theatres, clubs, and private houses. The General Electric Co.'s "Daisy" Vacuum Cleaner can be bought for £15 15s., complete with two nozzles, one being for carpets and the other for upholstery work. This cleaner is finished in a handsome oak case, mounted on wheels, and is wired complete with a length of flexible and a B.C. adaptor, and can be connected to any lampholder. The "Kleenall" is a small 10 guinea cleaner, which takes the place of the ordinary box broom or carpet sweeper. It comprises a powerful motor, which rotates an enclosed suction fan, with an 8 in. flat nozzle causing a vacuum. The motor, fan, brush, and all operating mechanism are completely enclosed and protected by aluminium casings. The handle is of seasoned maple. The dust bag is of special fabric, so woven that it filters the air, but retains every particle of dust. The complete machine weighs about 10 lbs.—just a little more than an ordinary carpet sweeper. This cleaner is also wired, complete with flexible and adaptor, and can also be attached to any ordinary lampholder. The switch is fixed on a convenient part of the handle, so that the current can be turned on and off at the convenience of the operator.

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New Post Office Telephone Exchange.

The Post Office, having decided, on acquiring the Corporation telephone plant, to supersede the call wire system in use, secured accommodation in the handsome Parcels Post Building in Waterloo-street for the Central Exchange equipment. This Exchange, which will be capable of dealing with 10,000 lines (double the number in use at present), occupies the complete fourth floor of the Parcels Post Building, and the space permits of a clear width between the suites of sections of from 39 to 43 ft., and of length between sections of 157 ft. The subscribers' switch consists of 28 equipped sections, 1 unequipped section, 1 cable turning section, and 1 one-third section. The sections are of the 3 position, 9 panel type, with subscribers' multiple capacity for 14,400 lines and equipment for 10,000 lines. Equipment is provided for 960 outgoing junctions multiplied every two positions; 120 answering jacks and lamps are equipped upon the panels of each position, with space for 150, and each keyboard is equipped for 17 cord circuits and 40 outgoing order wire circuits. The junction switchboard includes 12 equipped sections, 1 unequipped, 1 cable turning section, and 1 one-third section. The junction and the subscribers' switchboards form separate suites of sections, and as there is the space for answering equipment and the same number of outgoing junctions as on the subscribers' switchboard is not required, it has been possible to reduce the height of the panels upon the latter by 6 in. The outgoing junction multiple is fitted for 360 junctions, and the subscribers' multiple capacity requipment similar to these on the subscribers' sections. Equipment for 26 incoming junction circuits perposition has been provided, and the wiring makes for quite a variety of circuits. Incoming junctions from the Trunk Exchange; incoming junctions from the other C.B. exchanges; incoming junctions from the call wire exchanges; incoming junctions from the call key exchanges; two-way junctions from the other P.O. exchanges; transfer circuits over which calls for code-ringing party lines will be passed; lines from information desk. The wiring of junctions incoming from call wire and call key exchanges is arranged so as to facilitate conversion to common battery working later, if required. The fuse board, power board, and machines are erected in the test room, and the single common battery for all purposes is placed in an enclosure to the rear of the power board. The charging generators—2-49 h.p. G.E.C "Witton" motors, direct coupled to 30 k.w. "Witton" charging generators—are supplied from a double change over three-wire supply from the Corporation Electricity Lighting Department, so that there is no need for duplicating the common battery, consisting of 20 chloride cells, with a capacity of 3,030 amp. hrs. at the 9-hour discharge rate. The subscribers' meter circuit is in two sections, one associated with the subscribers' line circuit, the other with the answering side of the cord circuit, and all effective calls dealt with by the operator are recorded on the position meter, and those originated by each subscriber on his meter. A bare notice can only be given of a few of the many other interesting features. Arrangements for carrying out tests of all possible faults which may arise are provided, and there is a special testing circuit of the wire chief's desk; and information operator's telephone and intercepting circuit, monitoring circuit, service observation circuits. The whole equipment is made and installed by the Perl-Conner Telephone Works, Ltd., of Salford.

Electric Lighting for Country Residences.

The General Electric Co., Ltd., have been pioneers in the installation of private electric plants for lighting country houses in Scotland, and have a splendidly illustrated pamphlet giving particulars and prices of various sets capable of supplying current for 40–10 c.p. metal filament lamps to 500–10 c.p. metal filament lamps. They have supplied several complete plants, which have given entire satisfaction. At Giffnock, a few miles from Glasgow, there are two mansion houses, each having about 80–16 c.p. Osram lamps installed, the plant in each case consisting of engine, 3 brake h.p., driving a dynamo by belt having an output of 2 kw. 25 to 37 volts for charging accumulators. The switchboard in each case is of elegant and substantial design and finish, and complete in every detail, consisting of black enamelled slate slab, upon which is mounted ammeter for charging circuit, ammeter for discharging circuit, voltmeter for charging and discharging, automatic cut-in and cut-outs, double pole switches and fuses, battery regulating switches and 2-way voltmeter switch. The accumulators consist of 14 cells, and are capable of supplying current to all the lights for 9 hours. At Lesmahagow a similar plant has been installed; and at Ecclefechau, a gentleman farmer had his mansion wired for 25 50 volt 16 c.p. Osram lamps, installed dynamo and accumulators. The dynamo is driven from an existing water turbine by belt, and the output of same is only 16 amp. at 70 volts for charging accumulators. In the Aberfeldy district two similar sets, each capable of supplying current to 100–10 c.p. Osram lamps have been installed, and in one case the voltage is 25–37 and in the other 50–70. In each case the dynamo is direct coupled to an engine which is capable of developing 2·5 b.h.p. at 340 revs. per min. While other similar plants have been installed by them, we understand the General Electric Co. have the order to supply a gentleman in Peebles district with a complete plant, capable of supplying current to 200–10 c.p. Osram lamps, the voltage being 50–70 for charging the accumulators. The current will also be used for ironing, driving electric vacuum cleaner, and cooking. All the plants are so well designed and constructed that no skilled attendance is required to work them.

GERMANY.

BERLIN.

We are so accustomed in Berlin to big electrical undertakings, that one which promises to develop hugely, although it has begun on a small scale with a capital of only 20,000 marks, is not receiving the attention it deserves. I refer to the Elektrolytische Verzinkerein, G.m.b.h., at Vogelsang, in Westphalia, which undertakes electrolytic zincing of small articles of every kind. Such work is not undertaken by the present large concerns, and the new company is sure to fill an important place in electrotechnics.

Telephone Disinfection.

Much has been heard recently of the risk of infection incurred by telephone users from microbes left on the mouth and ear-pieces by previous senders or receivers of messages who may emit patho-germs from their ears or in their breath. At Charlottenburg, a Telephon-Disinfektious-Gesellschaft has just been floated, with the object of regularly cleaning and disinfecting the telephones of persons paying a subscription annually or otherwise. At present the capital is 21,000 marks only, which is wise, for there can be no doubt that the business will be small at first, so that over capitalisation must be avoided. The concern is practically a branch of the Rudels Nerolit Werke, also at Charlottenburg.

Electrical Road Goods Trains.

During the last decade many attempts have been made to run goods trains on roads as a substitute for separate motor wagons. Many difficulties have to be met, such as risk of damage to the road surface, and to the stability of bridges, and last, but not least, the necessity of making such a slow method of transport compete, in certain cases at all events, with railway carriage. The Berlin brewers are already experimenting with the system, and the doubt seems to be as to the character of the power employed, electricity or steam. We know that in London, Carter, Paterson & Co., and one or two other firms, have long enough run trains of two vehicles, a motor and a trailer, but we are going to do something more ambitious. The difficulty about electric traction is that, there being no rails, it is a question between accumulators and overhead wires. The latter system is, of course, impossible, but by dividing the weight of the accumulators among the vehicles something will undoubtedly be effected.

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Wireless Telegraphy Regulations.

The German Chancellor has issued some important regulations with reference to the use of wireless and other telegraphy by foreign ships in German waters. Foreign warships may send news by optical or acoustical signals, but not by sounds sent under water. They may use wireless telegraphy, provided they do not interfere with the wireless communications of the German Navy. Foreign merchantmen have the same privileges, except that light signals must not be such as might be mistaken for lighthouse and other safeguarding lights, and that in using wireless telegraphy they must conform to the German regulations; and in harbours, roads, estuaries, and inland waters must have the written permission of the German Post Office.

Vienna Metropolitan Electrified.

I hear from Vienna that the Metropolitan Railway in the Austrian capital is to be electrified. The work is to be carried out by the Siemens-Schukert firm of Berlin, the financial arrangements being in the hands of the Austrian Landerbank. German electrical firms are very active in Austria just now, where very great electrical developments are expected.

Fuel Consumption.

The *Berliner Elektrizitats Werke* has recently answered a question which is of considerable interest. It referred to the coal consumption per kw.-hr. at the Rummelsburg Power-station. It appears that, using a coal averaging 6,483 units of heat of combustion, the mean consumption during the first half of 1909 was 1·015 kg. per kw.-hr. This is practically 1 ton per 1,000 kw.-hrs., and, considering that the coal used was not of the very best quality, is a highly satisfactory result, and one which shows that steam power is not quite out of the field yet in electric current production, even in places where there is plenty of water with a good fall for driving turbines. Some of our friends, not so many miles from here, who use water power, are always resorting to the bad parts of the German language, especially in winter when their turbines get choked with ice and dead leaves.

Company Notices.

During the last financial year, the takings of the Hamburg-Altona Centralbahn Gesellschaft rose to 1,541,312 marks, an increase of 60,000. The gross profit was 60,113 marks, out of which a dividend of 9½% (9% in the previous year) will be paid on the capital of two million.

UNITED STATES.

NEW YORK.

At the fourth annual meeting of the Illuminating Engineering Society of New York the new President, Dr. Edward P. Hyde, dealing with the definition of an illuminating enigneer, expressed the conviction that an illuminating engineer is a practitioner, but in order to practice, one must know, and the knowledge that is required of the illuminating engineer is highly diversified. It is not enough that he should simply know the ordinary engineering formula and data for putting the illumination from given sources of light in certain positions, or even for deciding the location of sources of light to accomplish certain illumination. He must also be appreciative of the requirements of art and architecture. He should know something of the science of light itself, and of the measurement of it. He should not be ignorant of the great opportunity for lighting that will benefit the race ultimately, and the great opportunity, or chance, of having a lighting installation which may ultimately tend to conduce to the serious harm of the human race. In other words, there is the engineering element, there is the architectural element, the physical, the physiological—even the psychological; there is the artistic element—all must be combined.

Electricity in 2000 A.D.

In a lecture at Buffalo, Mr. R. B. Welbourn, a well-known electrician and inventor, declared that in the year 2000 the world will be deriving her fuel and power chiefly from the energy of the sun converted into electricity, the utilisation of sound developed into the same force and also from the world's water supply. Wireless telephones will bring all peoples of the earth within speaking distance, while by the magic of electric contrivance persons, immaterial of distance, will be visible to each other through the medium of a telegraph wire, and the physician, by likeness of the patient appearing, by such means in his office, will be able to diagnose the case without leaving his chair. Sound, he said, is one of the most efficient sources of energy, and can be converted into power and made to operate a motor. The vibrations resulting from blowing a whistle generate sufficient electricity to run a small dynamo and make a miniature incandescent lamp burn. The sound of the voice can be made to perform the same feats. The utilisation of the intensity of chemical action, of the motion of the world's water and the sun's heat were, he said, mentioned as the sources of the power of the future both for running the machinery of factories and supplying fuel when the wood and coal shall have become exhausted.

Electric Railway Notes.

Construction work will begin at once for the Mexico, Santa Fe and Perry Traction Company, on its new road at Mexico, Mo. The first sections to be built will be north from Mexico to Molino, and south from Mexico to Hereford. The entire line will connect Mexico with Hannibal and Columbia and Fulton, about 100 miles of road. Erection of the power house at Mexico will begin January 24. General contract for constructing this road is in the hands of Burns & Company, 705, Isabella-building, Chicago.—The Decatur Southern Traction Railway Company, Decatur, Ill., has been incorporated, to operate an electric railroad from Decature to Pana.—The Toledo and Indiana Electric Railway was sold at a receiver's sale at Toledo, Ohio. Mr. S. C. Schenck, of Toledo, representing the majority bondholders, including the Knickerbocker Trust Company of New York, bid in the property for $1,058,500.—The Motor Grand Traction Company, Belleville, Kan., has been incorporated, with a capital of $1,000,000, to build a line from Belleville *via* Concordia, Minneapolis, Salina, Canton and Newton to Wichita, Kan., a distance of about 150 miles.—The Portland Railway, Light and Power Company, Portland, Ore., is again increasing the capacity of its hydro-electric plant. It has recently placed an order with Allis-Chalmers Company for a 3,750 kw. water wheel type, 11,000 volt. 60-cycle, 3-phase, 360 r.p.m. alternator. This will be of the same general design as the two 2,500 kw., 11,000 volt, 33-cycle alternators already supplied by the same company, and will be semi-enclosed. A 50 kw., 120 volt exciter will be direct connected to an extention of the alternator shaft.

Big Michigan Merger.

Details in regard to the proposed $18,000,000 merger of street railway, power, gas and electric lighting concerns in Michigan have recently been given out. The corporate name for the combination will be the Commonwealth Power, Railway and Light Company. Of the total capital stock $6,000,000 will be preferred and the balance common. No bonds are issued. The following companies are to be included in the merger: Commonwealth Power Company, of Grand Rapids; Muskegon Power Company, Saginaw-Bay City Railway and Light Company, Grand Rapids Railway Company, Michigan Light Company, Flint Electric Company, Flint Gas Company, Cadillac Water and Light Company, Charlotte Electric Company, Pontiac Gas Company, Siawassee Light and Power Company and Ausable River property and rights. The total combined earnings of the companies for the calendar year 1909, November and December estimated, were $6,192,000, providing more than double the amount required for dividends on the preferred stock. The new concern is being formed by a syndicate of New York, Philadelphia and Michigan bankers.

Traction Reorganisation in Chicago.

Details of the proposed reorganisation of the Consolidated Traction Company, Chicago, and the formation of a new company to be known as the "United Railway Company," have been made public. The lines of the Consolidated Company are to be placed in first-class condition, and undoubtedly the new company will be merged with the Chicago

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Railways Company at an early date, and it is quite probable that this in turn may be absorbed by the new Chicago City and Connecting Railways, which will include all surface street railways in the city. The Consolidated Traction Company is itself the result of the combination of a number of outlying street railways on the north side and west side of Chicago. To provide for the expenses of rehabilitating the system, an issue of 5% first-mortgage bonds will be made. It is expected that these bonds will be issued to the amount of $6,000,000, of which $4,000,000 is to be expended on the north and north-west sides, and $2,000,000 on the west side.

Single-Phase Series Motor.

A valuable paper on the space economy of the single-phase series motor was presented at the last meeting of the American Institute of Electrical Engineers by Professor W. S. Franklin and Mr. S. Seyfert. The object of the paper was to discuss the question of the maximum single-phase series motor rating which can be placed within a given space. The principal feature in the design proposed by the authors consisted in removing the commutator from its usual position, making the armature stationary, arranging the field structure to revolve and placing the stationary commutator at some convenient point where the revolving brushes may be positively driven by the revolving field structure. For this arrangement it was claimed that all of the available space between the wheels would be occupied by active material, which would be utilised to the best possible advantage. The resistance leads, balanced choke-coils and similar apparatus could then be designed practically regardless of the amount of space they should occupy, and the designer could produce a machine which would commutate satisfactorily with a higher short voltage circuit than would otherwise be possible. Again, the power losses of the non-sparking device would take place outside of the motor region proper, and hence would not have to be taken care of by ventilation. Repairs to resistance leads, or other devices for preventing sparking, could be made with great ease and without opening up the motor in any way, and arrangements could be provided for the short-circuiting of any portion of the resistance leads of the disconnecting or the choke-coils at any prescribed motor speed, thus enabling the designer to treat the problem of starting and the problem of steady running independently of each other. The authors presented diagrams of a 500 h.p. motor of this general construction, and described the type of revolving brush holder which they proposed and of a non-sparking device based on the use of leads, providing great impedance for any short-circuit current and almost non-inductive for the main-line current.

Telephone Train Despatching.

The equipment of the Spokane division of the Great Northern Railway with telephone train despatching apparatus will complete a total of 2,100 miles of line which this road is now operating in this manner. The Spokane division extends from Troy, Mont., to Leavenworth, Wash., a distance of 337 miles. On account of the length of this division, and the amount of traffic passing over it, two despatchers are required to handle the division. They will have on their despatching circuits 45 way stations equipped with standard Western Electric telephones and Gill selectors. The standardisation of this apparatus for the railroads of the country has included a testing device which is installed throughout the Great Northern system. This is a panel somewhat similar to the well-known telegraph peg board, but containing telephone jacks and plugs. The circuits looking through an office, both telephone and telegraph, are wired through these jacks and by the operation of two keys and using the plugs at the despatcher's orders, it is possible to patch up temporarily a line in case of trouble, to interchange circuits, to locate a break or a cross to the nearest station, in fact, to make all the simple tests ordinarily required on a circuit of this character.

The Test Panels.

The test panels have been found an important and useful portion of the despatching equipment of railroads. Their simplicity makes them especially valuable, as they may be operated by the most inexperienced employés. Another interesting feature of the Great Northern installation is the use of siding telephones on the Spokane division. Seventy of these are to be installed. As the use of the telephone for despatching has increased, the railroads, as in this case, have come to appreciate more and more the advantages of being able to allow the train crews to talk directly to the despatcher at all important sidings. A siding telephone is sure to be at hand in case of emergency, as a large number of them have been installed. The fact that these siding telephones enable the despatcher to reach train crews waiting at the sidings and give them orders to proceed permits him to take advantage of all changes in the schedule, prevent congestion and keep traffic moving, thus effecting economies in motive power and reducing overtime expense. Any of these uses warrants the installation of the telephone system, as the savings effected in one emergency will more than pay the cost of the installation. When this equipment is cut into service the Great Northern will have a telephone train despatching the entire distance from Minneapolis to Seattle, with the exception of two short sections.

Current Items.

At the annual meeting of the New York State Electric Contractors, the principal business was the discussion of a Bill that it is proposed to have introduced in the Legislature providing for qualifying contractors and workers after the examinations required of plumbers. It is said that many fires are caused by defective wiring and the purpose of the suggested legislation is to protect the trade against incompetent workmen.

Although 4,500 volts of electricity passed through his body at the Lynn lighting plant, James McCloud was able to leave the hospital next day. He accidentally grasped a heavily-charged wire. As only 1,500 volts are used in executions at prisons, his escape is considered remarkable.

The two new electric elevators in Prospect Park, Niagara Falls, were formally opened to the public this week, following the meeting of the State Reservation Commission. Commissioner William Howland, of New York, paid the first fare on the new elevator. The other members of the commission, including the contractors, also made the trip down.

In the hearing at New York before the legislative committee which is trying to determine the advisability of placing telegraph and telephone companies under the jurisdiction of the Public Service Commission, Colonel Robert C. Clowery, president of the Western Union Telegraph Company, declared that the average profit on each message sent by his company was 3½ cents. "What is your opinion of the placing of public utilities under governmental and State control?" he was asked. "I have not had any experience in this line, but I would not object to reasonable control or regulation," he replied. "The principle seems to me to be correct so far as our business is concerned."

CLAIM BY ELECTRICIAN.

Lord Cullen, in the Court of Session, Edinburgh, disposed of an action in which George M'Laren, plumber and electrician, carrying on business under the name of David Stevens, at 15, Howe-street, Edinburgh, sued W. S. Cruickshank & Son, building contractors, Lower Gilmore-place, Edinburgh, for £1,021 16s. 6d., the balance of his account for the electrical lighting and other electrical work of the King's Theatre, Edinburgh. The defenders were contractors for the construction of the King's Theatre, and sub-contracted with the pursuer for the plumber work for the buildings. No question arose in regard to this sub-contract. The pursuer also executed the electrical work of the theatre, and an arbiter decided that the amount due under this head was £3,021 16s. 6d. Of that sum £2,000 was paid to account, leaving the balance now sued for due. The pursuer averred that the sub-contract for the electrical work was entered into with the defenders. This the defenders denied, and stated that the pursuer's contract was with the Edinburgh Construction Co. (Ltd.), on whose instructions the defenders paid the £2,000 to account.

Lord Cullen decerned against the defenders with expenses.

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LIGHTNING CONDUCTORS.

By ALFRED HANDS, F.R.Met.S.

When Benjamin Franklin, in 1752, proved the identity of lightning with electricity his practical mind immediately suggested the possibility of employing conductors of metal as a means of protecting buildings from its destructive effects, and the first lightning conductor was erected on his own house at Philadelphia the same year. Many others followed his example, and their use gradually spread over the North American Continent. Their adoption in Europe was very much slower. A few were erected in France, but it was not until 1762 that the first conductor was erected in England, on the residence of Sir William Watson, F.R.S. The earliest adoption of conductors to any considerable extent appears to have been in the neighbourhood of Hamburg, it being stated that five years after the protection of St. Jacob's Church in that city, in 1769—the first European church fitted with a conductor—there were over 700 within a radius of five miles of the town.

Opposition by the clergy in nearly every land on the plea that they were heretical in character and the ignorance of the main body of the people retarded their general adoption to a great extent, but the many cases that were brought to light of buildings fitted with these "heretical rods" being actually seen to be struck by lightning without injury, and the immunity from damage of others that had previously suffered again and again, gradually wore away projudice, and they came to be regarded as a necessary adjunct to any building that it was desired to save from injury. The Senate of Venice is even said to have issued a decree ordering the erection of lightning conductors throughout the Republic.*

It is worthy of note that throughout its earlier history the cause of the lightning conductor was fought by scientists against strong opposition on the part of the less learned, and it was only after it had been proved to be of service, and in no way detrimental, that its adoption became general.

In England the greatest advance was probably made in the time of Sir William Snow Harris, F.R.S., Advisor to the Crown on Lightning conductors, who acquired a high reputation as an authority on the subject. His persevering efforts caused the Lords of the Admiralty to adopt proper systems of conductors for British battleships, and damage by lightning, which had previously been of common occurrence and had been the source of enormous losses to the Navy, ceased entirely. It was not merely to ships that he gave his attention. A great number of buildings of all kinds were protected under his direction, including royal palaces, cathedrals and mansions, but his masterpiece was undoubtedly the then new Palace of Westminster. His writings and strong advocacy of the utility of lightning conductors did much to cause their more general adoption throughout the country. No damage ever occurred to a building he protected.

The success of a man who had studied his subject thoroughly did not deter others, who had not the requisite knowledge, from also trying their hands at protecting buildings, and it is not to be wondered at that, less than 30 years after Sir Snow Harris' death, cases of damage should have occurred to buildings supposed to have been protected by these men, nor that the subject should have fallen somewhat into disrepute. Ignoring the fact that the failures were due to the want of knowledge of those who applied them, the less enlightened of the public began to think that lightning conductors were useless.

To restore confidence in what was known to be a benefit to mankind, if scientifically applied, and to indue among lightning conductor manufacturers a uniformity in methods of procedure—previously varied and anomalous—the Royal Meteorological Society, in 1878, formed the Lightning Rod Conference, consisting of the following delegates from learned societies:—Messrs. C. Brooke, F.R.S., E. E. Dymond and G. J. Symons, F.R.S., representing the Royal Meteorological Society; Professor Lewis, F.S.A., and Mr. J. Whichcord, F.S.A., representing the Royal Institute of British Architects; Mr. Latimer Clark and Sir William Preece, F.R.S., from the Institute of Electrical Engineers; Professors W. G. Adams, F.R.S., and G. Carey Foster, F.R.S., from the Physical Society; with Professors W. E. Ayrton, F.R.S., and D. E. Hughes, F.R.S., as co-opted members.

The members of this Conference went whole-heartedly into the work. Cases of damage by lightning to a great number of unprotected, as well as protected, buildings were carefully considered; all the published writings on the subject were read and digested; and those concerned in the making and fitting of lightning conductors were invited to submit their views and experiences for the benefit of the Conference. After protracted meetings and discussions, extending over three years, at which all the members took active part with the exception of Mr. Brooke, the first president, who died in the first year of its proceedings, the report of the Conference was published, in 1882, by Spon's, and was long regarded as the highest authority on the subject in the English language. It forms the basis of the rules and instructions issued by, and now in force for, the Admiralty, War Office, and Home Office. It is still a valuable contribution to the subject, and it is a fact that no case has ever occurred in which a conductor system, erected in accordance with the rules the Conference formulated, has failed; but it is no less a fact that those rules might now be very greatly improved upon, owing to the greater light thrown upon the theoretical side of the matter in recent years, especially by Sir Oliver Lodge, F.R.S.

If we regard these rules as intended to teach anyone, irrespective of their having technical or practical knowledge, how to protect a building perfectly, we must pronounce them a failure, as any such rules are bound to be under the like circumstances, but as a guide to those sufficiently acquainted with the subject to be able to understand their purport, and to apply them properly, they may be regarded as the best rules, in so short a compass, that have ever been issued. They certainly had the effect of popularising lightning conductors, and have probably saved a large number of buildings from being damaged by lightning; but naturally they were not followed, or even read, by everyone and did not result in the entire cessation of damage to so-called "protected" buildings.

Owners of property and those having the care of buildings are apt to look upon a lightning conductor as a piece of apparatus put up for a definite purpose, and that should, therefore, effect that purpose. They ignore the fact that its efficiency depends more on the scientific knowledge of the electrician applying it than on the form or type of conductor, and so, in many cases, it has been (and will probably long continue to be) considered a matter that can be entrusted to the local builder, plumber, or even ironmonger, and, once erected, it is expected to remain efficient for ever; for is it not a lightning conductor? And what more is required?

Investigation by a competent observer into any case where damage has occurred to a building, supposed to have been protected, has shown that glaring defects in application or construction existed, or that alterations had been made to the buildings which rendered a different mode of procedure necessary, and in every case a qualified expert could have told, had he examined the building before the accident happened, that the system was inefficient, and that the damage would result if lightning struck it.

Such cases, while they have probably made a sceptic here and there as to the efficacy of conductors, were not sufficient to cause doubts to any great extent as to whether it was advisable to apply them, and, with the increase in knowledge that has taken place, not alone among scientists, but with the "man in the street" also, it might be considered highly improbable that any real want of confidence or disbelief in their utility would be possible. Curiously enough, however, an attempt made by Sir Oliver Lodge, 20 years ago, to place the subject on a better scientific basis, had, temporarily, such an effect. Later he nullified this by writing "An idea at one time got abroad that my experiments proved existing lightning conductors to be useless or dangerous; this is an entire misrepresentation. . . . They are essential to anything like security." Nevertheless, about 15 years later, a great wave of doubt swept over this country that even yet has not completely subsided, and many owners of houses, many custodians of buildings of all kinds, have been led to think, not only that conductors are valueless, but that they endanger the buildings on which they are fixed, and that they are, therefore, better to run the risk of damage or even death by lightning than, by

* Anderson's "Lightning Conductors."

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trying delusive methods of safeguarding their buildings, to invite the destruction they fear.

This wave of scepticism arose in 1905, and had a more far-reaching effect than might be considered possible. Architects have declared it was no use to advise their clients to have lightning conductors; they were afraid of them. A public body having the control of hundreds of buildings that had for many years escaped damage by lightning because they were fitted with conductors, decided not only to have no more, but to cut away many of those they already had. In this case Nature promptly taught a lesson that proved effective, for one of the buildings that had been denuded of conductors was damaged within a fortnight.

It was not only among laymen that the doubts were raised. A leading article in an electrical paper suggested that lightning conductors might be dangerous, and frequent paragraphs in the non-technical press conveyed similar information to an easily deluded public. Statements like these, made in the public press, are believed by a large number of uninformed readers, and, like all calumny, are none the less relished nor, for the time, none the less harmful, because they are absolutely without foundation.

These statements and the scepticism they aroused occurred in the year that the report of the Lightning Research Committee was published, and one must conclude that this report was directly, as well as indirectly, responsible for them. A little light thrown on the origin of this committee and its report may, therefore, be of interest.

In a biographical note that appeared in *Public Works* for January, 1905, it is stated that Mr. Killingworth Hedges "first took up the question of the better protection of buildings from lightning in connection with St. Paul's Cathedral, having been asked to report on the proposed electric lighting." It would appear from this that the cathedral authorities presumed that lightning conductors and electric lighting were synonymous terms. Whether this was the first building that Mr. Hedges protected is not stated, though if the biographer is correct in saying that he "first took up the question," then it would appear as if it was. At that time his name does not appear to have been prominently before the public in connection with this branch of electrical science. His recommendations in this case were adopted, and he afterwards read a paper before the Royal Institute of British Architects in which he described his scheme. In the discussion that followed he stated that he had found difficulty in obtaining reliable information later than the Report of the Lightning Rod Conference, about damage by lightning, and suggested the formation of a second conference to obtain more recent information. As a result, the Lightning Research Committee was formed in 1901, conjointly by the Royal Institute of British Architects and the Surveyors' Institution. In a letter, by Mr. Hedges, that appeared in THE ELECTRICAL ENGINEER of December 3, 1909, it is described as "the Lightning Research Committee of the Royal Society R.I.B.A., and Surveyors' Institution," but it appears from the report that the only authority for connecting it with the Royal Society is the fact that a Committee of that Society, having the administration of a Government grant for scientific investigations, made a donation of £20 to its finances: the bulk of the funds were provided by the R.I.B.A. and the Surveyors' Institution. When first formed, the Committee consisted of four architects and surveyors: Messrs. John Slater and H. Heathcote Statham, appointed by the R.I.B.A., and Messrs. A. R. Stenning and Arthur Vernon, appointed by the Surveyors' Institution; and Mr. Killingworth Hedges, M.Inst.C.E. These gentlemen afterwards invited the co-operation of Sir Oliver Lodge, F.R.S., Major-General E. R. Festing, C.B., Mr. J. Gavey, C.B., Dr. W. N. Shaw, F.R.S., and another surveyor, Mr. W. P. Goulding. Of these, eight signed the Report; of the two exceptions, Mr. Goulding had died before its completion, but we are not informed whether Mr. Statham disagreed with its findings or had resigned.

The inner working of this committee will probably never be fully known, but I believe I am right in saying that Sir Oliver Lodge—being in Birmingham and the committee holding its meetings in London—was not a regular attendant. Some of the reports received were sent to him from time to time for his opinion, and he gave a demonstration of electrical experiments before the members of the committee and some others. How far the other members participated in the work is not quite clear. I believe that a sub-committee, consisting of Mr. Hedges, Mr. Gavey and Mr. Goulding, was appointed to carry on the work, and, if so, it does not imply a very great display of zeal on the part of the others.

The committee's report, published in the R.I.B.A. Journal in May, 1905, has a preface by Sir Oliver Lodge which appears scarcely consistent with the report itself, to which, however, he appended his signature. Sir Oliver Lodge has written a work entitled "Lightning Conductors and Lightning Guards," published by Whittaker in 1892, which is one of the most important works on the subject for the student and well worthy of careful study by every expert, if regarded as a theoretical work and not as a practical guide, and his views have been set forth in it at considerable length. His preface to the report is such as one would have expected from his published views, and the fact that those views are theoretical, and not practical.

Referring to what may be called the older views, he says in this preface: "It was supposed that it (lightning) would always take the easiest path, and that the easiest path would protect all others. Attention was directed to the quantity of electricity which had to be conveyed down, and to nothing else." I consider this statement unwarranted. Reading the works of Sir Wm. Snow Harris and, better still, examining the buildings he protected, one finds that he took the most elaborate precautions in connecting his conductor systems to metals about the buildings. In the light of present-day knowledge, one would be disposed to say he rather overdid it, though the fault was one only of increased cost and not inefficiency. He has distinctly drawn attention to the danger of alternative paths of metal about buildings; hence the precautions he took in making connections to metals wherever he thought side-flash or lateral discharge was liable to occur. When Faraday was called upon to devise the lightning conductor systems for the light-houses round the English coast, he did not overlook the possibility of side-flash; he arranged for elaborate connections of metal to prevent possible damage by lightning following alternative paths, and the methods he recommended are still adopted by Trinity House. The Lightning Rod Conference also lays stress on the necessity for connecting other metals, so side-flash was not ignored by it either. And numerous other writers have said the same.

There is one point on which Sir Oliver Lodge is at variance with experts, and to this he refers in this preface. It has generally been considered that a lightning conductor should form an easy path for a discharge, but Sir Oliver Lodge's opinion, based on experiments and theoretical considerations, is that the resistance in the conductor should dissipate the energy of the flash. He has demonstrated this experimentally by taking a spark about six inches in length through, first, a stout copper wire about 100 feet or so in length, and then through a similar length of very thin iron wire, and a remarkable energy-reducing effect is shown when the discharge passes through the latter. Hence he contends that thin iron is better than thick copper, and it is very obvious to anyone who has read his book that the purport of the preface is a distinct recommendation of *small-sized* iron conductors and not of iron of such a size as to make its conductivity equal to that of the copper conductors ordinarily used, for in his book he says, "Let it be clearly understood once for all, that in comparing copper and iron conductors I never mean comparing them as of unequal thickness, *i.e.*, of equal conductivity. Such a comparison is ridiculous in the present state of knowledge. They are to be compared when of the *same* thickness; and under those circumstances I assert iron to be a trifle better, certainly not a whit worse, than copper." Yet the report which follows, and which bears his signature—and, apparently, therefore, his approval—upholds the Lightning Rod Conference rule of copper weighing not less than 6 ozs. to the foot run or iron not less than 2¼ lbs. per foot run, which makes the conductivity of the iron recommended equal to that of the copper. We are led to wonder whether Sir Oliver Lodge signed the report, but disagreed with it; or whether he has, without making any public pronouncement of the fact, withdrawn

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the views he advocated so strongly in his book, but the whole tenor of the preface suggests that the former is more probable.

The question as to whether it is better to get rid of a lightning flash as quickly as possible by having a conductor of very low resistance, or to keep it on the premises, so to speak, and try to dissipate its energy *en route* by converting it into heat, is a matter about which opinions may differ. At all events, we may say that his views are entirely theoretical, for his experiments are not conclusive in this respect. While it is true that a length of a 100 feet or so of thin iron wire has a great dissipating effect on a spark of a few inches in length, it does not follow that an iron wire conductor of similar length, but very much larger size, would have the same effect on a spark one mile or more in length. In fact, if we make the experiment more nearly proportional to an actual occurrence, by having the conducting wire one-fiftieth the length of the spark used in the experiment, the dissipating effect is found to be no longer apparent. In theory it is there, but practically it is so small as to be negligible.

We may, perhaps, as an analogy, say that a sheet of tissue paper, hung in front of a pop-gun, would impede the velocity of the cork, but would it be practical, therefore, to suggest the advisability of hanging sheets of tissue paper before troops exposed to rifle fire? The impedance effect would be there in theory, but it would be so infinitesimal as to be not worth consideration.

If breaking down or dissipation of energy were considered to be a *sine qua non* in lightning conductor practice, one would be disposed to say that it could be done more effectively by interposing the resistance of bad joints or a bad earth connection to a conductor. Although it might be thought that no one would seriously make such an absurd suggestion, it is worthy of note that an American pundit, many years ago, actually tried to introduce a lightning conductor with a box of carbon inserted in its length as a resistance to dissipate energy.

When Sir Oliver Lodge says in this preface, "A lightning conductor of perfect conductivity, if struck, would deal with the energy in far too rapid and sudden a manner," and "The rush in any case, however, is likely to be rather violent; and, like an avalanche, it will not take the easiest path provided for it, as if it were a trickling stream, but will crash through obstacles and make its own path," we are constrained to ask whether he regards a copper conductor as an entirely new invention that has never been put to the test of experience, and whether he is aware that copper conductors—which by signing the report he advocates—have been in use in this country for about three-quarters of a century; that they have been (and are still) fitted to a vast number of buildings in this and other countries, including the tallest and most important—the ones that may be regarded as the most liable to be struck by lightning, and that we feel sure would have suffered long ago had they not been provided with conductors—and which with a few trifling exceptions have escaped damage by lightning during this period? Also that, besides the number of recorded cases in which they have been seen to be struck without damage having been caused, a very great number of the conductors in existence are found on examination to bear unmistakable evidence of having at some time received lightning strokes harmlessly without the owners having even been aware of the occurrences?

When he adds that "the only way to protect a building with absolute completeness is to enclose it wholly in metal," we may not only make the same rejoinder, but remind him that not one of those buildings that have escaped damage was fitted with this "only way" of protection, and, further, that the only building fitted with the system he has advocated that has been known to be put to the test of an actual lightning stroke—the Hotel de Ville, Brussels—was set on fire by lightning.

Sir Oliver Lodge appears to ignore the fact that an electrician, when protecting a building against lightning, may apply quite as much intelligent thought to the matter as he would if engaged in any other department of the science, and may even bring such specialised knowledge and experience to bear on it as would enable him to foresee the damage that would be liable to occur and to devise the methods necessary to prevent it, without resorting to the extreme measure of encasing the whole structure in armour.

He further states that "a hot column of air, such as rises up a chimney, is even preferred to a conductor," and it may be well to enquire what justification there is for the assertion. It is, I presume, based on an experiment I saw him carry out before the Institute of Electrical Engineers (then called the Society of Telegraph Engineers and Electricians) in 1889. In this experiment he used a glass chimney (such as is used for oil lamps) to represent a chimney shaft. This was placed over a metal stand with burner supplied with lighted gas. The stand was in contact with a sheet of metal representing the earth and a similar metal sheet, a few inches above the chimney, represented the thundercloud. The reproduction, therefore, was really that of a chimney shaft with a huge mass of perfectly "earthed" metal in its interior, reaching to nearly half its height, and with a fire so fierce that the hot current of air would actually impinge on the cloud from which the discharge was to be expected. Under these remarkable and unnatural conditions, he placed a model lightning conductor at the side of the chimney and showed that a spark would strike down the current of hot air in preference to following the little lightning conductor at the side. On this experiment he based his recommendation that the upper terminal of a conductor should form an arch over the chimney cap.

I do not think that any electrician, called upon to protect a chimney shaft of such an extraordinary character—supposing that one could possibly exist—would rest content to recommend a single conductor on one side. He would not only have the coronal band with points at intervals, recommended by the Lightning Rod Conference, but would see that a connection was made between his conductor system and the mass of metal in the interior. If the experiment is repeated on lines that make it approximate to a probable, or even possible, case in Nature, by having a small glass tube with a little piece of tinder burning in its interior, and a model of the conductor system the Conference recommended attached to it, no liability to spark down the interior of the tube is found to occur.

Experiment is the method we adopt of asking Nature questions on matters about which we are uncertain, and she freely gives us replies of a very definite character. We could by experiment, I think, reproduce on a reduced scale any lightning effect that has been known to occur, or that is likely to occur, provided the conditions were made precisely the same, but any variations in the conditions may cause entirely different results.

It must not be thought that I am decrying the value of Sir Oliver Lodge's experimental work. It has had a remarkably illuminating effect and is the most important contribution to the subject ever put before electricians. But it does not necessarily follow that the practical recommendations he bases on this work must be accepted as conclusive. His practical views appear to be those of the theorist ignoring what has or has not occurred and concerned only with what ought to occur if the theories are well founded. I am inclined to think he places too much reliance on some quite incorrect accounts of occurrences that have been published. But it may be thought that they are based on the researches into actual occurrences carried out by the committee, especially as he says, "What the committee can do is to make a study of cases of damage according to buildings which on the old lines were supposed to be protected"; so it may be well to review the cases it published in its report.

In an appendix, 35 cases are given, including one building that was damaged twice, and a careful perusal of these gives some indication as to how far they were investigated. Probably every electrician will agree as to the importance of a good earth connection for a conductor, and this committee's report practically confirms that of the Conference of 1882 in this respect, even emphasizing it by its recommendations as to the advisability of testing "earths," so one of the most important things to be investigated and considered by this committee would be, one would think, the condition—whether good or bad—of the earth connection of each conductor that failed. If this was not ascertained, the investigation was a mere farce and of no real value.

Now, we find that of these 35 cases three are stated to have been "good"; one "not good"; one "stated no

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earth plate"; one "said to be faulty"; one "found to be in connection with electric light mains"; four "bad"; two "very bad"; two "character of earth unknown"; seven "not stated": eleven are dismissed with a dash, which would lead the reader to presume they were not known either; one is stated to have consisted of two earth-plates 20 in. by 10 in. "soil not of the best," from which we may infer it was bad; and in one case it is curiously described as "raining heavily." The details given in the other columns are scarcely more satisfactory. We find that where they are not dismissed with a dash or the more definitely acknowledged "unknown" or "uncertain," they are of the most meagre and unsatisfactory description.

The first case in the list, one that occurred very soon after the committee was formed, was situated only about four miles from its headquarters, and appeared from the original report of its observer to be of such an extraordinary character that one would have expected nearly every member to have visited and personally investigated it. We find in the column headed "remarks" one of the reasons for the failure given as "the lightning rod itself carried too close to the gas pipes." It was nearly 20 ft. away.

Having been afforded more than one opportunity of inspecting the original reports received by this committee, I am satisfied that the meagreness of the details given in this appendix is not due to a desire to withhold information from the reader, but only to the fact that the full particulars required for anything like a real scientific investigation were not, in most cases, forthcoming. We are warranted in concluding that Sir Oliver Lodge's views, whether altered or not, cannot be based on the committee's "research" work into the actual occurrences that took place during the years it was supposed to be investigating matters.

A yet closer scrutiny of this appendix leads to a curious discovery. The declared object of the committee was "the purpose of obtaining trustworthy information on future disasters from lightning," *i.e.*, those that should occur after it was formed. It was not, therefore, concerned with cases that had occurred before its formation, and did not ask for particulars of them to be sent. The report states, "the committee have had placed before them detailed reports from their observers of the damage done in 115 cases. Seventy-five cases related to buildings which were without any form of protection. The remaining 40 were provided with what had been considered by those responsible for the buildings as sufficient safeguards in the way of lightning rods. While taking due account of the lessons to be learnt from the action of the lightning on unprotected buildings which had been injured, the committee have deemed it unnecessary for the purpose of this report to go into the details of these cases. A selection, however, has been made from the reports of 'protected' cases, and these will be found summarised and put into tabular form in appendix A."

As already stated, this appendix contains 35 cases in all. If this is only a selection from the 40, it might be presumed there were 5 more, but when the correctness of the figures was challenged at a meeting of the Society of Arts, in 1905, Mr. Gavey, a member of the sub-committee, declared it contained all the cases, and that he had personally struck out several because they related to lightning-arresters on telegraph instruments and not to lightning rods. It is, therefore, apparently a complete list and not merely "a selection." The contention that 40 cases of damage occurred to buildings fitted with "what had been considered sufficient safeguards in the way of lightning rods" breaks down at once, but this is not the limit of the inaccuracy. Of the 35 cases alleged to be a selection from the "protected" cases only, because the committee "deemed it unnecessary for the purpose of this report to go into the details" of the unprotected ones, no less than 7 had no lightning conductors at all; in one the building (a magazine) was not damaged, the object struck and damaged (a wooden post) being nearly 50 yards away; in one case the damage (to a church spire) had been inspected by an expert and declared not to be the result of lightning, but probably due to the rusting of iron-work, while even if it had been in any way caused by a lightning flash it would have been outside the avowed province of the committee since it was visible in a photograph of the church taken many years before; and two other cases were damage by lightning that had occurred before the committee sat. This leaves 24 cases only that occurred during the three years of the committee's alleged investigations. As to these 24, we may admit they could be legitimately termed lightning conductor failures, in a sense, though in several instances the parts struck were ones that were not provided with conductors, although any recognised expert would have known were fully exposed to be struck and not in any way protected by the conductors on the other portions. In most cases the conductors were old ones, in existence for periods ranging from 20 to 60 or more years, and that had apparently received no repair or attention from the time they were fixed; did not in any case look like the work of a first-class firm of experts, nor could one of them be said to be in accordance with the rules of the Lightning Rod Conference of 1882. If it is true that those responsible for the buildings considered them "sufficient safeguards in the way of lightning rods" we can only say that no electrician would have agreed with them.

Where, then, are the 40 cases of damage to protected buildings that the committee's report alleges were received and on which apparently the remarkable statement "that no series of lightning conductors of the hitherto recognised type suffice to protect the building" is made?

We may get a little further light from another part of the report where it is stated, "The thunderstorms of 1901 were fruitful in cases for the committee's enquiry. Records were received of over 60 buildings struck and damaged, 14 of them being provided with some form of lightning conductor." At the ends of the first and second years the committee issued leaflets giving detailed lists of reports received from observers during each of those years. In these the buildings alleged to have had lightning conductors were marked with an asterisk, and they were publicly exhibited during the summer of 1903 at the Fire Exhibition at Earl's Court. The list for 1901 had 12 cases so marked, and one from which the asterisk was omitted because the committee did not learn till later that it had a lightning conductor. The list for 1902 contained two cases that occurred in December, 1901. This makes 15 cases of which one was descriptive of the entire destruction of the flagstaff on the Victoria Tower, Houses of Parliament, sent in by Mr. Killingworth Hedges, but which was inaccurate, as the flagstaff, which is a steel one, was not damaged and is still standing intact. One case was descriptive of the damage to the residence of the chief officers of the Kent County Fire Brigade, in which there was a fire-bell to which a "lightning conductor" was attached, *i.e.*, an earth wire as fitted to all telephone wires by the National Telephone Co., which one would think the wildest flight of fancy would scarcely construe into a "sufficient safeguard in the way of lightning rods." One was descriptive of the perforation of a lead pipe and ignition of gas at a church in Soho, but which it is stated that Mr. Killingworth Hedges was of opinion was not caused by lightning, and one related to a case that occurred about six years before the committee was formed.

(*To be concluded.*)

ELECTRICALLY DRIVEN ROLLING MILL FOR TERNI.

The great Italian ironworks at Terni have placed an order with Schneider & Co., of Le Creusot, for an armour plate rolling mill, to be electrically driven, as turbines cannot be made to give the necessary reversals direct. The plant will handle ingots up to 100 tons weight. The mill is driven by two coupled direct-current motors giving 15,000 h.p. at 90 revolutions a minute. They in their turn are driven by a dynamo current from three dynamos worked by a turbine of 2,600 h.p. The flywheel of the rolling mill is of cast steel and weighs 50 tons. It is found that the electric drive makes rapid reversal of the motion of the plate between the rolls much easier than when the mill is worked by a steam engine. The rapid deterioration of a rolling mill steam engine due to the frequent and sudden reversals is well known.

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THE P. & O. BATTI-WALLAHS SOCIETY.

The second smoking concert of the season took place in the Council Chamber of the Holborn Restaurant on Monday last. Mr. C. L. Lichtenberg, President, occupied the chair during the first part, and Mr. C. L. Pinching during the latter part of the evening. An excellent musical programme, arranged by Mr. Harry Heap, was much enjoyed by those present, encores being numerous. Songs rendered by Miss Rosa Dallort, Miss Marjorie Barrass, Miss Edith Blanchard, Mr. Will Edwards, Mr. Wallis Arthur, and banjo solos by Mr. Joseph Bull, and humorous sketches by Mr. Charles E. Nott, were exceptionally good.

It may be again mentioned that the Batti-Wallahs consists of members and associates who are or have been electricians on the P. & O. steamships. Rule IV. reads: "Every candidate for election must be duly proposed and seconded by members of the society and his nomination sent to the secretary, who will submit his name for election at the first committee meeting after receipt of such nomination. Members will be elected by the committee in one of three classes:—(a) Full Members, whose qualification shall be that they have served for at least one voyage as electrician in one of the P. & O. S. N. Co.'s steamships. Full members elected prior to the date of the first annual dinner shall be know as Founder Members. (b) Associate Members, whose qualification shall be that they have served at least one voyage as an officer other than an electrician, in the P. & O. S. N. Co.'s steamships, and who have since taken up an electrical appointment. (c) Associates, who shall be at the time of their application engaged in electrical work, and who shall not be qualified to enter the society under sections (a) or (b). The election of a member shall be by a majority of the committee present."

Mr. Pinching, during the evening, spoke of the facilities offered by the society to meet old comrades, and instanced the presence there that evening of an old friend, Mr. Smith, whom he had not seen for 15 years. It is almost needless to add that members upstanding drank to the toast of Mr. Smith, which was musically honoured with much gusto. The annual general meeting takes place on March 5 next, when Mr. L. M. Waterhouse, the first President of the society, will preside. Mr. J. F. Avila, hon. sec., of 113, Charing Cross-road, W.C., will be pleased to forward particulars to those desirous of joining the society and possessing the necessary qualifications.

SOUTH AFRICAN DEVELOPMENTS.

According to the *British South African Gazette*, orders for a quantity of electrical plant may be anticipated in the near future from the Pigg's Peak Development Co., Ltd.; while orders will shortly be given out for electric generators, cables, etc., by the Wankie (Rhodesia) Coal, Railway and Exploration Co., Ltd., and from the Johannesburg Municipality for the supply of 12,800 yards of cable.

Among the works being carried out, it is mentioned that a 60-ton electric crane is on order with Messrs. Nagel & Kæmp, Hamburg, for installation at the Lourenço Marques wharves; and an order for a 3,000 kw. steam turbo-alternator, including condensing plant, exhaust pipes, switch-gear, and cable connections, has been placed in England for the Johannesburg Municipality.

ELECTRICAL ENGINEERS TERRITORIALS (London Division).—Orders for week ending February 19: Monday, February 14, "A" Company, Recruits' Infantry Drill, 6 to 7 p.m.: Technical Drill, 7 to 9.30 p.m.; Tuesday, February 15, "B" Company, Technical Drill, 7 to 9.30 p.m.; Wednesday, February 16, Gymnasium, 6.30 to 9.30 p.m.; Thursday, February 17, "C" Company, Technical Drill, 7 to 9.30 p.m.; Friday, February 18, "D" Company, Recruits' Infantry Drill, 6 to 7 p.m.: Technical Drill, 7 to 8.45 p.m.: Infantry Drill, 8.45 to 9.45 p.m.; Saturday, February 19, "A" Company, Week-end Run at Coalhouse Fort: Parade at Fenchurch-street Station, 3.15 p.m.—dress as usual. (Signed) P. H. Campbell, Capt. R.E., Adjutant.

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Business Notes and News.

LIGHTING AND GENERAL—Home.

BARKING.—It is proposed to call in a consulting electrical engineer to overhaul the Urban District Council's electricity works.

BOGNOR.—The Chichester Electric Light Co., Ltd., will apply to the Board of Trade for a Provisional Order for the electric lighting of Bognor. If this is obtained, it is proposed to form a separate company to work the Order.

BRIDLINGTON.—The Town Council are about to spend £2,699 on new electrical machinery in order to cope with the increasing demand for current.

COLCHESTER.—A new dynamo has been purchased from Messrs. Crompton & Co., at a cost of £360, to replace one that had been damaged.

DARLINGTON.—Great satisfaction is expressed with the running of the new exhaust steam turbine and dynamo, which have been added to the Corporation's Electricity Works. The turbine has a capacity of 800 b.h.p., and the dynamo of 550 kw. The turbine is only 8 ft. long by 4 ft. wide by 5 ft. high. It is estimated that the turbine and the engines together are able to generate about 30% more electricity than the engines alone from the same amount of steam.

DUNDEE.—Owing to the increased demands which are being made on the Electricity Department for current since the inauguration of the new high tension system it has been necessary to instal at the Lochee sub-station another rotary converter set, of a 250 kw. capacity. This set, which is being supplied by the British Westinghouse Co., has now arrived, together with relative switchgear supplied by the British Thomson-Houston Co., and will forthwith be put into commission.

EDINBURGH.—Over £2,180 profit on the Electricity Department has been paid over for the relief of the general rates. It has been decided to pay off capital expenditure at the rate of 1-25th each year, instead of 1-30th as heretofore.

GREENOCK.—The Corporation have been requested to submit terms for the supply of electricity to Port Glasgow.

KEIGHLEY.—The Local Government Board have sanctioned the raising of a loan for £21,000 to provide a duplicate plant at the Corporation's electricity works.

LONDON (Stepney).—The Borough Council will apply to the London County Council for loans amounting to £20,000 for extensions at the electricity station, Limehouse.

MIDDLESBROUGH.—The annual report of the Electricity Department shows an increase of £232 in revenue and of £161 in profit.

NEWPORT, MON.—Mr. C. P. Sparks' report on the possibilities of introducing economies in connection with the Electricity Department is under consideration. It is probable that the Llanarth-street Power station will be discontinued for generating purposes and used as a sub-station.

SHILDON.—Some friction has arisen between the Urban District Council and the Electric Light Co., owing to alleged delay in carrying out work and the high price charged for current. It is understood that the company claim that owing to their contract with the Urban Council to keep the refuse destructor going, they find it impossible to lower the tariff to traders and others.

SUNDERLAND.—The Electricity Committee have instructed their Engineer to expedite the work which is necessary in order to supply Sir James Laing & Sons, Ltd., shipbuilders, with electricity for motive power, so that the firm may be able to re-start their yard at an early date.

TEMPLEMORE.—The Urban District Council are applying for a Board of Trade Provisional Order to extend the electricity undertaking.

LIGHTING AND GENERAL—Overseas.

MAAS, HOLLAND.—The Port Authorities are about to erect a large grain warehouse, electrically equipped, at a cost of £58,000.

MADRAS.—The Corporation has entrusted the work of the electric lighting of the city to Messrs. Siemens Brothers.

MEXICO.—The Chapala Hydro-Electric & Irrigation Co. is considering the question of constructing an electric railway about 120 miles long between Guadalajara and Aguascalientes.

WELLINGTON, NEW ZEALAND.—The Government have ratified an agreement with the Waihi Gold Mining Co., whereby the company may utilise the Horohoro water power for electrical generation. The company may take water to the extent of 10,000 h.p. for a term of 42 years, without the option of renewal, on payment of 3s. per h.p. per annum. The Government may take over the installation at any time during the term of the licence at a valuation, and any local body within access of the scheme has the right to be supplied with power by the company. The power will be utilised in connection with the company's mine and works at Waihi and Waikino. The scheme will involve the employing of a great many additional men, but will reduce costs of mining and treatment very considerably below those at present ruling, which are about 17s. per ton. It is estimated that the installation will cost about £150,000.

TRACTION—Home.

DONCASTER.—Col. Boughey and Mr. H. A. Steward, the Light Railway Commissioners, held an inquiry into the application of the Corporation for a Standing Order empowering them to extend their tramway from the terminus at Bentley to the new village at Bentley Colliery. Evidence was given by Mr. F. O. Kirby (borough surveyor) and Mr. E. S. Raynor (tramways manager). The extension will be 4 furlongs 4½ chains in length, and will cost £5,050, in addition to £2,550 for new tramcars. The colliery company have agreed to contribute £100 a year for two years towards the cost, besides throwing open a private road along which the extended line will run to the village.

LONDON: PADDINGTON.—The Borough Council have decided to oppose the project of the London County Council to construct an electric tramway extension from Cricklewood to the Marble Arch, which would necessitate heavy expenditure on street widening. Preference was expressed for tube electric railways along the proposed route.

TRACTION—Overseas.

BOZEN (Austria).—Projects are being discussed for the construction of a muncipal electric tramway from Bozen to St. Jakob, and of another from Pola to Dignano. It is expected that the first-named tramway will be begun in the autumn of 1910.

KLAGENFURT (Austria).—The communal authorities have raised a large loan, £62,500 of which is to be expended in the construction of an electric tramway.

ROSARIO, ARGENTINE.—The Rosario Electric Tramway Co. has laid 140 kilos. of line in the town. In its central power-house there exist 4 engines of 1,000 h.p. each, and the coal burnt in the past twelve months reached the respectable total of 15,000 tons. From January to November 19,500,000 passengers were carried by the trams. The company has in use actually 160 cars and 40 trailers and a personnel of 1,322 men; the assets being estimated at 30,000,000 francs. A project, pending now for some time, will be put through this year, the opening up of No. 12 route which will run along the Avenida Belgrano as far as the outskirts of the Saladillo.

SANTA FÉ, ARGENTINE.—It appears that some hitch arose over the concession proposed to be granted to Messrs. Colson, Brookhouse & Pyne for the construction of electric tramways, and the concession has been vetoed by the Mayor.

CONTRACTS OPEN.

Home.

BECKENHAM.—Urban District Council.—Annual supplies of electrical house cut-outs and service boxes. Particular, Clerk. Feb. 21.

BLACKBURN.—Borough Council.—General stores and other supplies. Feb. 16.

EDINBURGH.—City Council invite tenders for the electric lighting of buildings at the new Slaughter Houses, Gorgie. Particulars (one guinea) from the engineer's office, Dewar-place, Edinburgh. Feb. 14.

GLASGOW.—Corporation Sewage Department invite tenders for the supply and erection of three electric motors, shafting, gearing, belting, etc., for equipment of a workshop at Shieldhall Outfall Works. Specifications and tender forms (one guinea) from the Public Works Office, Cochrane-street, Glasgow. Particulars from Mr. W. D. Hamilton, consulting engineer, 59, Bath-street, Glasgow. Feb. 16.

GRIMSBY.—Corporation.—80 flame arc lamps. Spec., £1 1s., Borough Electrical Engineer. Feb. 19.

HAMMERSMITH.—Borough Council.—Annual supply of electrical stores. Part., Borough Electrical Engineer, 85, Fulham Palace-road. Feb. 16.

HAMMERSMITH—Borough Electricity Department.—Annual supplies. Feb. 16.

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HORNSEY.—(1) Meters, (2) cables, etc. Part., 10s. 6d., Borough Electrical Engineer, Tottenham-lane. Feb. 19.

ILFORD.—Urban District Council.—Annual supplies for Electricity Department. Part., Council's Electrical Engineer, Ley-street, Feb. 22.

LEEDS.—City Tramways.—Annual supplies of materials, etc.; sale of scrap, etc. Part., General Manager, City-square. Feb. 21.

LONDON.—The County Council invite tenders for wiring and fittings for the electric lighting of three schools. For particulars see page ix.

LONDON, S.W.—India Office. — Electric cranes. Part., Director-General of Stores, Whitehall, S.W. Feb. 15.

MANCHESTER.—Corporation Tramways.—Permanent way points, tongues, and hardened steel centres. Spec., £1 1s., General Manager, 55, Piccadilly. Feb. 15.

PORTSMOUTH.—Corporation Tramways.—Annual supplies of overhead line materials, castings, car repair stores, electrical and insulating materials, and general stores. Spec., Engineer, Fratton-grove. Feb. 14.

ROCHDALE.—Corporation Tramways Committee.—Construction of four miles of permanent way of Whitworth tramways. Spec., £1 1s., Engineer, Mellor-street. Feb. 19.

SALFORD.—Corporation Tramways Department.—Car accessories, overhead material, etc. Feb. 14.

ST. MARYLEBONE.—Borough Council.—Annual supply of underground cables, installation accessories, and other material for Electricity Department. Feb. 16.

WALTHAMSTOW.—Urban District Council.—Annual supply of cables and other stores for the Electricity Department. Part., Electrical Engineer, Priory-avenue. Feb. 25.

Overseas.

BRISBANE, QUEENSLAND.—Tenders will be received at the offices of the Deputy Postmaster-General, Brisbane, up to noon on March 30, for the supply and delivery, at the Post and Telegraph Stores, Brisbane, of a dust extractor, electrically driven. Local representation is necessary. Preliminary deposits may be paid at the Australian Commonwealth Offices in London, 72, Victoria-street, S.W. Copies of the specification and conditions of tender may be seen by British makers on application at the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, London, E.C.

BRUSSELS.—St. Gilles Hospices.—Accumulator battery. Part., 1s. 8d., 25, Rue du Fort. Feb. 18.

CADIZ.—The Spanish Government invite tenders for a 60 years' concession for the construction and working of an electric tramway from the Cadiz—San Fernando y Carraca tramway to the district of San Severiano, Cadiz. Tenders will be opened at the "Dirección General de Obras Públicas, Ministerio de Fomento," Madrid, at noon on March 30. The competition will turn on the percentage reduction offered on the upset price. A deposit of 1,550 pesetas (about £56) will be required with each tender, to be increased by the successful tenderer to 7,750 pesetas (about £280), which is 5 per cent. of the estimated cost of construction. The conditions of contract, etc., may be seen at the above-mentioned "Dirección. The "Sociedad Anónima Tranvía de Cadiz á San Fernando y Carraca" has certain preferential rights in this competition. Local representation is necessary.

CHRISTIANIA.—The Norwegian State Railway Authorities invite tenders for the supply of (1) Various kinds of telegraph material (including iron wire of different dimensions, insulators, copper wire, copper cable, zinc rods, etc.); tenders, marked "Anbud paa telegraf-material," will be received at "Styrelsens Expeditionskontor," Christiania, up to 3 p.m. on February 18. (2) Firebars; tenders, marked "Anbud paa leverance av ristejern," will be received at "Maskiningeniörens Kontor," Hamar, up to 11 a.m. on February 10. Copies of the specifications and conditions (in Norwegian), together with drawings in the case of (1), may be seen by British firms interested on application at the Commercial Intelligence Branch of the Board of Trade, 73 Basinghall-street, London, E.C. The Board of Trade state that in all Norwegian Government contracts a preference of from 10 to 15 per cent. (apart from Customs duties) is given to Norwegian manufacturers, and that it is obligatory that a resident agent (not necessarily a Norwegian firm) should act for tenders not residing in Norway.

TENDERS ACCEPTED—Home.

COLCHESTER.—The Town Council have accepted the tender of Messrs. Henley for supply of cable at a cost of £199.

LONDON COUNTY COUNCIL.—For the installation of electric lighting and bells at Poplar Divisional Offices, Tredegar-road, Bow: E. Newbald & Co., Court-road, Sutton, £133 (accepted); Sweet Bros., 100-2, Hampstead-road, £134; Johnson & Phillips, Ltd., £136; G. Weston & Sons, £143; Tilley Bros., £148 10s.; Stegman & Co., £152 14s. 6d.; British Westinghouse Electric & Manufacturing Co., Ltd., £198 13s. 8d.

TENDERS ACCEPTED—Overseas.

BOMBAY.—The Government have accepted the tender of Messrs. Greaves, Cotton & Co., for the electric installation at Ganeshkhind, Kirkee, amounting to about rupees one lakh. The generating station will contain three Gardner high-speed oil engines direct-coupled to 16 kw. compound dynamos, a large battery and switchboard. The same firm have also received the order for the electric lighting of the Camaand Allbless hospitals

FINANCIAL NOTE.

The transfer books and register of members of the South Metropolitan Electric Light & Power Co., Ltd., will be closed from February 15 to 28, 1910 (both days inclusive) for the preparation of dividend warrants payable the 28th inst.

PERSONAL.

Sir Clifton Robinson is succeeded in the Managing Directorship of the London United Tramways, Ltd., by Mr. Albert Stanley, of the Underground Railways. Sir Clifton, who has accepted the presidentship of the Metropolitan Association of Electric Tramways Managers, is about to start on a business trip to the Philippines on behalf of his company.

Mr. T. D. Clothier, electrical engineer to the Bootle Town Council, has been awarded an honorarium of £50 in viewofthe satisfactory condition of the undertaking, and of the fact that additional responsibility was about to devolve upon him in connection with the proposed alteration and additions to the machinery at the electric light station.

At a Board meeting of the National Electric Construction Co., Ltd., Dr. G. T. Moody was elected a director in place of Mr. W. Herbert Fowler, resigned.

CATALOGUES AND PRICE LISTS.

A collection of leaflets, illustrated, from Mr. F. J. Down, M.I.E.E., includes those on Gear Shields (over 115 of these are now used by electric tramways and railways); Portable Hac ksaw for cutting rails, girders, metal pipes, etc.; Guy Anchors for telegraph, telephone and other poles; Car Clutch levers and car ramp (for replacing on the track derailed electric tramcars); and Electric Jointing Materials.

A catalogue of Advertising Signs and Flashers from the Sun Electrical Co., Ltd., is doubly useful: for its information and its suggestiveness. A great variety of new designs are shown, including the effective kaleidoscopic changing colour signs, suitable for all purposes. A section is devoted to the patent "Thermo-Blink" motorless flashers, motor-driven flashers, and time switches.

A handsome book, copiously illustrated, on Telephone and Signalling Apparatus comes from the Adnil Electric Co., Ltd. It is a very full description of a large variety of appliances, many of which would come into more general use if they were better known among the classes of persons requiring them. It is a book for dealers to have on their tables. The title page, with the manufacturers' name, is perforated, and can be removed. The same firm's leaflet Section D, deals with plugs, wall sockets, branch blocks and ceiling roses.

Messrs. Balke & Co., Ltd., send us a catalogue of their centrifugal pumps with diagrams, tables of dimensions, capacities and prices. Also a reference list of their water cooling towers, largely used at electricity works and collieries. Price List 6e, of Messrs. Siemens Bros. Dynamo Works, Ltd., deals with their new "Zed" cartridge fuses, distribution boards, fuse and switch boxes.

Pamphlet No. 523, Messrs. Siemens Bros. & Co., Ltd., is concerned with "Direct Motor Driving of Automatic Telegraph Apparatus."

The Electric & Ordnance Accessories Co., Ltd., have issued an effectively illustrated circular of their "Victor" arc lamps for D.C. circuits, and shown in a great variety of patterns.

Messrs. Jesson, Birkett & Co., Ltd, have brought out a new catalogue and leaflet dealing with their latest designs in electric light fittings. Circular No. 30 contains illustrations of incandescent electric light fittings of an attractive design, while the small catalogue shows some of

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their newest designs in cast metal. We would draw our readers' attention to the little booklet containing a few remarks as to the selection of fittings, which should be of some guide to electrical engineers and contractors.

PUBLICATIONS.

The Post Office Electrical Engineers' Journal. January quarter.

The chief item in this issue is an exceedingly valuable monograph by Mr. J. W. Turner, A.I.E.E., on the Glasgow Telephone Service, with special reference to the new Post Office Common Battery Exchange, which provides for 10,000 lines. The article covers 54 pages, contains 48 diagrams and illustrations, besides a number of full-page photographic reproductions and 12 folding plates, chiefly dealing with the system of wiring. Other items include the second part of Mr. J. E. Taylor's article on "The Early History of Wireless Telegraphy," a description of the Forth Bridge cable by Mr. A. J. Stubbs, practical notes on a portable petrol-driven winch, undulators, and magnetic storms. It is a very good number.

Transactions of the South African Institute of Electrical Engineers.

Part I. of the official organ of this society, which, as we announced at the time, was founded in June and incorporated in December of last year, contains a list of officers, the Constitution and Rules, a list of foundation members (117 of different grades, but the membership now stands at over 150), and a brief report of the proceedings of the first general meeting. In future the transactions will be published monthly, and will contain abstracts of technical publications.

The January issue of *Installation News* contains several interesting items, the most notable being an article on "Some Causes of Breakdowns."

DIARY.

SATURDAY, FEBRUARY 12.

ROYAL INSTITUTION OF GREAT BRITAIN.—At 3 p.m., "Electric Waves and the Electromagnetic Theory of Light" (Lecture I.), by Sir J. J. Thomson, F.R.S.

NORTHAMPTON INSTITUTE ENGINEERING SOCIETY.—Visit to Lot's-road Power Station.

MONDAY, FEBRUARY 14.

INSTITUTION OF MECHANICAL ENGINEERS.—"Petrol Motors," by Mr. F. Leigh Martineau.

TUESDAY, FEBRUARY 15.

ELECTRO-HARMONIC SOCIETY.—Concert (Ladies' Night) at 8 p.m., at the King's Hall, Holborn Restaurant.

ILLUMINATING ENGINEERING SOCIETY.—At the Royal Society of Arts, Adelphi, at 8 p.m., discussion on "Glare: Its Causes and Effects," to be opened by Dr. J. Herbert Parsons.

INSTITUTION OF ELECTRICAL ENGINEERS (Manchester Section: Students').—At 7 p.m., "Gas *v.* Electricity for Industrial and Domestic Power and Heating Purposes," a discussion between members of the Institute and members of the Manchester and District Junior Gas Association.

WEDNESDAY, FEBRUARY 16.

INSTITUTION OF ELECTRICAL ENGINEERS (Students' Section). At 7.45 p.m., at 92, Victoria-street, paper by H. W. Gregory: "Alternating *versus* D.C. Supply from Sub-stations."

THURSDAY, FEBRUARY 17.

ROYAL INSTITUTION OF GREAT BRITAIN.—At 3 p.m., "Illumination: Natural and Artificial" (experimentally illustrated), Lecture I., by Prof. Silvanus P. Thompson.

INSTITUTION OF ELECTRICAL ENGINEERS.—At 8 p.m., at The Institution of Civil Engineers, Great George-street, Westminster, S.W., "Electric Clocks," by Mr. F. Hope-Jones.

FRIDAY, FEBRUARY 18.

NORTHAMPTON INSTITUTE ENGINEERING SOCIETY.—At the Northampton Institute, Clerkenwell, "Hydraulic Presses," by Mr. H. Webb.

NORTHAMPTON INSTITUTE ENGINEERING SOCIETY.—At 5.45 p.m., "Hydraulic Presses," by Mr. H. Webb.

LIGHT RAILWAYS ORDERS.

The Board of Trade have recently confirmed the undermentioned Order made by the Light Railway Commissioners: Clayton West and Darton Light Railway (Extension of time and Amendment) Order, 1910, reviving the powers granted by the Clayton West and Darton Light Railway Order, 1906, for the compulsory purchase of lands and extending the periods limited by that Order for the same and for the completion of the railway and works thereby authorised and for other purposes.

PATENTS.

Thermo Electric Pyrometer.

370.—1909. W. S. PEAKE, Cambridge. Two connecting leads are employed composed of metals or alloys dissimilar both to each other and to the metals forming the couple. The leads act as a compensator for the variations of temperature at their junction with the thermo couple.

Electric Tumbler Switches.

3130.—1909. J. B. BELCHER, Stafford. A metal strip, screw or stud is connected to the part of a tumbler switch not intended to carry the electrical current. This connection being in electrical contact with the earth makes a continuous metallic circuit between the part of the switch not intended to carry current and the earth. In the diagram a link A is connected to the parts B, which are not intended to carry the electrical current and the fixing hole C. The fixing screw D makes close electrical contact with the link A and earth E. A continuous metallic circuit is thus made between the part of the switch not intended to carry current

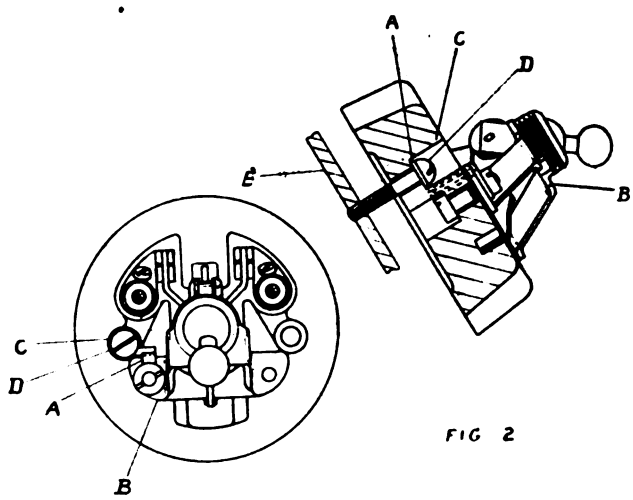

FIG 2

FIG. 1

and the earth. Any leakage currents to, or induced currents in, or any static charge in any of the parts of the switch not intended to carry current, will be led to earth by way of the link A. Should any electrical leakage occur between the current carrying parts of the switch and its part not intended to carry the electrical current, or should any electrical currents be induced in these parts, or should there be any static charge in these parts it will pass direct to earth by way of the earth connection and will not in any way injure the operator of the switch or any person coming in contact with it.

Incandescent Metal Filament Lamps.

142.—1909. H. HIRST, London. The current conducting joint between the filaments and leading in wires of the glow lamps consists of a solder composed of phosphides of copper, manganese, nickel, cobalt, chromium, molybdenum, tungsten gold and platinum. These finely divided phosphides are made into a paste with a volatile binding material and applied to the junction of the filament and leading in wire.

Electric Motor Controllers.

551.—1909. BRITISH THOMSON-HOUSTON CO., London. The object is to provide means whereby an alternating current motor of the induction type can be started and brought up to running speed in a safe and efficient manner. In connection with automatic means for cutting the resistance out of the secondary, means are also provided whereby the resistance may be automatically reinserted in the secondary circuit upon the opening of the primary circuit. The primary circuit may not be closed until the resistance is inserted in the secondary circuit.

Refractory Electric Conductors.

282.—1909. W. D. COOLIDGE, Schenectady. A mixture of refractory non-ductile material is shaped with a plastic metallic binder and subjected to the action of heat and a strong blast of inert gas in order to remove one or more components of the metal binder. The conductors are then raised to a high temperature, so as to shrink and sinter them to a state of stable conductivity.

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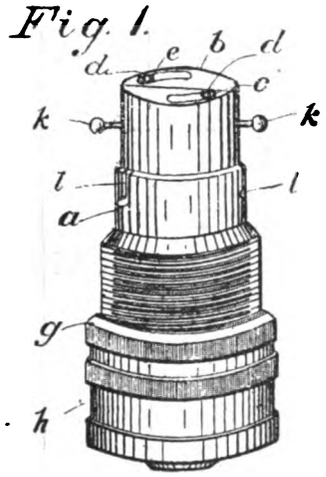
Electric Coupling.

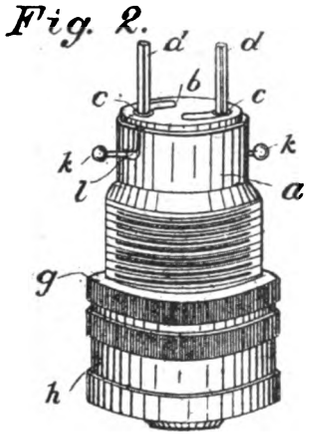
194.—1909. J. H. DRYSDALE, London. This is a combined bayonet joint coupling and wall plug constructed to connect a lead to either a wall socket or a lamp holder with equal facility. The device is simple, cheap and effective, and in use the one fitting by a slight and easy adjustment serves for either purpose as desired. Fig. 1 is an elevation in slight perspective of the device already for use as a lamp plug. Fig. 2 is a similar view showing it as applicable to fit a wall socket. Fig. 3 is a detail showing the contact pins which are made use of when the device acts as a wall plug. An

Fig. 1.



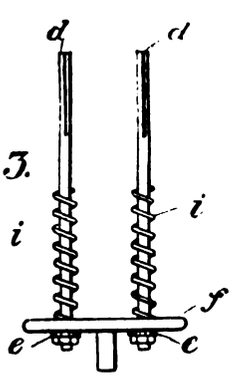
ordinary bayonet lamp holder *a* has an insulating sleeve *b* capable of freely rotating and moving, and is bored with holes *c* through which pass two pins *d d* froming the contacts when used as a wall plug. The opposite ends of these pins *d* pass through and are attached by back nits *e* to an insulating plate *f*, which fits in an enlargement *g* of the holder *a* but is free to rotate. Over this enlargement *g* is fixed a cap *h* of porcelain through the centre of which pass the

Fig. 2.



flexible wires connecting the terminals on the pins *d*. These pins bear against the inside of the insulating cap *h* but are free to move over the surface of it. Around the pins *d* and between the insulating sleeve *b* and the insulating plate *f* are arranged the spiral springs *i*. At the side of the insulating sleeve *b* the pins *k* are fitted which engage in the usual slots *l* of the bayonet holder *a*. When the device is used to connect a wall socket the insulating sleeve piece *b* is pressed into the

Fig. 3.



holder *a* until its surface is flush with the edge of the holder *a*, then the sleeve piece is given a slight turn so that the pins *k* lock into the slots *l* of the holder *a*. In this position, as in Fig. 2, the contact pins *d* project beyond the face of the plug sufficiently to form contact with an ordinary wall socket. When desired to convert the fitting into a bayonet joint coupling as in Fig. 1, the sleeve piece *b* is released from the locking slot *l* in the holder *a* by a slight movement to the left as in removing a lamp from a holder, when the sleeve piece is forced outwardly by the spiral springs *i* until its face is flush with the ends of the pins *d*, and the device can then be used to form a connection with an ordinary bayonet lamp holder. The locking pins *k* on the sleeve piece are then free to engage in the bayonet slots of the holder.

Metallic Fittings for Electric Continuity Systems.

14582.—1909. G. CLARKSON, Brondesbury Park. The fittings have a hole 1¼ inches in diameter counter sunk on the inside. The conduits have a hole about ⅛ in. in diameter. When the joint is fitted over the conduit the holes are made to come opposite each other. A leaded plug is fitted into the holes and the joint is thereby rendered strong and perfect as regards electrical continuity.

Electrical Switches.

18012.—1909. C. ZEE, Westminster. This is an improvement in switches of the type in which the contact maker is held in position against the terminals until a sufficient tension is put upon the operating spring to make a quick break. The invention provides in combination with the operating handle and spring a pair of sectors divided by a gap. The sectors are adapted to engage a member projecting from the contact maker and to hold the contact maker in or out of position until a sufficient tension has been put upon the operating spring to make a quick break or a quick make. Should the operating spring fail the contact bar can be positively moved from its off position to its in position or *vice versa*.

Electrolytic Apparatus with Liquid Electrode.

14288.—1909. SCHOTT & GEN., Jena. The apparatus comprises an upper vessel which contains a liquid anode and a lower vessel which contains the cathode. Both vessels communicate with each other and are filled with the electrolyte. A wall separates the anode liquid from the cathode vessel. A solid body rests within the anode vessel so as to restrain agitation of the anode caused by shocks to the apparatus. The specific gravity of the solid body is such that it floats between the anode and the electrolyte and prevents the anode liquid from being thrown over the wall and passing into the cathode vessel, without having been subject to electrolysis.

Electrically Actuated Air Pump.

12364.—1908. F. ROBERTS, Hunstanton. The object is to provide electrically actuated air pumps of the diaphragm type which shall be self contained so far as the motor and pump are concerned, compact and portable, and in which the stroke and speed of the diaphragm can be readily varied at the will of the operator. The diaphragm can be operated in both directions by electro-magnets. A variable make and break device is provided whereby the length of stroke and speed of the diaphragm may be varied.

Electrically Operated Railway Points and Signals.

21398.—1908. C. H. W. EDMONDS, Worcester. The object is to dispense with fuses and friction clutches, and to employ in their place an automatic circuit breaker and maker of improved construction located in the circuit of the operating motor.

Electric Light Signs.

25882.—1908. H. J. PALMER, West Hartlepool. The reflector consists of a zinc sheet covered with aluminium leaf stamped to a prismatic pattern. This is claimed to greatly improve the reflective power of the surface to be displayed so that a good effect can be obtained from one light.

Electric Organ.

91.—1909. F. J. THOMAS, Chertsey. A double pole electromagnet is fixed in a wind chest which actuates an armature of such shape that it is long enough to be fixed to a small pallet and made to an angle which causes it to move in front of the poles of the magnet and also to keep the pallet closed by its own gravitation when in its normal position, the pallet being hinged at the top or armature end. On the armature being drawn up to the poles of the magnet, the tail end of the pallet is lifted from the pipe supply ducts, allowing the wind to pass to the pipes; on the armature being released the pallet returns by gravitation owing to the angle in which the armature is fixed.

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TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns per week.			Increase or decrease.		Mil track	of open.	Accounts for past year.							Cost per car mile.
	Ending	1909-10.	1908-9.	Week.	Current year.	1909.	1908.	Ending	Total receipts.	Passengers carried.	Car miles run.	Receipts per Passenger.	Car mile.	Mile of track.	
		£	£	£	£				£						
Aberdeen Corporation	Feb. 2	1,128	1,163	— 35	— 910	27½	27½	May 31	71,930	17,517,304	1,566,119	·98	11·02	4,940	5·93
Ayr Corporation	Sept. 18	671	562	+ 108	—	8	8	—	—	—	—	—	—	—	—
Baker Street and Waterloo Ry.	Nov.	8,141	6,070	+2,071	—	4·25	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	Jan. 30	913	925	— 12	— 13	24·003	13·52	—	—	—	—	—	—	—	—
Birmingham Corporation	Jan. 29	6,386	6,026	+ 360	—	56·792	58·52	—	—	—	—	—	—	—	—
Blackburn Corporation	Oct. 6	1,100	1,293	— 173	—1,036	24·53	28·3	—	—	—	—	—	—	—	—
Blackpool Corporation	Aug. 26	2,152	2,050	+ 102	+ 732	—	—	—	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams	„ 8	2,304	2,309	— 24	—	—	—	—	—	—	—	—	—	—	—
Bolton Corporation	Oct. 10	2,416	2,337	+ 79	— 259	42	42	Mar. 31	117,799	25,492,902	2,492,147	1·1	11·34	2,804	6·50
Bournemouth Corporation	July 21	1,681	1,723	— 42	— 23	29¼	29¼	„ 31	86,225	13,991,328	1,766,068	1·47	11·71	2,912	7·22
Bradford Corporation	Jan. 22	4,510	4,309	+ 201	+ 7,812	98	54·81	„ 31	235,258	47,839,569	5,331,007	1·17	10·59	2,378	—
Brighton Corporation	Feb. 6	707	693	+ 14	+ 2,056	9·5	—	—	—	—	—	—	—	—	—
Bristol Tramway Company	Feb. 4	5,157	4,649	+ 508	—	57	51½	Dec. 31	265,362	46,652,389	5,756,842	—	—	—	—
Burnley Corporation	Feb. 5	1,101	1,148	— 47	—	19½	19½	Mar. 31	64,261	12,355,958	1,202,330	1·23	12·83	5,971	7·92
Burton Corporation	Feb. 6	252	233	+ 19	— 124	6½	6½	„ 31	14,918	3,221,595	430,913	1·04	8·30	1,460	5·85
Cardiff Corporation	April 3	2,000	1,957	+ 43	—	—	—	„ 31	109,979	25,058,146	2,497,169	—	10·57	—	—
Carlisle Tramways Company	June 19	170	175	— 5	— 89	—	—	—	—	—	—	—	—	—	—
Central London Railway	Feb. 5	5,535	5,516	+ 19	— 619	6·32	5·77	Dec. 31	350,150	41,898,373	1,456,781	2·01	5·769	55,404	30·27a
Charing X, Euston, & Hamp. Ry.	Nov.	6,822	6,092	+ 730	—	7·75	—	—	—	—	—	—	—	—	—
City and South London Railway	Feb. 6	3,343	3,337	+ 6	— 397	7·26	7·26	—	—	—	—	—	—	—	—
Colchester Corporation	July 14	200	219	— 39	—	8	—	Mar. 31	10,983	2,308,721	349,539	1·09	7·74	1,477	6·56
Cork E. T. and L. Company	Feb. 3	402	420	— 18	— 22	9·89	9·89	Dec. 31	24,044	5,737,478	896,945	—	6·43	—	4·43
Croydon Corporation	Jan. 21	1,589	1,237	+ 352	+ 7,192	11½	—	Mar. 31	74,132	16,277,418	1,884,137	1·06	9·56	3,703	7·109
Darwen Corporation	Oct. 1	239	256	— 17	— 201	7·23	7·23	„ 31	13,899	2,557,654	245,584	1·30	13·68	1,922	9·40
Dover Corporation	Sept. 18	230	252	— 22	— 395	7	—	„ 31	11,593	2,697,672	316,754	·98	8·78	—	—
Dublin and Lucan Electric Ry.	Feb. 4	86	112	— 26	— 69	7	7	—	—	—	—	—	—	—	—
Dublin U.T.	Feb. 4	4,879	4,844	+ 34	+ 280	54½	54½	—	—	—	—	—	—	—	—
Dundee City Tramways	Oct. 6	1,332	1,305	— 27	— 569	—	26½	May 15	60,573	16,367,911	1,281,552	·875	1·9	2,371	7·46
East Ham Corporation	Feb. 5	892	864	+ 28	+ 5,115	15	15	Mar. 31	47,430	15,355,703	1,091,586	·73	10·26	—	6·96
Glasgow Corporation	Jan. 29	15,075	16,262	—1,187	— 7,880	189	181	May 31	907,494	226,948,290	20,766,722	·96	10·49	5,060	5·89
Gloucester Corporation	Oct. 6	395	425	— 30	+ 535	15	—	—	—	—	—	—	—	—	—
G.N., Piccadilly and Brompton	Nov.	13,429	9,354	+4,075	—	9·25	—	—	—	—	—	—	—	—	—
Halifax Corporation	—	—	—	—	—	52·574	37	Mar. 31	81,872	20,378,672	1,786,390	11·40	11·13	1,528	8·46
Huddersfield Corporation	Dec. 4	1,613	1,357	+ 256	+ 2,663	28	28½	„ 31	84,704	16,200,020	1,960,329	1·29	10·37	2,421	5·10
Hull Corporation	Feb. 5	2,672	2,485	+ 187	+ 5,747	26	26	„ 31	128,722	30,964,254	3,022,844	1·	10·22	—	6·04
Ilford Corporation	Jan. 29	444	360	+ 84	+ 1,875	10	10½	„ 31	25,328	6,385,466	634,446	·87	9·58	2,066	6·42
Ilkeston Corporation	Feb. 2	115	114	+ 1	— 242	4	4	„ 31	7,214	1,968,850	198,415	9·1	7·9	1,803	7·04
Kirkcaldy Corporation	Sept. 8	269	266	— 7	—	7½	7½	May 15	14,993	4,874,199	459,066	·711	7·838	1,856	6·26
Lancashire United Tramways	Feb. 2	1,058	1,103	— 145	— 25	39	39	Dec. 31	68,904	12,554,593	2,244,344	—	—	—	—
Leeds Corporation	Sept. 18	6,896	6,624	+ 272	+ 3,662	108	96½	Mar. 31	340,368	75,734,083	7,694,989	1·06	10·62	3,527	5·31
Leicester Corporation	Sept. 11	2,162	2,130	+ 32	—	—	—	—	—	—	—	—	—	—	—
Liverpool Corporation	Nov. 6	10,803	10,687	+ 116	—1,977	109	104	Dec. 31	572,822	124,043,239	12,231,799	1·108	11·24	5,508	7·94
Liverpool Overhead Railway	Jan. 30	1,223	1,315	— 92	— 250	6·65	2·40	June 30	79,004	11,171,515	1,106,386	—	—	—	—
London County Council	Jan. 22	37,855	33,145	+4,710	+99,071	129½	191½	Mar. 31	1,274,660	279 166,461	25,591,028	1·08	11·74	—	6·79
Lowestoft Corporation	Dec. 11	155	150	+ 5	+ 30	3½	—	Sept. 30	11,399	2,645,206	370,320	1·03	7·36	2,279	6·12
Maidstone Corporation	Jan. 29	115	118	— 3	— 335	7·4	—	—	—	—	—	—	—	—	—
Manchester Corporation	Sept. 11	15,631	15,297	+ 334	— 2,871	183	181	—	—	—	—	—	—	—	—
Metropolitan District Railway	Jan. 29	10,470	9,822	+ 648	+3 320	24	24	—	—	—	—	—	—	—	—
Metropolitan Railway	Jan. 30	16,523	16,011	+ 512	+ 2,163	24½	24½	June 30	680,357	99,846,735	—	1·46	—	—	—
Nelson Corporation	Oct. 16	151	131	+ 20	+ 7	2½	2½	Mar. 31	7,362	2,060,712	204,710	·85	8·63	1,907	—
Newcastle-on-Tyne Corporation	Jan. 29	3,403	3,742	— 339	—1,465	60½	59½	„ 31	211,085	46,203,164	4,411,745	1·10	11·48	3,504	6·36
Newport (Mon.) Corporation	Oct. 9	663	638	+ 25	— 311	14½	14½	„ 31	35,531	8,174,003	798,029	1·04	9·89	2,450	7·21
Oldham Corporation	Jan. 24	1,778	1,516	+ 262	— 386	—	—	—	—	—	—	—	—	—	—
Portsmouth Corporation	Oct. 10	2,046	1,809	+ 237	—	28½	28½	Mar. 31	97,741	21,247,048	2,309,439	1·10	10·15	—	—
Reading Corporation	Feb. 3	525	527	— 2	— 23	13½	13½	„ 31	32,769	7,933,572	915,481	—	8·93	—	6·45
Rochdale Corporation	Dec. 26	1,240	1,126	+ 114	+ 746	20·9	20·93	„ 31	56,558	10,196,148	1,252,925	1·32	10·83	2,693	6·47
Rotherham Corporation	Feb. 4	555	587	— 32	—	—	—	—	—	—	—	—	—	—	—
Salford Corporation	Sept. 27	4,696	4,662	— 66	— 3,326	78	74½	Mar. 31	244,065	45,771,611	5,486,150	1·25	10·67	3,135	—
Scarborough Tramways Co.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Sheffield Corporation	Jan. 30	5,240	5 133	+ 106	+4,980	39½	37	Mar. 25	289,745	17,568,686	7,065,380	·896	9·842	4,225	5·04
Southampton Corporation	Jan. 26	923	852	+ 70	+ 24	18	18	„ 25	52,647	10,121,887	1,157,451	1·25	11·33	—	7·30
Southend-on-Sea Corporation	Aug 21	995	557	+ 438	+ 1,483	—	—	—	—	—	—	—	—	—	—
Stockport Corporation	—	—	—	—	—	25	25	Mar. 31	52,004	9,155,172	1,335,911	1·34	9·342	1,880	4·75
Sunderland Corporation	Jan. 27	1,310	1,336	— 26	— 7,984	—	—	—	—	—	—	—	—	—	—
Swindon Corporation	Dec. 11	126	114	+ 12	—	—	—	—	—	—	—	—	—	—	—
Torquay Tramways	Aug. 26	630	647	— 30	—	8·41	—	Dec. 31	15,065	2,880,420	353,297	1·40	1·023	—	—
Wallasey U.D.C.	Feb. 5	757	802	— 44	+ 794	12·68	12·45	Mar. 31	43,823	8,331,038	891,540	1·2	11·79	3,453	7·72
Warrington Corporation	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
West Ham Corporation	Jan. 27	2,095	1,810	+ 284	+ 6,679	27	14·7	Mar. 31	122,881	35,502,836	2,556,854	·789	10·95	4,417	6·79
Wolverhampton Corporation	Nov. 3	841	823	+ 18	— 206	21¾	—	„ 31	44,432	9,440,369	975,714	—	10·929	2,190	6·509

a Train Miles. *h* Half-year's figures.

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THE
Electrical Engineer.
An Illustrated Record and Review of Electrical Progress.
WITH WHICH IS INCORPORATED "ELECTRIC LIGHT."

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NOTES.

ELECTRIC LIGHT PRECAUTIONS.

The alarm caused by the very slight fire at Hertford House—attributed, as usual, to "fusing of the electric wires," endangering the precious Wallace collection—has given a fresh impetus to the discussion as to precautions necessary where electric lighting is adopted. Mr. W. R. Walton, A.M.I.E.E., writing from his varied experience in the North, in investigating electrical fires and reporting on safety of equipments in private, business, and public buildings, has contributed an important letter to the discussion. His experience points to the fact, as that of others does, that the risks are generally due to disregard of the most obvious dangers by the users themselves.

FAULTS.

Mr. Walton writes of one warehouse with a fuse-board which had been enclosed in an asbestos-lined frame box, but which, through carelessness, was constantly left uncovered, though loose, inflammable goods were piled upon the floor within a few inches of the unprotected fuses. As he says, a "short" on either of the circuits or on the board itself would have probably led to disaster. Another bad fault that came under his official cognisance was at a theatre, where a switchboard and a main gas meter were placed in close proximity. Here, of course, the mistake lay at the door of those who set up the equipment, for they might well have separated the two by an inexpensive fireproof partition. In the former case, however, protection had been provided, but was deliberately set aside by the users. The same thing is constantly occurring with lamps, where guards are removed by warehousemen, or inflammable articles placed close around the lamps. These difficulties will be overcome in time. When sanitary regulations were first enforced in factories, is was a common thing for the workmen, often with the tacit consent of managers, to disorganise appliances, such as ventilators. But time wore away ignorance, and now aids to sanitation are welcomed. So it will be in connection with safeguards against electrical fire risks. What is necessary at the moment is for extra care to be displayed by those responsible for installations, and rigorous penalising by insurance companies wherever it is found that safeguards have been disregarded. As for Hertford House, the trustees are urging upon His Majesty's Board of Works the necessity of extending the metal casings for lighting wires all over the building.

BUSINESS METHODS.

A rather sad example of bad business methods adopted in some municipal electrical undertakings has cropped up at Gray's. The Urban District Council were applying to the Local Government Board for powers to borrow the modest sum of £900 for extensions and additional fittings. It was the painful duty of the Inspector to point out many mistakes made in conducting the department. He said the Board would sanction the repayment of loans on cables to extend over 20 years, on services 15 years, and on meters 5 years. But, as he said, it would be sounder finance, far more economical, to pay for meters out of revenue. That this could be done was evident, when it is seen that a quite small undertaking such as this was actually contributing sums in relief of rates. Quite wrongly, according to the most elementary business rules, for the undertaking was making no real profit. On the contrary, there was a considerable deficit on capital account, due to the fact that the Council has borrowed £803 to buy a battery, and subsequently sold it for £50. No attempt had been made to wipe out the loan, beyond the payment of the sinking fund and interest contributions, so while they were paying away revenue in relief of the general rates, they were paying interest on non-existing plant. Such mistakes as these ought to be avoided. Happily, they are isolated, and occur but rarely; nevertheless, they give handle to the scoffers to criticise municipal management, to the detriment of progress.

MERCURY LAMP AS STERILISER.

Ever since the mercury vapour lamp was introduced it has attracted a good deal of attention, chiefly, it must be confessed, on account of its suggestiveness rather than in its actual merits. But a genuine discovery has often more far-reaching influence than the original inventor contemplated even in his most dreamy moments. So it has proved with the Kromayer lamp. At a comparatively early date it was noticed that the water envelope used in this lamp presented certain peculiarities; the water was invariably sterilised. This was rightly attributed to the ultra-violet rays, these same rays which in illuminating have been accused of injuring eyesight. Dr. Nogier, of Lyons, made a special study of these phenomena, and, as announced by our Paris correspondent last week, he has succeeded in turning his investigations to practical account, having devised a means whereby drinking water can be completely freed from bacterial growths, either in large volumes for town supplies or in small quantities for domestic use, by employing mercury vapour lamps under special conditions. A description of his methods and appliances has been given at length in the columns of *The Sanitary Record*, from whose columns we borrow a few salient details and two excellent illustrations.

PERFECT STERILISATION.

Our contemporary, after contrasting the ultra-violet rays method of sterilisation of water with that of purification by electrically produced ozone, to the disadvantage of the latter, because ozone sets up far-reaching and difficultly controlled chemical reactions, goes on to say in a leading article: "The sterilisation of drinking water by the mercury vapour lamp now appears to be within the domain of practical hygiene, and the beauty of the process put forward by Dr. Nogier is that it is perfectly automatic in action, and capable of being applied under the most diverse conditions, whether as part of a town's supply organisation or as a matter of domestic routine. It certainly is a most unexpected application of what at first looked like a freak of a scientific man, but which is likely to lead to immense developments. For the mercury vapour lamp not only shows how the ultra-violet rays may be brought to the assistance of hygiene, but points the way to a new era of illumination, when we shall have non-filament vapour globe lamps. When that time comes we shall be better able to imitate the luminosity of the sun's ray, and a great triumph will be achieved in the domain of artificial lighting as well as in water purification."

LUMINOUS VAPOURS.

With reference to the last two sentences, it may be mentioned that Mr. W. Mordey, speaking at the first annual dinner of the Illuminating Engineering Society, referred to the fact that engineers had "a great problem to solve in the terribly poor results in the way of lighting which they were able to achieve, having regard to the

quantity of coal consumed. The society would do much to help to solve that problem. They could not, however, hope to rival the glow-worm in the relation of the light yielded to the energy by which it was produced." Notwithstanding Mr. Mordey's latter remarks, it is along the lines suggested by biochemistry, and the chemistry of luminous vapours, that many are working with fair hopes of success.

ECONOMY AND PROFIT.

Liverpool's Electricity Department has done exceedingly well during last year, and it is easily to be understood that Mr. J. S. Harmood Banner should be agreeably surprised by the nice little lump sum of £20,000 coming from electricity in relief of rates. Because, after all, it is pretty well known that the use of metallic filament lamps have "caught on" to a very large extent, so a falling off in revenue was to be looked for. But it has not been so: the total income was £267,034, of which no less than £160,984 was received from private and business people for electric light. The secret of the thing is the go-a-head policy of the electric department under the able conduct of its consulting resident engineers. First, as regards production, considerable economy has been achieved by spending more money on up-to-date machinery, so that more current is produced cheaply. Then the sensible policy has been adopted of endeavouring to attract customers. While nominally there has been no reduction in rates, in effect there has, for under a new scale private houses of over £20 rental are given a supply at a fixed charge of 3% on the rateable value, plus a penny per unit consumed. For private houses under £20, a service fee of 10s. is charged, and a shilling-in-the-slot meter put in. With these facilities and economies, it is found that the public, while economising per individual lamp, are using more, and so the demand for current increases. No wonder that Mr. Holmes is not in the least dismayed by the prospect that in less than two years metal filament will entirely replace carbon lamps. By the way, the loan liabilities of the department amount to £1,473,840, while the land, buildings, and plant are valued at £2,099,709.

MEASURING SWITCHES IN ACCUMULATOR WORKS.

The following is a hint for the simplification of switching, especially where boosters are used.

In switching together two or more currents, whether for charging batteries or for parallel shunting of collecting bars, it is desirable to avoid sudden changes of current, or, better, to manage so that there is no current at the time of the switching. In every simple two conductor plant with a battery this switching together is effected by bringing the fresh current to the same voltage as that already in action, and then combining like poles together. Hence, generally two or more currents can be combined so as to neutralise each other, if the E.M.F. of each is the same and the poles connected are like. It follows that these E.M.F.'s have to be determined before any attempt is made to switch one current on to the other, and this is easy for two currents but more difficult for three. When we have to deal with three currents the switching operation is not so easy for the attendants unless it has been driven into them by constant practice, which is a very unlikely circumstance. Unskilled handling of the switches in such cases often gives rise to a need for costly repairs.

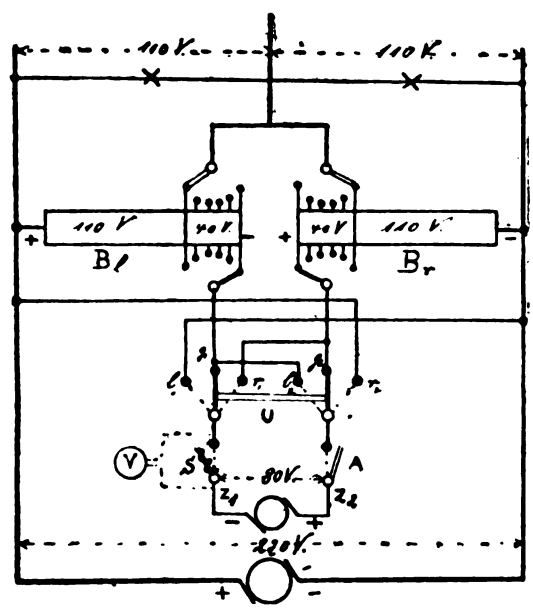
The figure shows a three conductor installation with its voltage divided by a battery in which the heightening of the voltage required for charging accumulators is effected by means of a booster. The latter can also be used for charging half the accumulator separately. This half-charging is done with the main machine and the booster together.

In the Fig. g_1 and g_2 we see the position of the commutator for charging the booster dynamo, a position assumed daily. In r_1 and r_2 on the other hand, we see the position of the commutator for charging the right hand half of the accumulator.

Let us suppose that at first the battery B^r has an E.M.F. of 150 volts. The main machine, which should act continuously on the bars with a constant voltage of 220 volts has, therefore, a voltage exceeding that of the half battery by 70. Now, these E.M.F.'s have to be equalised as above pointed out. Then the booster is called into play to bring the lower voltage up to 220.

It is obvious that for each of the three connections which can be made with the commutator, too, comparative volt measurements are necessary, which require either a voltmeter with a bipolar commutator for four circuits, or if a special voltmeter is allotted to the booster, two such voltmeters and a bipolar commutator for three circuits. In short, we have to measure the E.M.F. between 1 and l_2, r_1 and r_2, g_1 and g_2, and Z_1 and Z_2.

Such an arrangement is rather costly and must be rather complicated, but it can be greatly simplified and cheapened by inserting a voltmeter to the automatic contact breaker S. Once this is done, it serves for all the three possible switchings. If, for example, the switch A is closed, the voltmeter brings the E.M.F.'s in opposition to each other. If they are



not equal a current flows according to their difference, and the resistance of the voltmeter, and is indicated by the pointer of the instrument. The magnitude of this current does not matter, the point of importance is whether it does or does not exist. Only when the pointer goes to zero can we link up the currents by means of S. Hence the switching is very simple. The commutator V is put in a position corresponding to the charging desired, and the unipolar switch A is closed. Then the voltmeter, supposing the voltages are as in the above example, will show about 80 volts. Then we begin to excite the booster dynamo and watch the retreat of the pointer as it proceeds, stopping the excitation when the pointer is at zero. S is then closed. An ampere meter in the circuit of the booster gives no perceptible indication until the proper current strength has been reached. The booster tension need not be known, but if it is wanted it can be ascertained by placing a unipolar voltmeter in front of the voltmeter, which, while one connection of the instrument is unchanged, unites the other alternately with the other pole or with the switch arm.

This arrangement has, of course, many uses, but its special usefulness is, as already indicated, when two E.M.F.'s have to be opposed.

ELECTRICAL ENGINEERS TERRITORIALS (London Division).—Orders for week ending February 26, 1910:—Monday, February 21—"A" Co., Recruits' Infantry Drill, 6 to 7 p.m.; Technical Drill, 7 to 9.30 p.m.; Tuesday, February 22—"B" Co., Technical Drill, 7 to 9.30 p.m.; Wednesday, February 23—"B" Co., Gymnasium, 6.30 to 9.30 p.m.; Tuesday, February 24—"C" Co., Technical Drill, 7 to 9.30 p.m.; Friday, February 25—"D" Co., Recruits' Infantry Drill, 6 to 7 p.m.; Technical Drill, 7 to 8.45 p.m.; Infantry Drill, 8.45 to 9.45 p.m.; Saturday, February 26—"B" Co., week-end run at Coalhouse Fort, parade at Fenchurch-street Station, 3.15 p.m.; dress as usual.—(Signed(P. H. Campbell, Captain R.E., Adjutant.

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PRODUCTION, MEASUREMENT, AND EFFECT OF VARIABLE WAVE-FORM.*

By LANCELOT W. WILD.

In the course of everyday testing, discrepancies sometimes arise in the results obtained in different laboratories. In the case of alternating-current tests such discrepancies are often attributed to differences of wave-form, without those concerned having any clear idea as to what the effect of wave-form may be in the matter in dispute.

In order to be able to demonstrate when called upon to what extent wave-form may effect any particular apparatus, I have made arrangements in my laboratory for varying the wave-form over wide ranges.

In this paper I shall describe first the means by which I vary the wave-form, and secondly the means I have adopted for measuring its essential characteristics. Finally, I present the results of some tests carried out with the idea of indicating the sort of effect that may be expected with various apparatus when the wave-form is varied.

The Production of Variable Wave-form.

The ideal method of varying wave-form at will is to couple up several alternators, each separately excited and running at different frequencies. The first of these might run at 50 periods and generate the fundamental sine wave, the second at 150 and generate the third harmonic, and so on. At the National Bureau of Standards, Washington, they have such an arrangement (Bulletin of the Bureau of Standards, vol. 4, No. 4). The alternators are separately excited, and are arranged so that their shaft couplings can be shifted, so that not only can the amplitude of the harmonics be varied, but also their phases with respect to the fundamental. All the odd harmonics up to the fifteenth can thus be added to the wave, and at any desired phase displacement.

This method of producing variable wave-form was not at my disposal, so I have had to do the best I could with a single alternator, the armature of which is wound with three sets of coils.

This machine was originally a 6-pole direct-current machine of about 1½ kw. capacity. The armature is furnished with 7 slots per pole. The armature was rewound with 3 sets of coils and the commutator replaced by 5 collector rings.

One winding occupies the two outer pairs of slots, and gives on open circuit a flat-topped wave. This winding will be called F.

The second winding occupies the next three pairs of slots inside F and gives a peaked wave. This winding is known as P.

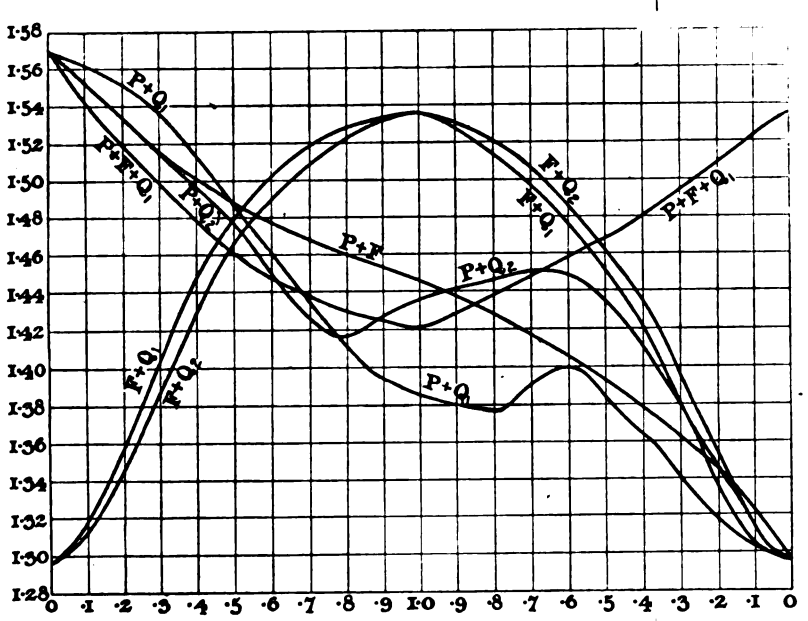

Fig. 1.

The remaining slots are occupied by a winding similar to F but in quadrature with it. This is designated Q_1 or Q_2 according to whether it is connected to lead or lag with regard to P or F.

From these three original waves some hundreds can be built up—peaked, flat, dimpled, symmetrical, and unsymmetrical. The waves are built up by combining the original waves in various proportions, the proportioning being effected by means of transformers.

By adding together P and F a series of symmetrical waves are produced from peaked to flat, according to the mixture. By subtracting a portion of P from F, a set of dimpled waves are produced—that is to say, waves with a double peak. By taking a portion of F from P a set of very peaked waves are produced, the greater part of the rise of the wave being concave instead of convex as usual.

F and Q_1 or F and Q_2 give a series fairly symmetrical, yet differing greatly from the P F series.

P and Q_1 and P and Q_2 give two series of extremely unsymmetrical waves.

Fig. 1 shows the range of amplitude factors obtainable. The ordinates of these curves are amplitude factors, and the abscissæ represent the proportion of the mixture. Thus at the figure 0 one winding only is employed, at 0·5 half the voltage of the second winding is added, at 1·0 the whole of the voltage of the second winding is added, and at the second 0 the voltage of the first winding is brought down to zero.

With the P+F series amplitude factors from 1·57 to 1·295 are produced. With all F and 0·67 P the amplitude factor is $\sqrt{2}$. The resulting wave is an almost perfect sine, the amplitude of the third harmonic being only about 1% of the fundamental. This is the only mixture by means of which a sine wave can be obtained.

The F Q_1 and F Q_2 series give amplitude factors from 1·295 to 1·535. It will be noticed that it makes some difference whether Q is connected to lead or lag with regard to F. Although the windings are supposed to be similar, yet there is a slight difference between the waves they generate, though the difference would be hardly apparent on an oscillogram. It should be noted that when two flat-topped waves in quadrature are connected in series the result is a peaked wave. The converse would also be true—namely, that two peaked waves would produce a flat-topped one if similarly connected.

Suppose a meter has to be tested on an inductive load, the phase being adjusted by means of a two-phase phase-shifter acting on the pressure circuit. It is apparent that unless the alternator gives a sine wave the voltage wave supplied to the meter will differ from the original wave of the circuit, sometimes by a considerable amount. The current wave, on the other hand, will remain unaltered. If, now, instead of using the phase-shifter the phase difference is produced by using a choking coil in the current circuit, the voltage wave will remain unaltered and the current wave will be effected, which is more like the conditions which the meter will have to experience in service. A phase-shifter should therefore be employed with caution if the wave-form differs widely from the sine form.

The P Q_1 and P Q_2 series are somewhat remarkable. Adding Q to P at first lowers the amplitude factor, but afterwards the curves rise again for a time before they finally fall. Also it will be noticed that with some mixtures it makes a considerable difference whether Q is leading or lagging with regard to P.

So far the author has only dealt with mixtures of two windings. By mixing the voltage from all three windings many more waves can be produced. For example, if P is mixed with F and Q_1, F and Q being varied as one unit, amplitude factors from 1·57 down to 1·42 and then up again to 1·535 are produced.

It will be noticed from these curves that an amplitude factor of $\sqrt{2}$ can be produced in no less than nine different ways. Only one of these, however, produces a sine wave, and some of the other waves though having the same factor as a sine wave yet have very different effects upon some classes of apparatus.

To thoroughly investigate all the waves obtainable from this alternator would be the work of years; the author

* Original communication to the Institution of Electrical Engineers.

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has accordingly contented himself with standardising sixteen waves for present use. These are delineated in Fig. 2.

Amongst the symmetrical waves No. 1 has the highest and No. 2 the lowest amplitude factor. These are P and F respectively. No. 3 is F + Q_1, and has rather a high amplitude factor. No. 4 is P + F, and is rather more peaked than a sine wave.

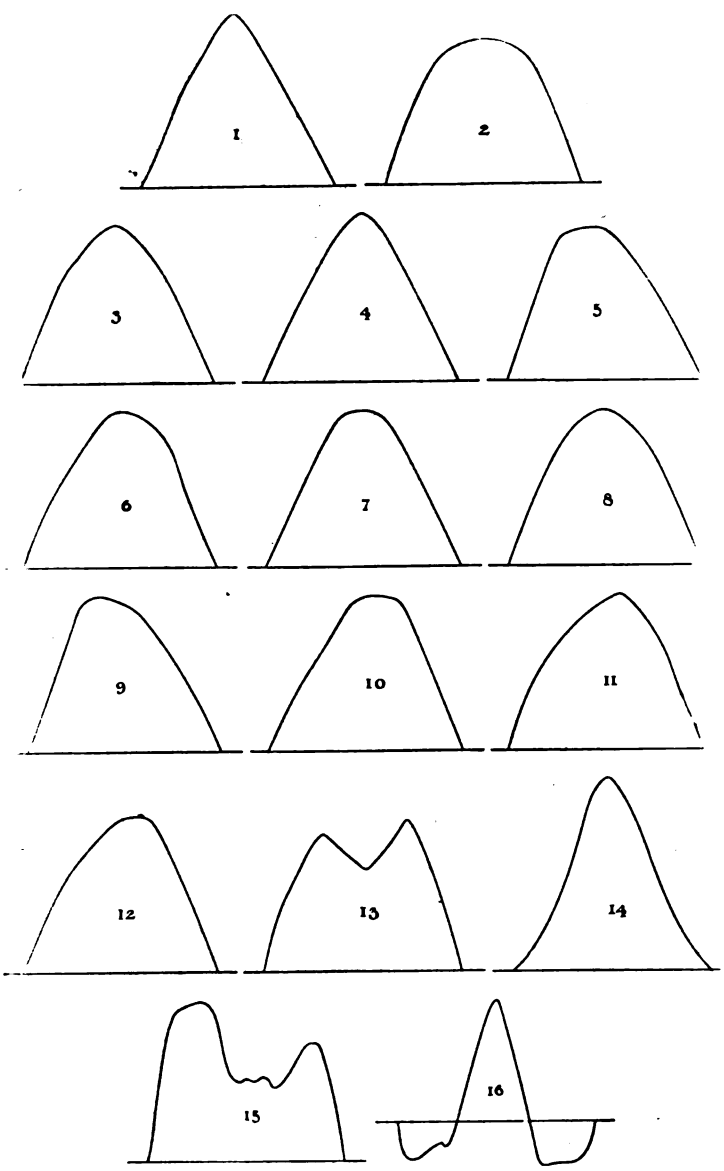

FIG. 2.

Waves 5 and 6 are P Q_1 and P Q_2 respectively. They are both unsymmetrical. Altering Q from leading to lagging not only considerably alters the shape of the wave, but also alters the amplitude factor from 1·385 to 1·435, and the mean ordinate factor from 0·894 to 0·896.

Waves No. 7 to 12 all have amplitude factors of $\sqrt{2}$. No. 8, however, is the only one resembling a sine. Their mean ordinate factors vary from 0·888 for 7, 9, and 10 to 0·908 for No. 11, which is sufficient to make about 4% difference in the hysteresis loss of a transformer working at 10,000 nominal $B_{max.}$ or over.

No. 13 is a dimpled wave produced by taking a portion of P from F. No. 14 is the converse of No. 13. Taking a portion of F from P scoops a bit out of the sides.

No. 15 is produced by opposing P to F and adding Q. It has an extremely high mean ordinate factor combined with rather a high amplitude factor.

No. 16 is the most curious wave of all. This is produced by opposing P to F without any transformation. The wave may be regarded in three ways: It is a highly peaked wave with dips below zero at start and finish; it is a dimpled wave with dimple going right below zero; or it is a wave of triple frequency containing even harmonics.

In Table A will be found particulars of the waves, their amplitude and mean ordinate factors, and their mixture formulæ.

The alternator has only a small output—namely, 10 amp. at 60 to 130 volts, according to wave-form at 50 periods. If the standard waves are to be maintained, it is necessary to avoid taking anything like full load from the machine, as it has been ascertained that loading the machine affects the wave-forms. It was found that the amplitude factors of the waves at half-load are altered from 1 to 3%. While in studying the effect of altering the field strength of the machine, it is seen that at half-volts the amplitude may alter as much as 2%.

Periodicity has no effect upon amplitude factor on open circuit.

In carrying out tests of precision it is necessary so to arrange matters with transformers that the field has not to be varied over wide limits, and the load actually put upon the machine is as small as possible.

In carrying out the tests following the load on the machine has been kept down to half an ampere as a maximum, and except for the tests for dielectric strength, the field has not been altered more than about 5%.

TABLE A.

Characteristics of Standard Waves.

Wave No.	Amplitude Factor.	Mean Ordinate Factor.	Formula.
1	1·570	0·872	P
2	1·295	0·914	F or Q
3	1·445	0·895	P F
4	1·535	0·878	F Q_1
5	1·385	0·894	P Q_1
6	1·435	0·896	P Q_2
7	1·420	0·888	P F Q_1
8	1·415	0·900	F 67% P
9	1·415	0·888	P 78% Q_1
10	1·415	0·888	P 78% Q_2
11	1·420	0·908	Q 44% P
12	1·415	0·899	F 33% Q_1
13	1·390	0·902	F — 50% P
14	1·790	0·845	P — 50% F
15	1·470	0·945	F — P + 33% Q_1
16	2·220	0·875	F — P

THE MEASUREMENT OF AMPLITUDE FACTOR.

In carrying out the foregoing tests some 200 amplitude factors have had to be measured accurately to within about ¼%. To have obtained these figures from a study of the waves themselves would have involved the expenditure of an immense amount of time, and the figures finally obtained would not have been so accurate as the author obtained by the following method:—

The alternator was coupled by a belt to another machine, the pulleys being of equal diameter. On a second pulley of the auxiliary machine was fixed a contact-maker, arranged to operate for a brief period once in every revolution.

The circuit was made up as in Fig. 3. V is an electrostatic voltmeter shunted by a couple of condensers C C. S_1 is a switch for short-circuiting the contact-maker. S_2 is a two-way switch for switching over on to direct current for testing the efficiency of the contact-maker.

With S_1 open and S_2 on right-hand contact the condensers are charged once in every revolution, and the voltmeter registers the instantaneous value of the voltage at the instant at which contact is broken.

If the pulleys are exactly similar, and there is no belt slip, the condensers will be charged always at one point of the wave. The slightest belt slip will, however, cause precession to take place, so that the voltmeter spot will never be at rest, but will move slowly up and down its scale from zero up to the maximum point of the wave.

By adjusting the tightness of the belt the voltmeter spot may be made to mov faster or more slowly as desired. The author has found no difficulty in so adjusting the belt as to lengthen, the time taken for the voltmeter to go through a half-period to 10 min. When the object is only to record the maximum point of the wave a quicker movement than this is preferable, say half a period in 1 min.

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In making a test for amplitude factor the procedure is as follows :—

After the belt slip has been adjusted to give a convenient speed to the voltmeter spot, S_2 is switched over to the left. The voltmeter is then on direct current. S_1 is then closed and opened again. The same reading should be obtained on the voltmeter whether S_1 is open or closed. If the reading is lower when S_1 is open, either the insulation resistance of the voltmeter, condensers, and leads are

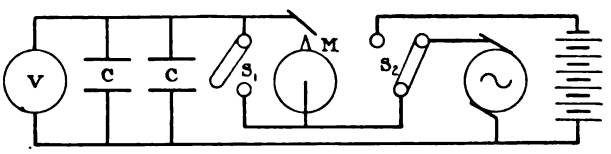

FIG. 3.

too low, or else the contact-maker is misfiring. The trouble must then be sought out and remedied, for otherwise the voltmeter will not register the true peak of the wave when switched on to alternating current.

When it is ascertained that everything is working properly, S_2 is switched over to the right, S_1 being open. The voltmeter will then register the ordinates of the wave. The maximum reading is noted, then the switch S_1 is closed, and the R.M.S. voltage read off on the same voltmeter. S_1 is then opened again, and as the spot comes up the scale the maximum is again read—this time on the other half of the wave. The mean of the two maximums should be taken, as thus contact force is eliminated from the measurement. The maximum ordinate divided by the R.M.S. voltage gives one the amplitude factor.

It is well to make tests with first one and then two condensers. In this way one obtains an alternative way of detecting any misfiring of the contact-maker or leakage between the periods of contact.

The voltmeter which I have been using can be read with an accuracy of 1 part in 1,000. The spot on steady voltage comes to rest in 10 sec. In making tests for amplitude factor, I have always had the belt slip so adjusted as to cause the spot to take at least 80 sec. to pass through a half-period. The accuracy of the measurement should be, therefore, well within the $\frac{1}{4}\%$ aimed at.

At first considerable difficulty was experienced in obtaining a satisfactory contact-maker. The type eventually adopted is shown in Fig. 4. P is a revolving drum—in this case a pulley. K, the striker, is made from a brass stud, and is filed to a knife-edge. S is a very light clock

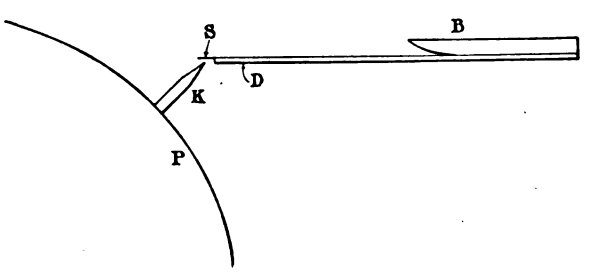

FIG. 4.

spring clamped between a back plate B and a damping plate D. D protrudes to within $\frac{1}{8}$ in. of the end of S. As the spring rebounds after being struck, it hits against the damping plate, and all vibration is damped out before the striker comes round again. Thus the striker always finds the spring at rest, the contact is always of the same duration, and the make and break are always made at the same exact point of the revolution.

THE DELINEATION OF WAVE-FORM.

The same arrangement as employed for the measurement of amplitude factor could also be used for plotting out waves. It suffices to take readings of the voltmeter at equal intervals of time, and then the wave can be plotted out. However, with an electrostatic voltmeter having a square law scale there is some difficulty in arriving at the exact instant of the zero, and I have, therefore, found it better to modify slightly the arrangement for plotting the waves. The arrangement of the circuit is shown in Fig. 5. The chief alteration is that a battery of accumulators is permanently connected in series with the voltmeter, so that the zero of the wave comes some way up the scale into a position where the voltmeter is fairly sensitive.

The mode of procedure is as follows :—

S_2 is switched to the left, cutting out the alternator, and readings are taken with S_1 closed and open. The reading thus obtained fixes the zero of the wave. S_2 is then turned to the right, and S_1 is opened. As the voltmeter spot passes through the false zero a stop-watch is started, and then readings are taken of the ordinates every 10 seconds. As the spot passes a second time through the false zezo the watch is stopped and the odd seconds noted. The number of degrees and fractions of a degree corresponding to each 10 seconds is then calculated, and the ordinates are then plotted out on sectional paper.

The author's practice is to go through each wave 3 times and plot the points on the same paper. Taking about 200 seconds per half-wave about 60 points are thus obtained. The wave is then drawn passing through as many points as possible. Generally speaking, no point falls more than 1° off the wave as finally drawn.

Greater precision might be obtained by replacing the belt drive by suitable gearing, arranged to give a difference of speed between the two shafts of 1 part in, say, 50,000.

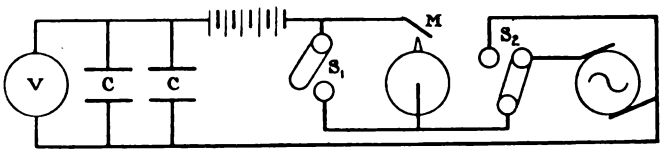

FIG. 5.

The author has not, however, thought it necessary to go to this expense, as the waves obtained with the belt drive are sufficiently accurate for his purpose, the object being rather to obtain a picture showing the type of the wave rather than an exact representation from which the harmonics could be calculated with a very high degree of exactness.

THE MEASUREMENT OF MEAN ORDINATE FACTOR.

A knowledge of amplitude factor is useful, but for many purposes the mean ordinate factor is of much greater importance. Mean ordinate factors do not vary through anything like the same range as amplitude factors, and consequently a higher degree of accuracy is demanded in their measurement.

By the following means the author believes that he has secured an accuracy of to 1 part in 1,000 in the measurement of his mean ordinate factors.

If a direct-current moving-coil voltmeter is connected to an alternating-current circuit it registers, not the R.M.S. voltage, but the algebraic mean of the wave. This ordinarily is zero. If, however, a rectifier is connected in series so as to reverse connections at the zero of the wave, the voltmeter will correctly register the mean ordinate of the half-wave.

All one requires, then, to measure mean ordinates is a moving coil voltmeter, a rectifying commutator, and an eloctrostatic voltmeter. Inasmuch as it is difficult to set the brushes of the rectifier to commutate exactly at zero, the author puts his rectifier on a separate shaft driven by a slipping belt as employed for the measurement of amplitute factor. The voltmeter needle then moves up and down the scale, the maximum reading obtained when multiplied by the constant of the instrument being the mean ordinate of the E.M.F. wave.

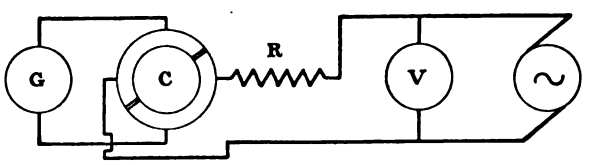

FIG. 6.

Fig 6 shows the manner of connecting up. C is the rectifier. V is an electrostatic voltmeter. R is a non-inductive non-capacious resistance. G is a direct-current moving-coil galvanometer.

In order that the highest accuracy possible may be obtained, the galvanometer is calibrated against the electrostatic voltmeter as a standard.

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The mean ordinate of the E.M.F. wave is read off from the maximum reading of the galvanometer and the R.M.S. value of the wave from the electrostatic voltmeter. The ratio of these two gives the mean ordinate factor.

If readings are taken on the galvanometer at equal time intervals one obtains the ordinates of the B wave corresponding to the E.M.F. wave. There is, however, some danger that an error may be made due to the missing out of a portion of the integration of the E.M.F. when commutation does not take place at the zero of the E.M.F. wave. I should prefer to calculate B waves from E.M.F. waves determined in some other manner.

The Effect of Wave-form on the Losses in Transformer Iron.

It is commonly stated that the loss in transformer iron is less for a peaked than for a flat-topped wave. This is not always true. The loss depends not upon the amplitude factor, but upon the mean ordinate factor of the wave, and although a high amplitude factor is generally accompanied by a low mean ordinate factor the two are not inseparably connected, as witness wave No. 15, which has a rather high amplitude factor and an extremely high mean ordinate factor.

Messrs. Joseph Sankey & Sons kindly supplied three samples of transformer iron labelled Armature, Lohys, and Stalloy, for the tests for the effects of wave-form. The general data of these samples are given in Table B.

The samples were built up into magnetic squares with interleaved butt joints as in ordinary transformer construction, and were tested by a wattmeter method at various inductions and frequencies for loss on varying waves.

The coils were wound on formers fixed to a baseboard, all that was required to prepare for a test being to thread in the stampings and connect up the various circuits.

Fig 7 shows diagrammatically the magnetic square and its circuit connections. The magnetising coil M consists of a single layer of No. 14 wire wound all round the square and as close in to the corners as circumstances would permit.

Over this coil is wound a second coil S also wound all round the square. This coil supplies current to the wattmeter pressure circuit, R being a non-inductive non-capacious resistance and P the moving coil of the wattmeter.

Table B.

Transformer Iron Tests. General Data.

	Armature.	Lohys.	Stalloy.
Number of stampings ..	200	192	192
Weight in pounds ..	5·44	5·25	5·39
Specific gravity ..	7·88	7·61	7·52
Thickness, in inches ..	0·0136	0·0142	0·0148
Length of stampings ..	7 in.	7 in.	7 in.

A set of four fine wire coils, each of 500 turns, is wound over all, and one or more sections of these as required is connected to the electrostatic voltmeter V.

Current is supplied to the magnetising coil by an auto-transformer T. The ratio of this transformer can be varied as required, the alternator field being only altered to obtain the final fine adjustment.

The wattmeter reads the watts consumed in the iron plus the watts consumed in the pressure circuit. The watts consumed in the current coil of the wattmeter and the magnetising coil of the square are excluded from the measurement. The amount to be deducted for the watts taken by the wattmeter shunt is readily calculated from the voltmeter reading and the known resistance of the pressure circuit.

The value of nominal $B_{max.}$ is calculated by the usual formula—

$$\text{Nominal B} = \frac{\sqrt{2} \times V \times 10^6}{2\pi \times \sim \times T \times A}.$$

where A is the area of iron in square centimetres, V is the voltage, T is the number of turns on voltmeter coils.

The true $B_{max.}$ is found by multiplying the nominal $B_{max.}$ by the mean ordinate factor of the wave and divided by 0·900 the mean ordinate factor of a sine wave.

The wattmeter employed for these tests was a reflecting deflectional instrument of the dynamometer type, with bifilar suspensions 15 in. long and ¼ in. apart.

The instrument is furnished with resistances giving ranges of 10, 30, and 100 watts. Most of the tests were made on the 10-watt range, the 30-watt range being occasionally required.

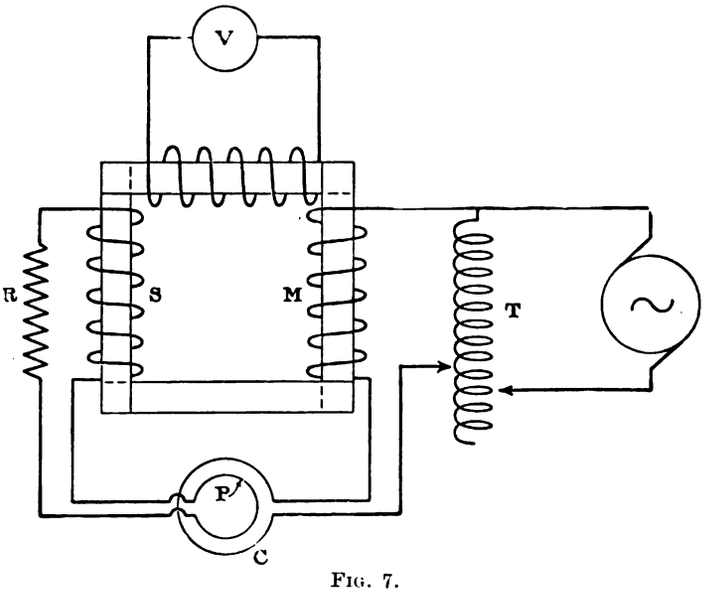

Fig. 7.

At 10,000 $B_{max.}$ and 50 periods, the wattmeter pressure circuit consumes about 0·2 watt, generally about 5% of

Table C.

Transformer Iron Tests at 50 Periods on Waves Nos. 1 and 2.

Nominal $B_{max.}$	Watts per lb.					
	Armature.		Lohys.		Stalloy.	
	No. 1.	No. 2.	No. 1.	No. 2.	No. 1.	No. 2.
2,500	0·122	0·131	0·113	0·122	0·0650	0·0705
	1·65	1·65	1·70	1·70	1·70	1·70
5,000	0·386	0·415	0·373	0·392	0·2145	0·2320
	1·65	1·65	1·70	1·70	1·65	1·65
7,500	0·753	0·810	0·741	0·787	0·4200	0·4570
	1·65	1·65	1·70	1·70	1·70	1·70
10,000	1·220	1·310	1·205	1·285	0·6850	0·7430
	1·80	1·80	1·75	1·85	1·75	1·85
12,500	1·790	1·952	1·787	1·944	1·0180	1·1200
	1·90	1·95	2·00	2·10	1·80	1·80
15,000	2·540	2·780	2·570	2·840	1·4100	1·5600

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the loss in the iron. The error introduced by the self-induction of the wattmeter coil is 0·5% on 0·4 power factor and 50 periods on the 10-watt range.

The control is sufficiently strong to prevent the shifting of the zero of more than one part in 1,000 after one hour's deflection to the top of the scale.

The drop in the alternator, transformer, series, coil of wattmeter, and magnetising coil amounts to about 1% at 10,000 B and 50 periods. The amount of drop would not seriously affect the wave-form.

A wattmeter for testing small quantities of transformer iron is of necessity a compromise. One requires both shunt and series losses to be small on the one hand; and, on the other hand, one requires as large a control as possible and a minimum of self-induction in the pressure circuit.

In Table C is given the loss in watts per pound for the three samples on waves 1 and 2 at 50 periods and at various values of nominal $B_{max.}$

The figures between the lines are the exponents. Thus

TABLE D.

Transformer Iron Test. Percentage difference in Total Loss on Waves 1 and 2 at 50 Periods and various Values of Nominal $B_{max.}$

Nominal $B_{max.}$	Armature.	Lohys.	Stalloy.
2,500	7·4	7·9	8·5
5,000	7·5	5·1	8·2
7,500	7·6	6·2	8·8
10,000	7·4	6·6	8·5
12,500	9·1	8·8	10·0
15,000	9·5	10·5	10·6

for armature iron the total loss exponent is 1·65 up to 10,000 $B_{max.}$ increasing to 1·9 between 12,500 and 15,000. The exponent for Lohys is 1·7 at the lower inductions, increasing to 2 or 2·1 at the highest. Stalloy is more uniform—the exponent only goes up to about 1·8 at the higher inductions.

Table D refers to the same test, and shows the percentage difference in the total losses on the two waves. The percentage difference for armature is about constant up to 10,000 $B_{max.}$, but then increases greatly. Lohys shows a minimum percentage difference at about 5,000 $B_{max.}$ with an increase at 2,500, and a much larger increase at 15,000. Stalloy behaves much as Armature, the difference being fairly constant to 10,000, and then increasing considerably.

The difference in the mean ordinate factors of the two waves is 4·8%, and the difference in the true $B_{max.}$ must also be 4·8%. Yet the difference in the total loss sometimes amounts to over 10%, in spite of the fact that probably only the hysteresis portion of the loss is affected by wave-form.

Fig. 8 gives the curves showing the loss in watts per pound at 10,000 nominal B_{max} and 50 periods on waves Nos. 1 to 12. It will be noticed that the total loss increases in the same order as the mean ordinate factor, the amplitude factors having very little to do with it.

The ordinates are watts per pound and the abscissæ mean ordinate factors. The dots, it will be observed, all fall within 0·2% of the curves.

Fig. 9 gives the curves showing the total losses in joules per pound per cycle on waves 1 or 2 at 10,000 nominal $B_{max.}$ and at various periodicities.

These curves are simple, parallel straight lines, showing that the total losses can be divided into two parts: the one, generally called hysteresis, is independent of periodicity but dependent upon wave-form; the second, generally known as eddies, is proportional to periodicity and independent of wave-form.

The tests were made at periodicities from 100 down to 25; the curves have been extended to zero by exterpolation. At zero periodicity eddies must be zero, so the hysteresis and eddy losses are thus readily separated.

Tests recently made by Messrs. Lloyd and Fisher at the National Bureau of Standards (Bulletin of the Bureau of Standards, Vol. 5, No. 4) show that the curves are no longer straight at higher periodicities, the curves beginning to bend downwards a little from 90 periods and upwards. The author has found no evidence of this bend in his tests, but, as in the case cited, the droop at 100 periods was less than 1%, and thicker specimens were employed, it is not very surprising that the author's results were not quite confirmed at 100 periods.

It will be observed that Lohys has a smaller hysteresis loss than Armature, but that the eddies are greater. At below 60 periods the total loss is the lesser in Lohys, above 60 periods Armature is the better of the two.

Stalloy claims to have an exceedingly small eddy loss.

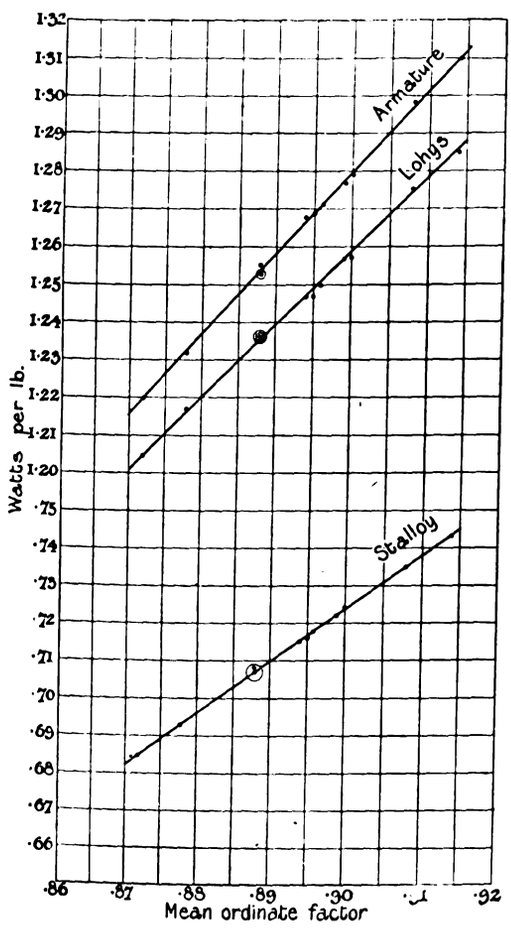

FIG. 8.

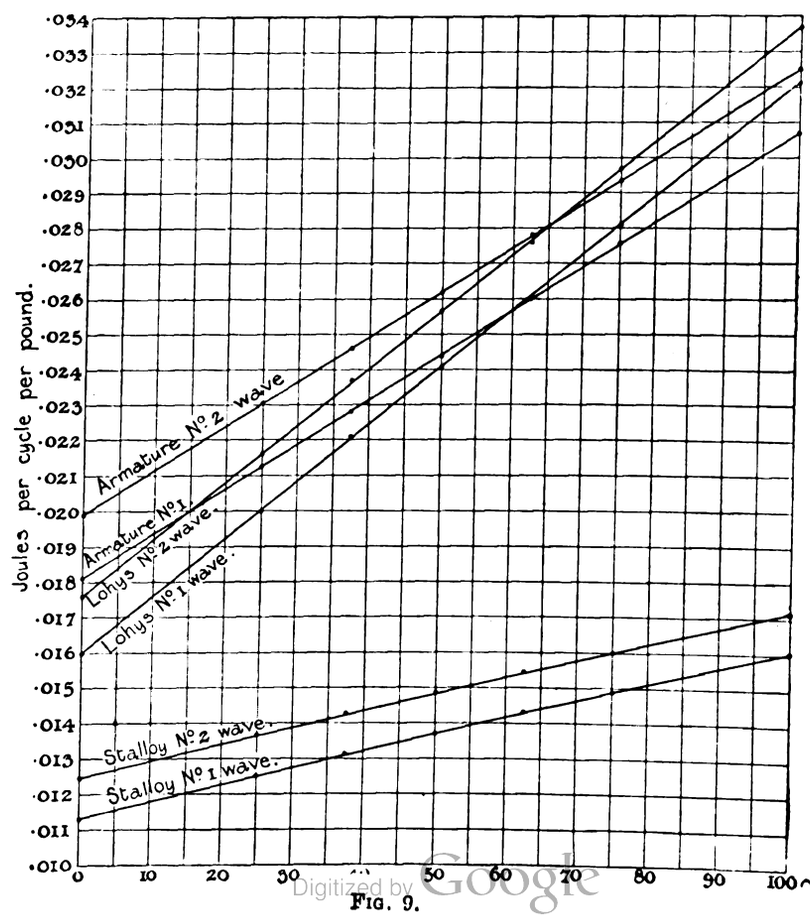

FIG. 9.

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This is confirmed; but it should also be noted that a great deal of the improvement is due to a reduction of the hysteresis loss also.

The percentage of eddies in the three samples varies from 9% for Stalloy at 25 periods up to 50% for Lohys at 100 periods. The percentage of eddies is zero at zero frequency, and in each case rises steadily as the periodicity increases.

Still referring to the same test, Table E shows the percentage difference in total loss on the two waves. All three samples are affected by about 10% at zero frequency. At higher periodicities the percentage difference decreases as the percentage of eddies increase. At 100 periods Armature is affected 5·9%, Lohys 5%, and Stalloy 7·2%.

It should be noted that a difference of 4·8% in the mean ordinate factor of the wave, corresponding to a difference of the same percentage in the true $B_{max.}$ alters the hysteresis loss by no less than 10% for all three samples.

It is evident from these tests that differences of the order of 7% are likely to be found by different authorities in the total losses if due attention is not paid to wave-form. Such differences are sufficiently great to lead to disputes and to cause general inconvenience, especially when the iron is paid for by results.

TABLE E.

Transformer Iron Tests at 10,000 *Nominal* $B_{max.}$ *on Waves* 1 *and* 2, *and Various Periodicities.*

Periodicity.	Difference in per cent.		
	Armature.	Lohys.	Stalloy.
0	10·0	10·0	10·2
25	8·5	8·0	9·2
50	7·4	6·7	8·4
75	6·5	5·7	7·7
100	5·9	5·0	7·2

EFFECT OF WAVE-FORM ON DIELECTRIC STRENGTH.

It is sometimes assumed that the breakdown of an insulating material is directly related to the maximum value of the E.M.F. wave. On consideration, however, it is evident that this may not always be the case. If the insulation resistance of the material is low, there may be a sufficient leakage current passing to seriously heat up the material. Such leakage would depend more upon the R.M.S. than the maximum value of the E.M.F., and breakdown in extreme cases might take place on the same R.M.S. voltage whatever the wave-form.

The presence of dielectric hysteresis and capacity also complicates matters, so that it is difficult to forecast with certainty what will be the effect of wave-form in any particular case.

The carrying out of tests to ascertain the effect of wave-form on dielectric strength presents great difficulties. The results obtained are generally very erratic, apparently due to want of homogeneousness in the material. The author has, therefore, confined himself to carrying out tests on air and oil. The results of these tests, though far from exact, confirm what has already been said, that the breakdown of an insulating material is not always to be referred to the maximum value of the wave.

DIELECTRIC STRENGTH OF AIR.

Tests were made on waves 1 to 7, using spheres 2·22 and 4·5 cms diameter and 1 cm. apart. The wave-forms were preserved by using an auto-transformer, the field being only adjusted for the last 5% of the raising of the pressure. The voltage was raised in steps of ½% at 10-second intervals.

The breakdown depends entirely upon the maximum of the wave, the greatest divergence from the mean of all seven maximums being only 1½% for wave No. 5 and with the smaller spheres.

Correcting by Dr. Russell's tables,* the dielectric strength of air works out to 39 kilovolts for the smaller spheres and 35 kilovolts for the larger ones. This difference roughly confirms the results found by Mr. E. A. Watson,† who suggested as a possible explanation of the variation that air had a higher resistance in the neighbourhood of a conductor than at some distance from it.

EFFECT OF WAVE-FORM ON THE DIELECTRIC STRENGTH OF OIL.

Three samples of oil were tested on waves 1 and 2 with spheres 4·5 cms. diameter fully immersed in the oil. The voltage was generated by one transformer, a second potential transformer being used to step down the voltage to an electrostatic voltmeter. The voltage had to be regulated to a large extent on the field, as the time taken to change over transformer connections would have seriously interfered with the ritual necessary to be observed in making such tests. The wave-forms were not, therefore, quite preserved to standard, and the amplitude factor of No. 1 may have sometimes been as much as 2% above standard, and that of No. 2 2% below standard.

The oils were first dried by heating up to 230° F. for half-an-hour, and were then left overnight to cool. Even after drying, the results obtained were so erratic that it was necessary to make a large number of tests to obtain an average for comparison.

The ritual employed was as follows: The first application of the voltage was at about half the average breakdown voltage. The pressure was raised in steps of 2% at intervals of 10 seconds. After each breakdown the oil was stirred by rocking the electrodes backwards and forwards through the oil without actually removing them above the surface. A test was first made on No. 1 wave, then two on No. 2, then two on No. 1 again, and so on to the finish.

Each breakdown was a regular short circuit, and blew a two-ampere fuse in the primary circuit to the transformer. There was none of the intermittent flicking that is so troublesome in oil not dried.

Three samples of oil were tested, known as Wilcox light dynamo oil, Duckham transformer oil, and resin oil. The two former were found to be pure mineral oils; the last is a vegetable oil. As a guide to quality of the oils, their viscosities at 70° F. were tested, and were found to be 67, 40, and 81 respectively. As far as the tests go, it would appear that high viscosity is accompanied by high dielectric strength, but this might not be borne out if more samples were tested.

The breakdown voltages obtained were so very erratic that the only thing to be done was to take an average of all on each wave. The ratio of the two amplitude factors of the waves was 1·21, or perhaps a little more, due to the alternator field not always being at full strength. The average of the R.M.S. breakdown voltages is: For the Wilcox oil, 1·245; for the Duckham oil, 1·13; and for the resin oil, 0·985.

These ratios cannot be taken as very exact owing to the variation of individual results, but they are sufficiently exact to show that the dielectric strength of oil should not be stated in terms of the maximum voltage of the wave in every case.

The Wilcox oil appears to depend upon the maximum value of the wave for its breakdown, the resin oil upon the R.M.S. value, and the Duckham oil upon something half-way between the two.

It was noticed that before the oils broke down they generally began to sing. This singing appeared to be more pronounced in the case of the resin oil than with the others. It was thought that perhaps leakage had some influence upon these results.

In order to test this point, the author measured the insulation resistance of the oils. The tests were made in the tank with the spheres separated 1 mm. in each case. The testing pressure was 500 volts.

The resin oil came out at 47,000 megohms, the Duckham at 34,000 megohms, and the Wilcox oil at 8,400 megohms, which is in exactly the reverse order to that required to account for their peculiar behaviour when the wave-form is varied.

It is, however, improbable that the insulation resistances are maintained when the samples are subjected to a voltage approaching that at which they break down.

An attempt was made to measure the watts consumed by these three samples up to the point of breakdown. The most sensitive wattmeter available for the test was a

* *Journal of the Institution of Electrical Engineers*, vol. 40, pp. 9–10, 1908.
† Ibid., vol. 43, p. 113, 1909.

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dynamometer instrument with a range of 10 watts, together with a potential transformer with a 100 to 1 ratio extending the range to 1,000 watts.

No deflection of this instrument was obtained with any of the samples right up to the point of breakdown, when a momentary kick was observed just as the fuse blew. Had any of the oils taken as much as a quarter of a watt a deflection would have been observed, though it could not have been read with accuracy.

In view of the small power consumed, it hardly looks as if the breakdown was in any of the three oils or on either wave accelerated by local heating.

Effect of Wave-form on Induction Meters.

House service meters of the induction type have long been suspected of being affected by wave-form. When one inquires of the makers, however, the usual answer one gets is that no doubt other meters are badly affected by wave-form, but their own hardly at all.

To test every make of meter on the market at all sorts of loads and periodicities would have been too big a task for the author to undertake. He has, accordingly, had to content himself with testing six meters on six loads and two waves. This alone meant over a week's work. The meters were all rated at 10 amperes, 110 volts, and 50 periods.

The differences to be discovered being small, special precautions had to be undertaken to detect them properly. The loads were chosen to suit the wattmeter, so that a deflection at the top of the scale could always be obtained. The alternator was run on load for one hour before starting in order to secure that the frequency should not vary excessively during the tests. At each load six tests were made on each wave, the two sets of tests being sandwiched between each other and the wattmeter being always brought up to the same reading for each set of tests.

The wattmeter could be read to an accuracy of one part in 2,000. The revolutions were counted through about 100 seconds on a stop-watch beating one-tenth second. By taking the average of six tests on each wave the author believes that he has obtained the differences to one part in 1,000, or 0·1%.

Tests were made on non-inductive loads and also at 375 watts and 0·5 power factor. The latter tests were made on a choking coil with air core. The two E.M.F. waves

Table F.

Effect of Wave-form on Meters. All Meters Rated at 110 *Volts,* 10 *Amperes, and* 50 *Periods. Percentage Effect on Changing Over from No.* 1 *to No.* 2 *Waves.*

Watts.	Power Factor.	B.T.H.	Aron.	Westinghouse.	Ferranti.	Siemens	Alva.
1,000	1·0	0·2—	0·5+	0·1+	0·7—	0·5+	0·3—
750	1·0	0·3—	0·5+	0·1+	0·6—	0·4+	nil.
500	1·0	0·3—	0·6+	0·1+	0·5—	0·4+	0·3+
200	1·0	0·5—	0·4+	0·3+	0·4—	0·3+	0·6+
100	1·0	0·5—	0·5+	0·4+	0·2—	0·3+	0·8+
375	0·5	0·1+	0·2+	0·7+	0·4+	0·3—	1·0—

not being sines, it follows that on inductive load the current waves differed considerably from the E.M.F. waves. No record was made of these current waves, but they ought to be calculable, the power factor being known.

The results obtained are embodied in Table F. In addition, each meter was also tested on a non-inductive load of 500 watts and a sine wave. These results are omitted from the table, as these tests were not made with the same degree of accuracy, tests on a sine wave being made only at the start and finish of the other tests when the conditions may have been slightly different. It is sufficient to say, however, that on a sine wave each meter ran at a speed midway between the speeds on waves Nos. 1 and 2. The object of making the tests on the sine wave was merely to ascertain that there was not some effect depending upon the harmonics, but quite apart from amplitude or mean ordinate factor, which would make the meters run either much faster or much slower on a sine than on either a flat or peaked wave.

It is to be observed that two meters run faster on the flat wave throughout, two slower on non-inductive and faster on inductive load, one exactly opposite to this, and the last runs on No. 2 wave slower on full load but faster on the lower loads, and slower again on an inductive load.

The author cannot give any explanation of why the different meters should behave so differently to each other on changing the wave-form, but probably it has something to do with the iron losses and magnetising currents of the shunt coils. If the differences were larger the matter could be further investigated by testing on other waves, but with such small differences occurring such an investigation would be very difficult and hardly worth while.

The effect of wave-form is so small with these meters as to be of little or no consequence.

The following is a brief description of the main features of the meters :—

B.T.H.

The cores are entirely laminated. The main current divides between two coils in parallel. One of these has a maximum of self-induction, and the other has a resistance in series with it. The combined fields lead with respect to the outside current and true quadrature between shunt and series fields is thus obtained. Friction is compensated for by a magnetic starting horn.

Aron.

The cores are entirely laminated. Quadrature is secured by putting a short-circuit secondary winding on shunt core. Friction is compensated for by means of a strip of iron on poles.

Westinghouse.

The cores are entirely laminated. Quadrature is secured partly by providing a leakage path for the shunt field and partly by a short-circuit secondary winding on shunt poles. Friction is compensated for by short-circuited winding on leakage field.

Ferranti.

The cores are entirely solid. Quadrature is secured by the use of solid iron, and is adjusted by altering the position of the shunt coil on its core. Leakage field also helps the production of quadrature. Friction is compensated for by turning the series cores a little out of symmetry with respect to the shunt poles.

Siemens.

Cores are laminated. Quadrature is adjusted by short-circuited secondary winding on shunt core.

Alva.

Cores are partly laminated and partly solid. Quadrature is partly secured by the use of solid iron and partly by providing a leakage path for the shunt field. Friction is compensated by an eddy disc on poles.

A consideration of the special features of the meters as outlined above does not appear to the author to throw any light upon the individual behaviour of the meters on a changing wave-form.

INDIAN ELECTRICAL STANDARDS LABORATORY.

It appears that Babu Sirish Chunder Basu, the Electrical Supervisor in the office of the Electrical Adviser to the Government of India, has been sent to England for six months, according to *Indian Engineering*, in order to enable him to qualify for the proposed appointment of Laboratory Assistant in the Electrical Standards Testing Laboratory which will be necessary when the new Electricity Act comes into effect. There is already a laboratory in connection with the electrical advisers' office, but when the new Act and the rules under the latter are passed the existing laboratory will have to be equipped with the apparatus required for electrical standard testing work. Instead of getting out a specially trained man from England for the charge of this part of the work of the laboratory, it has been decided to give the Indian assistant in charge of the existing laboratory a chance, and in order to enable him to properly qualify for the work which will be required of him, he has been sent to England to undergo a short course of training in the National Physical Laboratory. Our contemporary adds : We sincerely trust that this Indian will justify the expense of his deputation to England and his selection for his new office.

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LIGHTNING CONDUCTORS.

By ALFRED HANDS, F.R.Met.S.

Author of "Scientific Protection: A Guide to the Proper Application of Lightning Conductors," "Lightning and the Churches," etc. etc.

(*Concluded from page* 180).

At the time these lists were publicly exhibited the committee had been informed that the Houses of Parliament report was unwarranted, yet it was not expunged. When the committee's report was being prepared and the statement made that the "thunderstorms of 1901 were fruitful in cases for the committee's enquiry. Records were received of over 60 buildings struck and damaged, 14 of them being provided with some form of lightning conductor." Which of these cases was omitted so as to reduce the 15 to 14? Was it the one from which the asterisk was omitted, but which had a conductor? Was it the Victoria Tower one? Or the one that Mr. Hedges considered was not caused by lightning? Or the earth wire called by the local observer a lightning conductor, but which the members of the committee must surely have realised was not intended for the protection of the building? Or was it the case that had occurred six years before? Whatever the answer might be, it would set one thinking.

The misleading figures of this committee were circulated widely in the public press, even before the report was published, and did much to cause the wave of scepticism already referred to since it was supposed that, if 40 out of 115 of the buildings damaged had lightning conductors, those conductors must in some way have been responsible for the strokes and that, in place of being a source of protection, lightning conductors might well be regarded as a menace to property. The readers were not aware that the real figures were 24 cases (or 25 if we differ from Mr. Hedges as to the Soho incident) of damage to buildings with ignorantly fitted and defective conductors, out of a total number of nearly 1,200 buildings damaged by lightning in this country in the three years, or an average of 2% in place of the 34% that was generally deduced from the committee's figures.

To characterise these figures as misleading is a mild way of putting the matter. Why were they published? Was it that the members of the committee were not capable of discriminating between buildings with lightning conductors and those without? Was it due to carelessness or indifference as to whether they were correct or not? Was it that the committee started with a great flourish of trumpets to show the world how it would improve matters and wanted to justify its appointment?

Without descending to particulars, we may say that there were members of the committee with well-deserved reputations? How did they come to sign a report containing such misleading figures? If in this respect they took no trouble to investigate matters, how can we believe that they gave greater attention to other parts of the report? If the answer is that the report was literally correct in stating that 40 reports were received because that number included ones of unfounded cases, those that were ancient history, and duplications of the same cases by different observers, it would not place the matter in a better light. Nor would it be a satisfactory explanation to say that Mr. Gavey was mistaken in saying that the list published was a complete one and not merely a selection for, if there were other cases during those three years which were not made public through the ordinary channels, we feel sure the committee would have given full publicity to them in its list in lieu of including the unprotected buildings and old cases that it gave prominence to.

We are justified in regarding the whole compilation from start to finish with grave suspicion. It would appear almost as if, for some reason, there had been a desire to throw doubts on orthodox methods of protection in favour of some other method not clearly specified. It can scarcely be the "contrivance in the nature of a bird-cage," which is stated to be the only way of assuring absolute protection since the report, while laying such stress on the amount of damage caused through lightning conductor failures in the past—in many cases comparatively trivial—suggests that "in cases where protection is considered desirable, but heavy expense is not justified," a lesser system than the "bird-cage"—according to its own showing one that would, therefore, not be efficient—might be erected, which could scarcely be regarded as an advance on the methods it set out to improve.

This is not the only inconsistency in this extraordinary report. Notwithstanding that iron is stated to be "so much better" than copper, "the use of copper as a material for a lightning rod is still recommended for main conductors in relatively inaccessible positions," because iron "unfortunately oxidises rapidly in towns and smoky districts"; yet it suggests that "subsidiary conductors for connecting metal ridging, etc., to earth may with advantage be of iron and of smaller gauge." An expert, bearing in mind the objection most persons have to pay fees for inspections and tests and the damage that has in consequence occurred through systems of great age having got out of order, would say that, if the subsidiary conductors were required for the efficient protection of the structure, it would be quite as important for these as for the main conductors to be of a metal that would not corrode away and be useless in a few years.

The report also lays stress on the importance of good electrical joints in a lightning conductor, adding to the soldering recommended by the Lightning Rod Conference a suggestion that they "should be protected from the action of the air, especially in cities"; yet a little further on we find it stated that "the electrical testing of the whole circuit is difficult and needless."

The conclusion we are forced to is that the recommendations of this committee are not of greater value than its statistics, and that it is far from an improvement on the report of the Lightning Rod Conference of 1882. There was one notable difference between the methods of procedure of the two institutions. The older one realised that among those long engaged in the making and fitting of lightning conductors there must be some who had acquired exceptional experience and whose methods would be good because they had reputations at stake and could not afford to have failures occur. These were, therefore, invited to give full information as to their methods and experiences and it is obvious that the Conference, which was not composed of men with practical experience, benefited greatly from the replies received. The Research Committee took no such steps. It was apparently content to take as its criterion of existing ideas the views of "the man in the street," and the methods found to have been adopted by the unskilled and inexperienced fitters of conductors—the systems that had failed—as the methods of experts.

The theorists on this committee probably thought that its architect members, having protected buildings they had designed, would be experienced, and the architects probably depended on the theorists, but knowing the importance of continued efficiency may have contended for conductors that would be sufficiently durable to be of practical use. But anyone who has had to do with architects in connection with the protection of buildings knows that it is generally the one with only a little knowledge who specifies his own lightning conductors, the man with most knowledge usually relies on an expert's advice. With theorists it is not very different. Professor Tyndall, F.R.S., whose name was intimately connected with the subject, consulted an expert when having his own house protected; but experts have sometimes been greatly amused by the specifications drawn up by theorists and have found it a difficult proceeding, and one requiring a considerable display of tact, to get an efficient and durable system substituted.

Whether the doubts aroused by the report of the Lightning Research Committee have been responsible for damage and loss, through owners of property and those responsible for buildings having been deterred from having conductors fitted, we cannot tell. But we can say that this report has not served to benefit the community by popularising lightning conductors and inducing the property owners to have themselves and their buildings protected. Nor has it placed the subject on a firmer scientific basis than it was before.

There was a time when British knowledge on protection from lightning was regarded as pre-eminent, and other countries copied our methods; but, if the report of the Lightning Research Committee is taken to be a highly authoritative publication, they will probably in future look elsewhere for light on the subject.

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ELECTRIC RAILWAY IMPROVEMENTS.

In comparing English and American electric railways, it may be stated broadly that we are ahead in the matter of permanent way and current transmission equipment, which is largely due to the more stringent Government regulations, regulations which are rather severe, almost to the point of restrictiveness, but undoubtedly are greatly responsible for our enviable record as to accidents. The Americans are decidedly ahead of us as regards motors, and, to some extent, in the matter of power station equipment. For one thing, our friends across the water have had longer and far wider experience than we have. Another noticeable point is that with them there is a very real participation of the whole staff of a railway in the study of the particular problems that have to be faced on their own individual system. Something of this was well brought out in the course of an instructive lecture by Mr. Paul Winsor, chief engineer of the motive power and rolling stock, Boston Elevated Railway Co., delivered before the Boston Section of the American Institute of Electrical Engineers. The company have an elaborate plan of keeping records, all reports are based on mileage, and are prepared by the foremen and heads of departments and sent up to the central office. All work, too, is based on the mileage, the periods for overhauling every piece of machinery being determined by the mileage records. In this way comparison and checking is easy, and by the additional system of tagging or labelling, any piece of machinery for which a man is responsible, the source of troubles may be readily investigated. This is again facilitated by the monthly meetings, at which foremen and men foregather, with someone in authority presiding, to discuss the periodical returns of failures of one kind or another. Motormen and others are encouraged to take part in discussions, to become familiar with their own branch of work and all relating to it. They study their machines, learn their peculiarities and how to

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remedy them, so that the return of motors or parts of machines to the workshops has steadily declined. This, too, notwithstanding the fact that quite old types of motors are still in daily use, having been gradually adapted to the increasing demands of service. At one time the Boston Co. suffered a good deal from damage to rails and motors put out of order from undue vibration as the result of unsuitable handling of the cars. Motormen, in speeding up, took things at a rush, the wheels skidded, and everything suffered. So the company's "schoolmaster" went out with the men and told them to speed up within a given distance. Nearly all the men got bad results owing to skidding, but promptly mended their ways when they found that their instructor could beat them on time, through non-skidding, merely by feeding the controller handle slowly. The same efforts to instil higher efficiency by means of care in handling characterises the management right through. A direct current turbo-generator taught the useful lesson of cleaning up machinery before shutting down, so that by removing oil and lubrication from the commutator there could be no hardening of the oil on the machine as it cooled down, afterwards to cause sparking through blotchiness when the machines were re-started. On testing dynamos, many were found a good deal out of balance, but the defect was easily overcome by placing the brushes at unequal distances from each other. Over-adjusting to load is not encouraged, because if this is carried too far it was found that the spark instead of coming from the top came from under the brush, which honey-combed them badly, shortening their lives and giving bad-running commutators. On the other hand, much time and care has been spent on equalising and compounding the generators, with the result the machinery is in greater harmony, and smoother running is obtained. A point connected with motor maintenance is most interesting. Before the maintenance records were perfected it constantly occurred that new armatures were wanted for a car, owing to burning or flashing, but with the recording of defects as against machine and man, there came more careful study of the machine, and instead of merely lifting out a flashing armature to replace it with a fresh one again and again, the cause of trouble was investigated and the trouble generally located in the field. It was found that the old cotton fields charred with service. These cotton fields are still retained, and still char with service, but without evil effect, because the plan of filling them with a compound of Japan and French chalk has been adopted, which forms a very solid field, and even when the cotton is charred, the wires are kept apart. At first a mixture of japan, varnish and Portland cement was tried, but the latter merely acted as a filler. In the new mixture the japan divides the chalk into thin layers, and as it dries, the whole makes a solid mass. Motor troubles are found to result from vibration, and experiments are being made to suspend the motors on springs over the axles instead of attaching thereto. Overheating has also caused bother, which has been overcome in some instances by increasing the size of motors; in others by using blowers to cool down. It is in this direction the practice is tending, small, light motors being provided with artificial cooking apparatus. These glimpses into the inner working of a great and representative American electric railway system not only afford useful hints as regards details of practice, but give food for thought on the general principles of management.

LOSSES OFF TRANSMISSION LINES DUE TO BRUSH DISCHARGE.*

By E. A. WATSON, M.Sc. (Eng.), Student.

Leaving aside economical considerations, there are three factors which may be said to limit the voltage which can be employed on a transmission line. These are: (1) The generating or transforming apparatus; (2) the line insulators; (3) brush discharge off the line itself.

Of these it may safely be said that the third is the only one which will ultimately need to be considered, and is, at the present time, of considerable importance. The limits imposed by (1) and (2) are chiefly a matter of design, requiring, of course, a large amount of experience, but none the less capable of considerable expansion above the values at present customary.

The use of oil insulation for transformers and switches, the introduction of "condenser-type" terminals for bringing out leads from apparatus, and the new and rapidly growing use of "suspension-type" insulators for the overhead line, seem to indicate that on neither of these scores is it possible to say that any definite voltage has been reached beyond which it is impossible to go.

With the third factor, however, it seems to be otherwise, and since it is beyond our power to increase the insulating power of air, unless there takes place a considerable change in the present practice of line construction, there will always be some voltage limit which it is not possible to exceed. It is proposed to consider this question in detail.

Some experiments were made by the author upon the loss off wires under direct-current pressures and with different conditions, special attention being paid to the effect of variations of atmospheric pressure.

These experiments were carried out at the Electrical Engineering Laboratories of the University of Liverpool during the months of May, June, and July, 1909.

Although the question of losses off direct-current transmission lines is not of such immediate importance as the corresponding case for alternating currents, it is yet of considerable interest in view of the extensive adoption of high-tension direct-current transmission in France and Switzerland and its advocacy for the proposed transmission from Victoria Falls to the Rand.

Experiments were made upon—

1. A wire in a concentric cylinder.
2. Two wires stretched parallel out of doors.

It was intended to use (1) as the principal source of information in the tests and employ (2) chiefly as a check upon the deductions made from (1), and also to determine what factor of safety ought to be allowed in an actual transmission line upon the figures obtained by the tests on the wire and cylinder.

Two things were to be noticed from a general inspection of the curves: Firstly, the increasing value of $\frac{dI}{dV}$ with the size of the wire; and secondly, the decreasing value of the critical electric stress.

The first of these is, of course, only natural owing to the increasing surface presented by the wire, but the second might, perhaps, hardly be expected. It does not, of course, mean that the actual voltage required to start a corona decreased as the wire diameter increased. That was not the case, but the value of the electric stress showed a steady downward tendency falling from 81·4 for the 0·70 mm. wire to 40·2 for the 9·53 mm. one.

It is stated by some authorities that the explanation of apparent decrease of electric strength is to be found in the assumption of a constant potential drop occurring at the

* Abstract of paper read before the Institution of Electrical Engineers, London, February 10, Dr. Gisbert Kapp (President of the Institution) in the chair. General summary of conclusions appeared in the last issue of THE ELECTRICAL ENGINEER.

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boundary of the wire, this being the same for all sizes, so that we may write—

$$\frac{V - E}{a \log \frac{b}{a}} = \text{constant} = R_o,$$

where E is the constant voltage drop in question. This gives—

$$V = R_o\, a \log \frac{b}{a} + E.$$

If this holds, we should on plotting V against a $\log \frac{b}{a}$ obtain a straight line passing through the point.

$$a \log \frac{b}{a} = 0, \qquad V = E,$$

and thus giving the value of E and R_o.

If this be done for the points in question, the points obtained will be found to lie not on a straight line but upon a curve concave to the axis of $a \log \frac{b}{a}$. Moreover, if a straight line be drawn tangential to the curve for points between $a \log \frac{b}{a} = 0{\cdot}6$ and $1{\cdot}2$, it will be found to give values of E ranging between 10 and 20 kilovolts—*i.e.*, in the latter case actually more than the observed critical voltage for the smaller wire.

It does not, therefore, appear as if this explanation is a satisfactory one, and, to the author's mind, a far more reasonable one lies in the assumption that the layers of air near the wire or, in fact, near any conducting surface, have an electric strength greater than that of the main body. This is an old idea, and has been suggested by Steinmetz, Ryan, and others. It will readily explain the high values of electric strength obtained with the small wires as the thickness of the layer of electrically strong air is greater in proportion to a small wire than a large one. It is supported by the fact that the thin films formed in certain electrolytes such as are used in electrolytic rectifiers and lightning arresters are known to possess an abnormally high electric strength. It is also supported by the following fact observed in connection with the above tests :

When the wire was positive to the tube it was found that for wires more than 6 mm. diameter a disruptive discharge occurred instead of a corona. Now it can be easily shown that if the electric strength of air were constant this could not occur unless the diameter of the wire was more than $\frac{1}{2{\cdot}718}$ of the diameter of the cylinder. The wire was actually much less than this, and we can only conclude that the electric strength was not constant but decreased the further one went from the wire, so that once the discharge started actual disruption occurred.

If we accept this hypothesis, we can find the relation between distance from surface of conductor and electric strength by plotting against distance from conductor surface the value of the electric stress at that distance due to the charge on the wire. This is equal to—

$$R_a \times \frac{a}{r}$$

where—

R_a = stress at surface of wire.
r = distance of point considered from centre of wire.
a = radius of wire.

At some point this curve must touch the curve expressing the electric strength of the air—it cannot cut it. Hence, if a number of such curves are drawn for different wire diameters, their envelope will give the relation between electric strength and distance from conductor surface which is desired.

If the values of the electric strength of air deduced from these experiments against the diameter of the conductor employed are compared, they will be seen to agree very well indeed with Ryan's and the Telluride measurements, but are considerably higher than given by Mershon's tests. The conditions, however, more resembled those of the former than the latter experiments, so that such an agreement is really highly satisfactory. It seems to show that the critical voltage is the same both for alternating and direct current pressures, provided that in every case the maximum value of the impressed voltage is taken as the determining factor. It would, therefore, appear that the frequency of supply in an alternating-current system will make no difference to the critical voltage, although it will, of course, considerably affect the losses after the critical voltage has been passed.

The second conclusion to be drawn from the curves is the effect of atmospheric pressure upon the critical stress.

As far as can be told from the readings taken, this is represented by a straight line which does not, however, pass through the origin, giving if produced back a residual electric strength for zero air pressure. Of course, this is not actually the case, and the curve bends down somewhere, but between ½ atmosphere and 1 atmosphere it seems to be practically straight.

An equation which appears to fit the lines for all the wires very fairly well is—

$$R = R_o \left(0{\cdot}2 + 0{\cdot}8 \frac{P}{760}\right),$$

where—

R_o is the electric strength at 760 mm.
P is the barometric pressure considered.
R is the electric strength at that pressure.

(It should be stated that the temperature during the experiments was 17° C.)

This result is rather higher than that obtained on a wire 0·125 in. diameter by Professor Ryan, who obtains a straight line having the equation—

$$R = R_o \left(0{\cdot}115 + 0{\cdot}885 \frac{p}{760}\right).$$

This wire is, however, smaller than most of those used in the foregoing experiments.

An attempt was made to determine whether the presence of water vapour had any effect upon the critical stress, the cylinder being filled with dry air, which was then drawn out by the pump, moist air being allowed to take its place. No noticeable effect should, however, be observed both the starting-point of the corona and the loss remaining unaffected.

If these figures are to be applied to the case of an alternating-current line, it must be remembered that the voltages given are the maximum values, and must for that case be divided by the amplitude factor.

It now remains to consider the tests which were made upon the two parallel wires hung out of doors. It can hardly be claimed that these tests are anything like as complete or conclusive as those which were carried out on the wire and cylinder, as they were very much limited by the apparatus which was available, chiefly by the generator.

This, as has been mentioned, could only work up to 70,000 volts, whereas to obtain results with wires of the sizes normally employed in transmission work would have required voltages of 200,000 to 300,000. An arrangement was made for connecting another machine in series with the main one, but the current given by this one was so small that no definite corona or critical point could be observed. As a consequence of this, tests could only be made on small-sized wires (diameters of 0·70 mm., 1·195 mm., and 1·65 mm. being employed), and one had to be content with attempting to predict from these what would be the behaviour of larger ones were it possible to employ them.

The influence machine employed had to be specially made for the purpose in order to get sufficient output, and no other was available to put in series with it. It is hoped that when another influence machine of sufficient output has been built, it will be possible to obtain some tests at higher voltages.

Of the tests which were carried out special attention should be paid to the one on the 0·70 mm. wire, as this is the most complete and affords the best basis for comparison with the wire, in cylinder tests.

The values of the critical stress given by the curves are considerably lower than those obtained from the tests of the wire in the cylinder being for the dry wire only 65 instead of 81·4 k.v./cms.

The two curves for the wet and dry wires, although starting at considerably different values, gradually approach one another and show a tendency to run together.

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The explanation of these effects is believed to lie in the fact that the wire being dirty was not behaving in quite the same way as when tested in the cylinder. A large loss would probably occur before the wire was uniformly surrounded by a true corona, and it is conceivable that upon a loss occurring in this manner the presence of moisture might produce some effect which would not occur for a perfectly clean wire.

The tendency of the two curves for the wet and dry state of the wire to run together is explainable on this assumption as the loss prior to the formation of the true corona, which alone is affected by the presence of water vapour would become relatively of less importance after the corona had formed and as the loss was increased.

Another peculiarity of these results is that the value of $\frac{dI}{dV}$ is much less than it was for the case of the wire in the cylinder—*i.e.*, a given increase of voltage above the critical one produced a much smaller increase in the value of the current loss per kilometre of line. This was not expected, as it was thought that the rate at which the ions would leave the surface of wire would depend simply upon the potential gradient in its neighbourhood which was urging them forward, and would be uninfluenced by the manner in which the gradient was produced, whether by placing the wire in a concentric cylinder or parallel to another wire. This should certainly be the case were the potential gradient near the wire settled only by the ordinary electrostatic laws, but it seems probable that once a discharge has commenced this will not be the case, as the distribution of electric stress will be affected by the presence of the charge carrying ions which permeate the surrounding space. It seems, indeed, very probable that the electric stresses shown on the curves as existing at the wire after the corona has formed are only apparent and do not really exist.

It was hoped when the experiments on the parallel wires were started that it would be possible to obtain some factor by which to multiply the values of electric stress obtained from the tests on the wire in the cylinder in order to obtain values which could be used if designing an actual line. It can hardly be claimed that the tests given enable one to do this with certainty without allowing a considerable margin. Judging from the tests given a factor of safety of two would cover all ordinary cases, and one of still less, say 1·7 to 1·8, would probably be sufficient. It is true that the larger wires appear to require a bigger factor of safety than the one of 0·70 mm., but it was not possible to carry the voltage high enough to obtain a definite corona with these sizes, and the distribution of loss may not have been uniform, being possibly greater at the ends (which were near to buildings) than in the middle. It is worthy of note that the ratios by which Ryan's tests on the wire in the cylinder exceed Mershon's Niagara experiments vary from 1·73 for a wire 2·5 mm. diameter to 1·59 for one of 10 mm.

DISCUSSION.

Mr. J. Highfield: In making these tests with direct current on the leakage due to air discharge, one of the greatest difficulties is to obtain a sufficiently high current pressure with any amperes behind the volts. With the ordinary influence machine it is quite impossible to get anything like sufficient watts to take such experiments. Mr. Watson appears to have used a machine which gives results very much superior to anything I have heard of before, and I hope some day he may give us a description of the machine that he uses. It does not seem to me, however, that the losses ascertained in the paper quite agree with the actual losses over long lines in practice. Mr. Watson's tests seem to show that the critical voltage is the same both for alternating and direct current pressures, provided that in each case the maximum value of the impressed voltage is taken as the determining factor. It appears to me that those tests made under actual conditions of practise have a great deal more value than tests made in tubes. I have no doubt that with still further improvement of the influence machine such tests could be made, and would prove of very great practical value.

Dr. A. Russell: One or two points Mr. Watson has not made quite clear. He opens by saying that what limits the voltage for use in practise is the brush discharge of the line itself. There is no reason why one should not put an insulator leading round it so as to prevent the electricity escaping, just as we have a little packing round steel pipes to prevent heat escaping. I do not at all agree with Mr. Watson in the assumption that the layers of air near the wire or, in fact, near any conducting surface, have an electric strength greater than that of the main body. I think the electric strength of air is something definite. The explanation that I now favour for these different values is that the electric stress near the wire of a high potential is not that given by the formulæ. I appreciate very much the figure, shown by Mr. Watson, in which are plotted the values of the electric strength of air deduced from his experiments against the diameter of the conductor employed: it shows what a careful experimenter he is. With the general conclusions I am in agreement. There, apparently, is little difference between alternating and direct-current tests.

Mr. E. H. Rayner (of the National Physical Laboratory): Mr. Watson has just been describing the same experiment which I did a few weeks ago. The results show a wonderful concordance between us. High voltage continuous current is rather a hard nut to crack. I should like Mr. Watson to give us some details as to the output of this machine at different voltages. To those who have to consider the question of apparatus, some little information as to the output of a high voltage continuous current machine is very useful. As to the effect of dirty wires, I have not come across the trouble or did not notice it. It seems to me that if you have a very thin wire dirt will be of advantage to keep the current on. If you have a very big wire and a little lump of dirt you will get your corona formed at lower voltage. I have been using smaller wires, and it might be that smaller wires would not show the same trouble to increase loss at lower voltages simply due to dirt. Dirt would act on the thin wire as increasing the diameter of the wire. My own experiments have been founded in the works of the Engineering Standards Committee on insulating materials. The wattmeter which I constructed to measure the actual watt losses in insulation is extremely simple, and works surprisingly well. It is an electrostatic arrangement, and works up to 10,000 or 15,000 voltages, and without much trouble can go up to higher voltages. The maximum voltage of alternating current and continuous voltage seems to have the same effect on the air, and the ionizing begins at the same stress whichever you take into account.

Mr. J. S. Cooper: The whole question really depends upon economical considerations and nothing else. Turning to the technical side, we find all through the paper that the thing off which the losses take place is called a "wire"; in other words, we do not find anywhere what that wire is made up of. That amounts to a decided presumption that the phenomena is purely physical, but as far as I know it has not been proved it is absolutely physical. In Mershon's experiment he actually gives the comparative curves of the same size of copper and aluminium wires, and there he found there was greater loss at a given voltage per kilo of a mile on aluminium than there is on copper. It may be that the difference is due to surface texture. There is the possibility that the corona as an illuminating factor would have an influence on the use of aluminium instead of copper.

Mr. M. Hobart: The question of how to transmit electricity to a distance to the best advantage is one of greatest importance, and while my own opinion is that the alternating system is in practically all respects the best, nevertheless, a great many good points have been claimed to be made out for the continuous system.

Dr. Gisbert Kapp: May I appeal to the author to satisfy the desire expressed by several of the members, not to give us merely an outside perspective view of that interesting machine, but to publish working drawings of it. So many men are working on this most important subject, that it would, I think, be of great help to us if we had working drawings of that machine with which he produced those high voltages, ranging up to 80,000. I understand he used the principle of working the machine in compressed air. That was the means of getting these high voltages without having any internal disturbance with the machine.

Mr. E. A. Watson (in briefly replying to the discussion) said he would be very pleased to describe the construction of the influence machine referred to in the paper.

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PUBLICITY.

In this Section of "The Electrical Engineer" we give Publicity to New Inventions and Specialities.

TRUSTWORTHY FUSES.

Fuses being one of the vulnerable points of electrical installations, have received a considerable amount of attention from inventors and manufacturers, and not least among these we must reckon Messrs. Siemens. Their endeavours were directed to produce a more mechanical and trustworthy system of fusing than any of those now

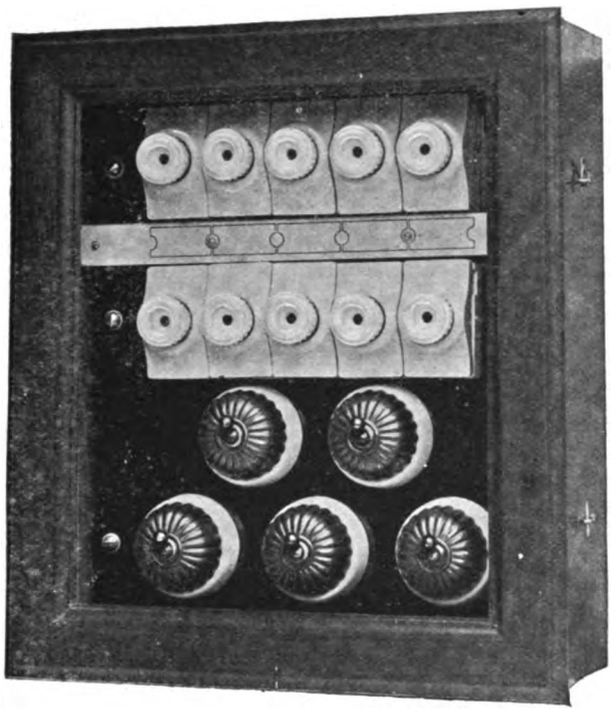

Fig. 1.

in vogue. After carefully studying the special conditions to be met and the efforts towards the standardisation of fuses in British, American and Continental practice, Messrs. Siemens Bros. Dynamo Works, Ltd., have designed the new "Zed" fuses so as to embody those points essential to a good device suitable for electrical work in this country.

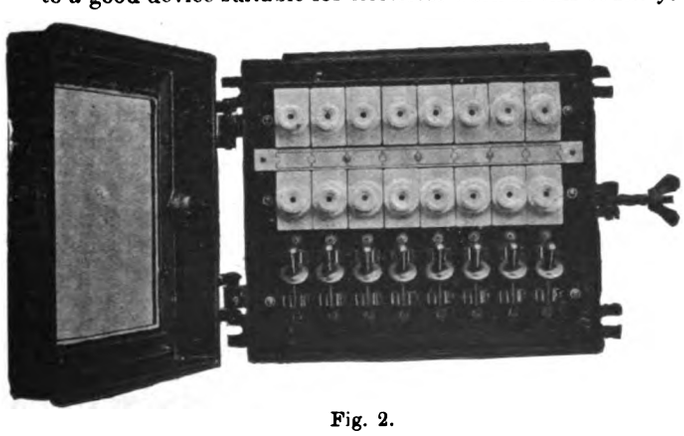

Fig. 2.

The sound design, reliable action and convenience of this new "Zed" type will unquestionably earn a high reputation for them, and for all installations in which they are used, and it is well to give a brief outline of their particular merits.

They are so constructed that all live parts are completely enclosed, and when in operation the molten fuse wire remains in the cartridge, and there can be no "flashing" or arcing, so that they are safe and conform to the requirements of the Home Office. The covering in also protects the wires from oxidisation. As the dimensions

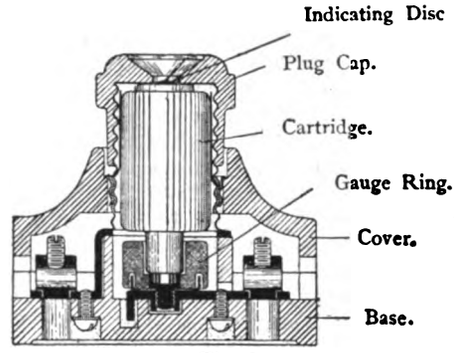

Fig. 3.

of the fuse holder and wire are proportioned to the current and voltage, certainty is assured of blowing at a definite overload. Another safety device is the gauging of each fuse fitting to a definite current capacity, thus making it impossible to insert cartridges of too strong or too weak capacity. The fuses act on a "dead" short circuit, and the

Fig. 4.

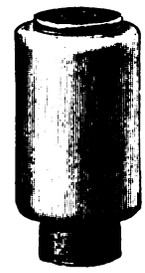

Fig. 5.

blowing is instantly made known by an indicating device. Fig. 1 shows a 5-way 6-amp. wood cased distribution board, with double-pole fuses and single-pole tumbler switches, while Fig. 2 represents an 8-way, 15-amp. iron-cased distribution board with double-pole fuses and single-pole quick break knife switches. The actual construction,

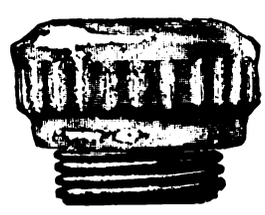

Fig. 6.

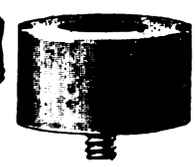

Fig. 7.

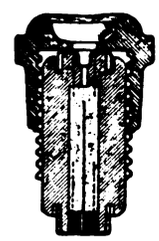

Fig. 8.

and relative position of the different parts, is well shown in Fig. 3. The indicator disc is coloured differently according to the amperage, from pink for 2 amps., to copper for 60 amps. It will be seen from these illustrations, and Fig. 4, how safety is attained with perfect control. Figs. 5, 6 and

7 show respectively the complete cartridge, the gauge ring and the plug cap with indicator disc. Fig. 8 shows a section of the cartridge fitted with plug cap. These "Zed" fuses make a safe job, give complete control of circuits, operating perfectly on a "dead" short fed by large capacity generators; they are easy and safe to fix, and look well. Altogether, the system is one to be recommended to engineers, contractors and consumers.

STERILISATION OF WATER BY THE ULTRA VIOLET RAYS.

An interesting account of the Nogier system of sterilising water by means of mercury vapour lamps is given in the *Sanitary Record*. After describing the various experiments carried out by Dr. Nogier and his colleagues, it is explained that water containing one million bacteria and 100,000 Bacilli coli per cubic centimentre was completely sterilised in one minute. The same result was obtained when the content of B. coli was doubled. A still worse mixture, containing a million bacteria, 100,000 B. coli, and 200,000 Eberth's bacilli was treated equally successfully.

It was found that the ultra violet rays emitted from a mercury vapour lamp did not modify the chemical constituents of the water. Nogier's early experiments showed that there was no ozone in the cooling water of a Kromayer lamp. His experiments with Rochaix and Morel went to prove that chemical reaction is not set up. Water containing organic matter of various kinds was exposed to the ultra violet rays for 10 min., and no ozone was generated. This was also found to be the case when highly oxygenated water was used. The same observations are recorded as regards ammonia, nitrites and nitrates. In fact, Nogier points out that preliminary filtration is necessary. The ultra violet rays act essentially as bactericides. An important and rather unexpected confirmation of this was obtained in treating toxines. It was found that a prolonged exposure of a concentrated preparation of tetanic toxine gave practically no result. The toxic effect remained as virulent as ever; but when the toxine was abundantly diluted in water (as might conceivably occur in an extreme case of pollution), the toxine was quickly destroyed by the ultra voilet rays of the mercury lamp. It is all a question of penetration.

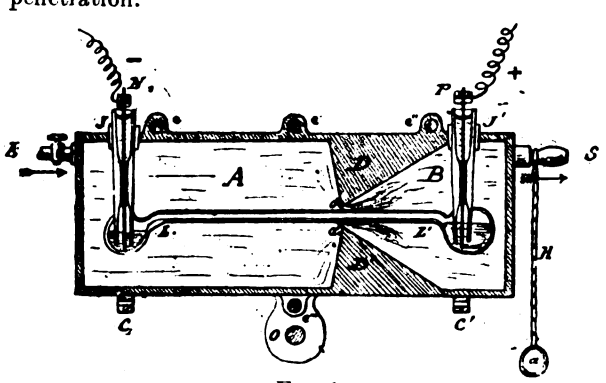

FIG. 1.

Treated water undergoes no appreciable alteration as regards appearance, odour, or taste. Rabbits, guinea pigs, and dogs were given the sterilised water to drink for over a month, and flourished on it.

Convinced, therefore, of the practicability of sterilising water by means of the ultra violet rays from mercury lamps, the next step was to find an economical solution to commercial application of the discovery. This has been done by M. Nogier, who describes his apparatus as follows:—There are three parts (Fig. 1). (1) The burner, or quartz, or crystal mercury lamp, designed to emit the rays in short waves. It is a long tube L L^1, terminating at each end by a bulb containing mercury. The electric current is conveyed by two special metallic electrodes N and P, and is suspended in the middle of the casing by two tubes protecting the electrodes, and fixed hermetically at J J^1 to the casing.

(2) The casing is in aluminium, and consists of two chambers of unequal dimensions A and B, divided by a diaphragm D D^1, with bevelled sides. The first section A is a kind of preparatory chamber, while in B the sterilisation is perfected. In order to allow of the introduction of the lamp, the casing is made in two equal parts, pivoted on two hinges, C and C^1, and fastened together by means of screws tightened in the cars *e*, e^1, e^{11}, e^{111}. The water enters by a cock E, and is withdrawn through a pipe S. The whole apparatus can be oscillated on the axis O, the lamp being lighted by tipping over. At the side of the casing is a peep-hole protected by glass, from which an exceedingly brilliant shaft of violet light streams when the lamp is in action.

(3) A second method of control, however, is provided by the automatic cock (Fig. 2). It is made up of two principal parts. (*a*) The cock B, consisting of a point with truncated cone end, which fits into a bevelled chamber in the thick copper end piece AA^1. (*b*) Its armature F^1 in malleable iron, attached to a malleable iron piston TT^1, which a powerful spring R presses downward. The spring is calculated so as to equalise the pressure of the water, so that when the apparatus is out of action, not a drop of water coming in through E can escape through S. Above the armature F^1 is a piece of malleable iron F which can become a powerful magnet when influenced by the ring armature El which surrounds it. The piece F can be adjusted by means of a nut V.

The whole action of the apparatus is quite simple. The electrodes are connected with a continuous electric current, and the ring armature El of the automatic cock is also placed in circuit, then the chain H attached to the ring *a* (Fig. 1) is pulled, and the apparatus is oscillated from right

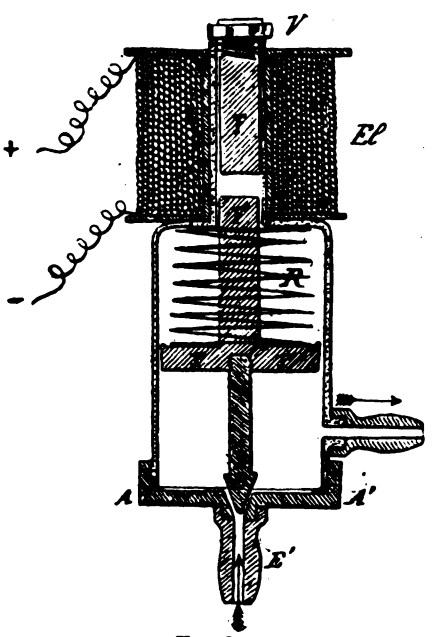

FIG. 2.

to left, thereby lighting the lamp. As soon as this is done the current passes through the lamp, causing the mercury to vaporise and making the vapour luminous, and at the same time it magnetises F and thereby attracts F^1. At once a circulation of water takes place, entering by E^1 and leaving by S^1 (Fig. 2) through the sterilising chamber by way of E and S (Fig. 1). This circulation is kept up so long as the lamp is alight, because it corresponds to the passage of the electric current. But so soon as the current ceases to pass the electro-magnet El is demagnetised, and no longer attracting F, the cone B descends and lodges in the bevelled orifice, stopping the inflow until the electro-magnetic ring is once more energised by the passage of the electric current.

The sterilising process is easy to follow. Water on entering chamber A is exposed to the action of the ultra violet rays from the lamp LL^1, but the diaphragm DD^1 causes the circulating water to come into contact with the lamp in a very thin layer, which, owing to the special bevelled form of the diaphragm, is pressed against the lamp, thus subjecting it thoroughly to the influence of the violet rays. An important point is that the automatic cock assures the proper function of sterilising, for if through any accident the lamp is extinguished the electro-magnet is instantly demagnetised and closes the flow of water.

From the above it will be seen that the apparatus is simple, and the working presents no difficulties, whether the process is to be carried out on a large or small scale, and that it is cheap.

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Electrical Progress at Home & Abroad.

A Review by our Special Correspondents.

TYNESIDE.

NEWCASTLE-ON-TYNE.

The extensive developments which are now being carried out by Messrs. Sir W. G. Armstrong Whitworth & Co., Ltd., at Walker, and which have been previously reported in this column, have, by a report which has just been circulated, received their true significance. It appears as though the movement of the whole of the shipbuilding work to the below-bridge location is to be effected, and that Elswick will become solely an engineering branch of the firm. This is a step in the right direction, not only on account of the increasing size of warships rendering it difficult to navigate them past the bridges, but also because there is at present considerable congestion in the engineering department. With further reference to the renewed activity of Sir J. Laing & Co., Ltd., of Sunderland, a report has been circulated that the Sunderland Corporation intends to sue the firm under the terms of contract for electricity supply, in consideration of the fact that the stoppage of the works curtailed the output of the electricity supply station during the period of suspension. Whether this is correct or not, it has been decided by the Corporation to lose no time in re-establishing a supply to the firm, in order to assist it to commence work at the earliest possible date, and so to some extent relieve the distress in the town.

Local Engineering Work.

Acting on the recent report of Mr. Kirkpatrick, the City Engineer, the Newcastle Corporation Trade and Commerce Committee have sent a recommendation to the City Council that they should place an additional crane on the Quayside, at a cost of approximately £1,300. The present cranes are electrically operated, and it may, therefore, be assumed that the new one will be similarly equipped. There is also a report that two new cranes are to be installed upon the Fish Quay, North Shields. In general work, the removal of the process block-making firm known as Northern Inventions, Ltd., from their premises in Grainger-street to improved quarters in High Bridge, has been made the opportunity of providing a highly efficient and modern equipment, including arc lamps of the latest special type, both for camera work and for printing the pictures so taken on to the zinc plates before etching.

Electrical Agencies in Newcastle.

Manufacturers are apparently anticipating a strong revival of trade in Newcastle district by strengthening their sales agency equipments here. The staff of the Armoduct Manufacturing Co., Ltd., has been strengthened; while Mr. J. Parmley Graham is opening new and extensive showrooms and sales offices in the Cloth Market, Newcastle, on behalf of Messrs. J. H. Holmes & Co., the Western Electric Co., Arc Lamps, Ltd., Messrs. Wellman, Seaver & Head, and the Credenda Conduits Co. A range of stock will be shown covering these firm's mining and engineering appliances, and the bringing of these specialities prominently before the public will, it is anticipated, develop sales. Some months ago the premises of the Simplex Conduits, Ltd., were destroyed by fire, and since then business has been conducted in temporary premises. Rebuilding has, however, now been finished, and the firm will almost immediately remove back to its old address in High Bridge, with the advantage of new and up-to-date rooms in which to show the large range of material carried

Electric Shock.

A further meeting of the Institution of Mining Electrical Engineers was held under the chairmanship of Mr. W. C. Mountain, of Messrs. Ernest Scott & Mountain, on Wednesday, the 9th inst., to further discuss the paper on "Electric Shock." Details of design of cables and the methods of avoiding shock from them were carefully gone into; and Mr. Clothier, of Messrs. A. Reyrolle &.Co., Ltd., gave some interesting particulars of the Merz-Price system of electrical protection as applied to mines. This particular application of the Merz-Price system has, so far, escaped much attention, and its value should be emphasised. Among other speakers were Mr. Fisher, the local Secretary, who gave valuable details on cable design from the practical chargemen's point of view, Dr. Thornton and Mr. A. M. C. Field. The discussion was long, owing to no paper having occupied the time, but interest was unflagging throughout the long session. On Saturday, the 12th inst., at a general meeting of the North of England Institute of Mining and Mechanical Engineers, a discussion was resumed upon the papers read at the previous meeting, among which was the paper by Mr. J. Douglas upon "Electric Shot Firing."

THE MIDLANDS.

BIRMINGHAM.

A decided preference of iron over copper as a suitable material for lightning conductors was expressed by Sir Oliver Lodge in a lecture on "Lightning" given by him last week to the University Engineering Society in Birmingham. Sir Oliver pointed out that in designing a lightning conductor there was a great deal more than the mere getting down to the earth of the volume of the electric charge. There was also the question of its potentiality. Such a charge was one of hundreds of millions of volts and carried with it a great amount of energy, and the problem really consisted in dissipating or getting rid of that energy. It did not at all follow that in order to get rid of that enormous amount of energy it had to be done quickly; it might be safer and wiser to get rid of it gradually. A copper pillar a foot thick by providing very perfect conductor could get rid suddenly of a store of energy in the clouds, but in that case violence must be expected. A conductor made of thin iron would not carry the lightning away so quickly, and consequently there would be less violence. The iron offered a great deal more resistance than copper because the current was so throttled that it had to keep to the thin layer on the outside. Thus, the energy was dissipated and the discharge was made quietly instead of violently. Therefore, the merest film of iron was sufficient to act as a conductor for the rapidly alternating currents in some of the lightning flashes.

Iron v. Copper.

It will be remembered that, in the case of the buildings on the dams of the Birmingham Waterworks in the Elan Valley, referred to in our last week's notes, Sir Oliver advised the use of copper as a conducting medium. Sir Oliver, however, in his report to the committee, explained that he specified copper solely because of its chemical durability. Iron or lead, he said, would be equally efficient, and iron would be even preferable electrically; but iron would rust away and lead would be deleterious. Copper, therefore, seemed to him most likely to be efficient and durable under or near the water.

Incandescent Lamps.

The incandescent lamp continues to occupy a prominent position in local electrical societies' discussions. The subject was brought before the monthly meeting of the Birmingham and District Electric Club, held at the Colonnade Hotel on Saturday evening, under the presidency of Mr. G. O. Donovan, M.I.E.E., when Mr. James Findlay read a paper on "The Electric Incandescent Lamp: Its Manufacture and Application." In his review of the history of the subject since the electric incandescent lamp was first made a commercial article by Swan & Edison about 30 years ago, Mr. Findlay said that the most important advance was the substitution of the tungsten filament for the carbon filament.

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The price of the carbon lamp had fallen rapidly to 5d., but the metallic filament lamp was not likely to reach so low a price, for though it could be produced by an expert workman at the rate of one per minute, the costliness of the materials precluded all possibility of any great reduction in price. The filament consisted of, among other things, a small piece of platinum which, in itself, was 50% dearer than a similar quantity of gold.

Testing Lamps.

Replying to questions, Mr. Findlay said that in the United States an arrangement existed in many cases between manufacturers and customers with regard to the testing of lamps by which if a test of a sample lamp showed that the lot to which it belonged was of better quality than was specified a bonus was paid by the customer; while if it fell short something was taken off the account. This was only possible where trusts existed, but it was certainly one of the good points of the trust system. In one case, where a manufacturer turned out 24 million lamps a year, one customer took as many as four million, so that the conditions for the carrying out of such a system were ideal.

High Efficiency and Long Life.

Mr. Findlay, like other manufacturers of incandescent lamps, has been confronted frequently with the difficulty of meeting the desire of the customer for a lamp combining high efficiency with long life, but he was unable to suggest any probability of the two things being rendered to any great extent compatible under present conditions. He added that it was only recently that the electric lamp had really been able to compete from the point of view of economy with the gas lamp. It was a remarkable thing that the man who gave gas consumers the mantle, and so greatly increased the efficiency and economy of gas lighting, was also the first to undertake experiments, the outcome of which had been to make the tungsten lamp a possibility. Welsbach probably did not quite make the tungsten lamp. He called his lamp the Osmium lamp, but that certainly paved the way for the tungsten. Tungsten was by nature very brittle, owing to the presence of carbon. As manufacturers became able to make filaments more and more free from carbon they would get them less and less brittle, but they would not get the tungsten filament like the tantalum. This matter of the carbon, Mr. Findlay pointed out also, bore upon the question which had been asked with regard to the blackening of the bulb. The problem here was one, he pointed out, partly of the efficient treatment of the filament and partly of proper exhaustion of the bulb. Among other matters referred to in Mr. Findlay's reply, was the American system of repair by taking out and recoating filaments. Three new members were elected at this meeting, namely, Mr. C. W. Arthur electrical engineer; Mr. R. E. Bentley, mechanical and electrical engineer, and Mr. B. W. Coles.

Electric Dispersion of Fogs.

The experimental researches into the effect of electricity upon fog commenced by Sir Oliver Lodge in Liverpool and continued by him in Birmingham have been temporarily suspended. The reason for this is not any modification of Sir Oliver's views on the subject or any cessation of his interest. It is simply that the spot selected for the experiments in the neighbourhood of the old university buildings in Edmund-street has failed to furnish the *corpus vile* in the shape of fogs to disperse. There is a proposal to conduct a similar experiment under Sir Oliver's direction and on a more extensive scale in London, somewhere in the neighbourhood of Hungerford Bridge, where, it is hoped, a choice assortment of fogs may be more often available. A sum of about £1,000, however, is required in order to enable this installation to be made, and at present it is not clear how the funds are to be provided for.

Vitrite.

A site has been secured in Wolverhampton for the manufacture of lamp caps under the "Vitrite" patents by the company which has been formed under the auspices of the Wolverhampton Industrial Development Committee. The premises selected are those of the new Griffin Works, Horseley Fields, which have an extent of about 4 acres. Half of this property has been taken on lease by the company, but it is not expected that manufacturing operations will commence until three or four months hence.

LANCASHIRE.

MANCHESTER.

One of the most interesting events to record is the 54th annual dinner of the Manchester Association of Engineers, which took place on Friday. A number of distinguished engineers attended, among whom were Sir William White, Messrs. Dufald Clerk, T. Astbury, J. C. Newbigging, Prof. Petanel, of Manchester University, and Mr. S. J. Watson, Chairman of the Local Section I.E.E. The Chairman, Mr. J. H. Stubbs, presided. Sir William White, in responding to the toast of the visitors, made some remarks on the position of the engineer in relation to modern life. He said it was absolutely impossible to do without the engineer, in all great centres of industry he was a necessity. As the years go by, the demands made upon him were ever increasing, and still further demands would yet be made. He thought the essence of all successful engineering was good fellowship, the free communication of ideas and results, and a spirit of mutual helpfulness. That was the spirit of their Association. Engineers all over the world were ever striving to increase the general store of knowledge for the benefit of their brother engineers, their nation, and the world.

Students Section I.C.E.

The Manchester Association of Students of the Institution of Civil Engineers took as the subject of their annual debate, Gas *v.* Electricity. The discussion centred round the question of lighting chiefly. Mr. J. H. Robinson, who opened the discussion in favour of gas, quoted £6 5s. as the cost of a 180 candle-power gas lamp running for 4,000 hours for street lighting. He reckoned the cost, using electricity, for the same work would be £13 2s. Berlin, he said, would in future be lit by high-pressure gas burners of 60 candle-power each, at a cost of 10s. per 100 hours, replacing the electric lights of the same intensity at £1 4s. 2d. per 100 hours. Mr. Cunliffe, dealing with the metal filament lamp, pointed out that it was as yet only partially developed, and expressed the opinion that when it had been perfected gas would be found dear as a light. The method of charging for electricity supply was based on the fact that the maximum amount of energy required had to be produced at the moment, as there was no efficient way of storing large quantities of electricity. This entailed a relatively large plant, working to its full extent for only a very short time each day. This was a disadvantage from which the gas industry was free. As a instance of freedom from breakdown, he instanced the overhead trolley lines in Manchester. There were over 200 miles, and they had not had half-a-dozen breakdowns in six years.

FRANCE.

PARIS.

From the electrical point of view, Paris and its suburbs are still in a very bad way. Little beyond clearing up has been possible, owing to the extent of the damage done both at the generating stations and in the underground mains. However, the work of overhauling is being grasped with vigour, and steps will shortly be taken to make good all deficiencies. As I said in my last, now is the time to act, for French electrical engineers will be glad of prompt assistance from manufacturers abroad. Troubles among electricians here do not yet appear to be over, for there are again signs of a rising flood, and in spite of the engineering precautions taken, another overflow would be bound to do considerable damage.

L'Eclairage Electrique.

This company has proved a sore disappointment to its many shareholders. Last year's trading of just over £38,000 brought in a meagre profit of some £1,200, which, on a capital of £240,000 will not go very far. The previous year the profits had been over £29,000, and the dividend paid was 15%, as it had been for two years running before that, which was not bad, even compared to the 20% paid for the two trading years of 1903–4 and 1905–6. In five years to fall from 20% to nothing is rather severe.

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Electrical Tillage.

A few miles from Arcachon an elaborate system of tillage by electricity has been carried on for the past four or five months. A miniature hydro-electric station has been erected, the power being obtained from a fall secured by means of the Canal des Usines, which unites the Cazau Pond to the dock at Arcachon. This canal runs through the Villemarie Pond, which is utilised as a reservoir. Sufficient force is available to work a 50 h.p. turbine. Two continuous-current dynamos generate 33 amp. at 600 v. The current is conveyed to the fields by two copper cables. Various forms of harrows, ploughs and reapers are used, and the undertaking has worked out most economically.

GERMANY.

BERLIN.

During last year the postal telegraph service in Germany was increased by the addition of 1,416 new offices, and by the installation of several new direct lines, including those between Bremen and Chemnitz, Bremen and Dusseldorf, Breslau and Danzig, Hamburg and Duisburg, Leipzig and Stettin, etc. The chief new telephone lines are those from Cologne to Paris, from Berlin to Amsterdam and from the latter place to Basle and Frankfort. Others are in progress of construction, including one between Berlin and Vienna, one connecting Frankfort with Nuremberg and Vienna, as well as lines from Leipzig to Prague, and from Hamburg. The Frankfort-Vienna line is actually at work, having been started on New Year's Day, to Antwerp. Many technical improvements have been introduced into the service, and we can claim to be the first to experiment with public telephones with which it is possible to communicate direct without first calling up an exchange. This new departure is, however, still under probation. We hear that it may ultimately be brought under the fee in the slot system. It is evident, however, that such a plan can only be adopted between country places, as it would otherwise entail an enormous multiplication of wires.

A Berlin Triumph.

All the Berlin papers note with the utmost satisfaction the remarks of Lord Bessborough, chairman of the London and Brighton Railway, in regard to the electrification of the line. The work was done by the Allgemeine Electricitats Gesellschaft, of Berlin, and at the recent meeting of shareholders Lord Bessborough informed them that the traffic had increased by 63% since the electrification. Your German contemporaries remark on the generous praise accorded to a German company.

Optical Voltage Control.

Prof. M. Kallmann proposes arrangements for automatic voltage and insulation control in which resistances with a high temperature co-efficient are used to increase sensitiveness and a meter is used as an indicator. Two bridge branches contain the variable resistances, and the other two the constant resistances required for comparison. Corresponding to the working voltage to be controlled is a suitable constant resistance and also a resistance regulable at will. The indicating meter is in the diagonal, and is preferably in the form of an ampere-hour meter. The use of meters for this purpose is new and is highly advantageous as we get much greater sensitiveness than is possible with most volt meters or relays, while the movement of rotation gives a more distinct indication than other optical arrangements, and in very simple fashion. A falling off or increase in potential of one-hundredth of a volt is sufficient to set the meter in motion. To show in which direction the movement takes place, *i.e.*, whether the voltage is rising or falling, a reflecting ribbon is wound spirally on the revolving axis and reflects the light of a lamp to the eye. It is easy to see towards which end of the axis the screw appears to be moving.

Popularising Electricity.

E. Wikander, in the *Elektrotechnische Zeitschrift*, sums up all the proposals that have been made to make the public like electricity more and more under the following ten heads :—

1. Installations should be put in free of charge, with, of course, a higher charge for current, after the example of the Berliner Elektrizitatswerke.
2. The consumer should guarantee a minimum consumption of current during the first year if he gets his installation free.
3. If consumer pays for his own installation he should be allowed current gratis, or at a reduced price, for a certain time, say a year.
4. The cost of an installation should be payable by instalments.
5. Lamps should be sold or let on hire by the current producers. The sale should be at cost price, or at least at a very small profit.
6. Meter rents should be as low as possible.
7. The public should be instructed on the advantages and cost of electric lighting, and should be canvassed from house to house.
8. The installation cost should be lowered by simplifying the regulations.
9. Removal of lamps should be gratis.
10. Payment of the cost of connecting up a house with the street main should be payable in three yearly instalments.

Tidal Power.

News from Hamburg states that the project of Civil Engineer Pein, of Hamburg, for making a power station to be worked by the tides of the North Sea is within an ace of practical realisation at a cost of £150,000. The station will be erected outside the dyke at Blumenkoog, near Tondern, in Schleswig Holstein, where there is a mean tidal rise and fall of about 9 ft. A reservoir will be filled at high water for driving the turbines.

More German Progress.

A project for supplying all Upper Swabia with electricity is in course of execution. Lakes in the neighbourhood of Wangen are to be fused into one big reservoir covering about 5,000 acres, to be fed by the river Argen. It is confidently expected that 14,000 h.p. will be got from the reservoir.

A Shocking Turkish Bath.

A friend of ours has been greatly shocked at Solingen, and he was not the only victim. The shocks occurred with mathematical regularity, every third day between 5 and 6.30 p.m., to anyone touching the metal soap dishes or stepping on the metal treads of the stairs. Even in the swimming bath it was dangerous to catch hold of the safety rail surrounding the bath near the surface of the water. The trouble was finally traced to an alternating arc lamp using a 15 ampere current at 34 volts. When on every third day new carbons were put in, the interrupted current, through some defect in the insulation, escaped through the supports of the lamp down into the rooms, and made its passage thence to mother earth known after the playful fashion of its kind. The establishment is now quite safe, and at the worst the chief victim was *quitte pour la peur*.

UNITED STATES.

NEW YORK.

Mr. George Westinghouse, speaking at the Engineering Societies annual dinnner at Boston, put forward a strong plea for engineering standardization, the importance of which in the electrical field has never been sufficiently recognised in this country, notwithstanding the excellent results which followed the establishment nearly nine years ago of the Engineering Standard Committee of Great Britain. Mr. Westinghouse, who, it will be remembered, is the new President of the American Society of Mechanical Engineers as well as of the Westinghouse Electric and Manufacturing Company, pointed out that the wonderful material advances which have been made in this country are largely the results of the skill and activities of engineers, who, realising the value of co-operation, have, to still further add to their power and influence, associated themselves in organisations or societies representing many

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branches of engineering, civil, mechanical, electrical, mining, chemical, architectural, nautical and others. It therefore, he urged, seems most fitting and logical that we should encourage closer and more intimate relations between all engineering societies, in order that we may benefit from the power and influence which may come from combined efforts, not only for the advancement of science, but for the general welfare of every inhabitant of our country; and by working on broad, generous lines cause individual and professional prejudice with narrowness of vision to give way to that healthful condition of mind so necessary to correct conceptions and actions.

Need of Standardization.

Mr. Westinghouse declared that unregulated competition and rivalry in business had established conditions which made costs greater and rendered ideal conditions in industrial engineering matters most difficult of realization. "No, user of electrical apparatus," he said, "can fail to appreciate the advantage it would be to him when some repair part is needed if certain standards were followed by all constructors with reference to equivalent devices; but it is lamentable to say that with the single exception of uniform bases for incandescent lamps, there are now practically no standards. No other development has been comparable with the electrical, and never were there so many active minds at work on further developments as at the present moment. Each inventor sees what he believes to be a chief thing to attain. The vast majority of our inventors, however, having had but little experience in mechanics and mechanical engineering, usually proceed along independent lines, with the result of a constantly growing confusion, to the disadvantage of everybody. I have long believed," he continued, "and have urged upon my associates for the 14 years during which the two large electric companies have had the joint use by a license agreement of several thousands of patents relating to their business, that by co-operation in the development of apparatus and by the use of the same designs and by the exchange of engineering and manufacturing particulars, there would be evolved the very best of all kinds of electrical machinery and details, and that the products of the two companies could be made interchangeable, not only to the advantage of the purchasers and users of electrical apparatus, but also to the advantage of the companies themselves. Other views have prevailed, however, and there has existed an unregulated competition which has made the electrical industry about the poorest of all in the matter of profits. By a combined effort of all the engineering societies with the financial support of all manufacturers, a well-equipped and well-officered bureau of standardization could be established, and could work a reform of incalculable value."

Multiplicity of Motor Ratings.

In the course of his address, Mr. Westinghouse read a letter on the subject of motor ratings, which gave remarkable point to his plea. The writer gave a summary of the motors manufactured by his company, from which it appeared that though only stationary motors in sizes up to 200 h.p. were referred to, a total of 135 frames were used, giving 3,550 ratings—for direct current, 55 frames, giving 1,600 ratings; and for alternating current, 80 frames, giving 1,950 ratings. But this is only the beginning. Practically any one of these may be furnished in three types: (*a*) shaft horizontal; (*b*) shaft vertical; (*c*) with countershaft bracket and bearings mounted on the frame. This makes a total of three times 3,550, or something over 10,000 different motors available. Moreover, the standard motor may have differed in any one of the following characteristics: (*a*) Horse-power or speed rating; (*b*) dimensions of base; (*c*) over-all dimensions; (*d*) height from base to centre of shaft; (*e*) weight; (*f*) method of lubrication; (*g*) size of shaft; (*h*) performance guarantees. This demand for special apparatus places a heavy burden on the manufacturer. The purchaser also suffers because of increased cost and long deliveries. These particulars relate to only a part of the motors made by one large company, and there are half a hundred others manufacturing equivalent lines of motors; so it is safe to say there are many thousands of needless variations in motors which have added many millions to the investment already made in installations of electrical machinery.

The Edison-Beach Electric Car.

The description which I transmitted to you last week of the Edison Storage Battery may this week be appropriately supplemented by some details of the street railway car, by means of which the battery was tested with such complete and unequivocal success. Careful observation having demonstrated the fact that the power consumption of electric automobiles per ton-mile was very much smaller than the power consumption of standard railway cars, the Edison Storage Battery Company undertook to develop a car on new lines. The designer of the new car is Mr. Ralph Beach. The body of the car is 18 ft. long between posts, with 4 ft. vestibule platforms. The width at the sills is 6 ft. 6 in., and the width at the drip rails 7 ft. 3 in. The seating capacity of the car is 26. The underframe of the car is made up of two 3 in. × 6 in. ash longitudinal sills, and 9 cross-sills of the same size and material. A steel tie rod runs by the side of each cross-sill, and passes through the longitudinal sills, thus firmly binding the under structure. The battery equipment of the car consists of 200 cells of Edison A4 type for driving, and 10 cells of the same type for lighting. These cells are separately connected in working, but are connected in series when being charged, so that any variations in voltage owing to the operation of the car will not affect the lamps. The truck is of the standard gauge, four-wheel type, with 6 ft. 6 in. wheel base. The driving equipment consists of two 5 h.p., 110 volt Northern motors, which, besides possessing fairly high speed, are much lighter in construction than standard motors of the same output. The wheels are driven from these motors by means of a silent chain drive. During the trials it was found that the motors gave the car a maximum speed of 15 miles per hour, and with 14 stops per mile enabled a schedule of 8 miles per hour to be maintained. The power consumption in accelerating is said to be about 3½ kw. and in running about 1½ kw. The controllers are arranged to give the following three combinations: First step, batteries in multiple at 50 volts and motors in series; second step, batteries in multiple at 100 volts and motors in series; third step, batteries at 100 volts and motors in multiple. During the tests the car accelerated quite smoothly. The body of the car weighs 3,500 lbs., the truck and electric equipment 3,500 lbs., and the battery 3,000 lbs., giving a complete car of 10,000 lbs. The battery equipment is said to be capable of supplying energy for 150 miles on a single charge.

Edison Satisfied.

Mr. Edison has been interviewed by some of the electrical papers on the subject of the new storage battery. He intimated that he had really completed it to his satisfaction, and hinted a doubt as to whether any material improvements could be effected, at any rate, with our present knowledge. "After several years of interesting, though, at times, rather exasperating experiment," he said, "I am satisfied." Referring to the car with which the battery was tested, he said: "The new car is absolutely practical for commercial purposes. I have reduced the ordinary depreciation from 30 to 15% in the new motor. The new car might be used in the immediate future for taking care of the increased street railroad traffic in large cities without increasing the existing number of power-houses." He has several wonderful things coming along "in the electrical line," but they are not ripe yet for talking about, it appears. By this time Mr. Edison will have gone down into Florida for his annual holiday. He has a laboratory there, and he is taking five men with him. He hopes to perfect several wonderful notions during his two months' stay.

New Storage Battery Patent.

A new patent has just been granted to Mr. Edison for a process for impregnating the mass of material for alkaline storage batteries with an oxygen compound of bismuth. Nickel hydroxide is first crushed into small granules so that the whole mass will pass a 20-mesh screen. To this material is added a concentrated solution of trichlorid of bismuth dissolved in a strong aqueous solution of chloride of ammonia. Enough of this solution is added to cover the nickel hydroxid mass, which is allowed to soak for several hours in the solution until the pores of the hydroxid particles become saturated therewith. The solution is then drawn

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off, and the wet mass of active material is subjected to the action of a centrifuge, by which most of the adhering solution will be removed. The mass is then dried, and when thoroughly dry, is added to a considerable excess of a 10% solution of potassic or sodium hydrate, which is then heated for several hours near the boiling point, and for about 30 min. at the boiling point. Afterward the caustic sclution is drawn off and the resulting mass is successively washed with warm water until the alkali is washed out, after which the mass is dried and is ready to be used in connection with the make-up of the electrodes in any suitable way. It is claimed that storage batteries employing nickel hydroxid, the particles of which contain in their pores, bismuth oxid of hydroxid, will not deteriorate in capacity to the same extent over long periods of time, as when nickel hydroxid alone is used. By employing in the electrolyte a small percentage of lithium hydroxid the capactiy of the battery is very greatly increased, especially when used in badly ventilated places in which the temperature of the cells is unduly raised.

Success of High Voltage.

A review of eight months' operation of high voltage working by the Central Colorada Power System more than ever convinces the New York *Electrical World* of the truth of the theory that engineers have in the past been "more scared than hurt" in the matter of high voltage. It is pointed out that this plant transmits energy at 100,000 volts over the Rocky Mountains over a distance of 150 miles and up to a maximum altitude of 13,700 ft. The lines are exposed to the ordinary contingencies of wind and snow, and also to sleet conditions which are exceptionally severe. Success has been obtained by very thorough and skilful tower construction, together with the use of suspension insulators, which are undoubtedly a very considerable factor in the success of the installation. The average spacing of the towers is about 750 ft., and they carry three hemp-core cables of No. 0 equivalent. These cables are supported on a single top cross-arm in a horizontal plane, the distance between the conductors being 10 ft. 4 in. The insulators are four suspension discs, each of which is rated at 25,000 volts working pressure. The suspension insulator has been the greatest recent improvement in the electrical transmission of energy, and this line, subjected as it is to enormous strains, is an admirable example of the success of the device. Although no lightning arresters were installed, no damage was caused to the line or apparatus by lightning during the entire summer service, the only delay being that due to putting in apparatus temporarily cut out by the oil switches on account of induced surges.

Electric Railway Notes.

The City Council of Trenton, N.J., is seeking to enforce an ordinance requiring the New Jersey and Pennsylvania Traction Company and the Trenton Street Railway to carry passengers free who are not provided with seats.—The Columbia River and Mount Adams Railroad Company has been incorporated with a capital of $20,000,000, to build an electric railway from some point on the Columbia river in Klickitat county, northerly through parts of Klickitat, Yakima and Skamania counties, to a point in the vicinity of Mount Adams.—The sale of the property of the Metropolitan Street Railway under foreclosure has been postponed indefinitely pending the discussion of Judges Ward, Holt and Hough of the United States Circuit Court of Appeals, who have before them the appeal of the Guaranty Trust Company, New York, N.Y., from the order of Judge Lacombe of the United States Circuit Court that the claims of the receivers of the Metropolitan Street Railway and the New York City Railway be made a first lien upon the proceeds of the sale.—The Southern Pacific Railroad has announced that it is proposed to operate cars by electricity between San José, Meridian Corners, Monte Vista, Los Altos, Mayfield and Palo Alto. The line from Mayfield to Los Gatos will be affected, as steam trains will hereafter use only the east track of the double-track line between Mayfield and Congress Junction, the west track being turned over to the Peninsula Railways, which is now equipping the line for operation by electricity to Monte Vista, where the tracks connect with those of the Cupertino line to San José. Five multiple-unit cars for the new service have already been received from the St. Louis Car Company.

New Traffic Unit for Street Cars.

Much interesting discussion has been aroused by a letter which Mr. Horatio A. Foster, the well-known traffic authority of Detroit, has addressed to the *Electric Railway Journal*. Mr. Foster urges the adoption of a traffic-unit of 1,000 seat miles. He points out that all who have had to do with the handling of street railways have recognised the difficulties arising from the use of the car-mile unit, which can only be useful in comparisons on one property and then becomes untrue when double-truck car-miles are compared with single-truck lines. But the use of the traffic-unit 1,000 seat-miles in place of a car-mile takes into account the differences in the seating capacity of cars, and it is seating, or carrying, capacity that brings in the income, while when compiling statistics regarding operating income and cost the full benefit of the use of the traffic-unit is brought out. In studying the service, the traffic-unit per mile of track would give the rate of car service, and in comparisons would show the growth. This can be done with the car-mile, but if car-miles with double-truck cars are counted as equivalent to the same unit with single-truck cars the comparison is misleading; whereas, with the new unit the use of cars with different seating capacities would make no difference.

Electric Drive in Mills.

Electricity continues to make headway as a motive powe for mills. During the week a contract has been placed by the Fuld & Hatch Knitting Company, of Cohoes, New York State, with the Allis-Chalmers Company, Milwaukee, Wis., for a 600 kw., 3,600 r.p.m., 480 volt, 60-cycle, three-phase condensing steam turbo-generator set. Orders have also been placed by the Passaic Cotton Mills, New Jersey, with the Allis-Chalmers Company for an 18 × 28 × 36 heavy-duty, cross-compound, non-condensing engine, which will be direct-connected to a 250-kva, 240 volt, three-phase, 60-cycle, 120 r.p.m., revolving field alternator and will also be supplied with a belt fly-wheel, designed to transmit about 200 h.p. to a line shaft, the normal rating of the engine being about 500 h.p. A 17 kw. belted exciter is also included. Arrangements are being made to drive the machinery of the Maverick mills by electric motors. The contract for electrical machinery, which has been awarded to the Allis-Chalmers Company, includes a 1,500 kw., 1,800 r.p.m., 60-cycle, three-phase, 600 volt condensing steam turbo-generator set. A 15 kw. motor generator set and a 15 kw. engine-driven exciter are provided for excitation. A four-panel switchboard will also be provided. Four 100 h.p. and seven 150 h.p. induction motors will drive the looms.

Some General Electric Installations.

The General Electric Company have contracts for installing a number of electrical equipments in mines in California. These include a 400 h.p. induction motor, 440 volts, to be installed at the South Eureka Mine, Sutter Creek, Cal., and a 2,600 k.w. hydro-electric plant at Sheep Creek, Alaska, for the Alaska Treadwell Mining Company. This power is to be transmitted to the mines on Treadwell Island at 2,300 volts through a submarine cable. The General Electric is also installing for the White Pass and Yukon Railway at Skagway, Alaska, two type AQB 100 kw., 3,600 r.p.m., 2,300 volt, horizontal Curtis turbine generating sets with direct connected exciters and two water-driven units, 250 and 125 kw., respectively. The generators are two-phase, 60-cycle machines. The Whatcom County Railway and Light Company, whose steam plant at Bellingham, Wash., was recently changed to oil-firing, is installing an additional 2,000 kw., 2,500 k.v.a., 1,800 r.p.m., 2,300 volt horizontal Curtis steam turbine generating set supplied by the General Electric Company.

Current Items.

Messrs. Ketcham & Company, of this city, announce that plans have been drawn for the development of an extensive hydroelectric proposition on the Hiawasse River in western North Carolina, near the border line of Tennessee. Two dams will be constructed 13 miles apart. Each will be more than 1,000 ft. long and 150 ft. high. The watershed drain will amount to about 37,500 acres.

The directors of the Westinghouse Electric and Manufacturing Company have voted a six months' leave of absence to Mr. George Westinghouse, president of the company.

Mr. Westinghouse will spend a considerable portion of his holiday in England.

The site for the proposed great dam that is to be built by the Fderal Government across the Nazas River in Northern Mexico at an estimated cost of $6,000,000 has been selected and the surveys and estimates have been deposited for official approval. The contract for this great structure is held by the British firm of S. Pearson & Son, Ltd. Power will be distributed by means of electric transmission lines to the cities of Torreon, Durango, Lerdo, Gomez Palacio, Mapimi, San Pedro and a number of other places.

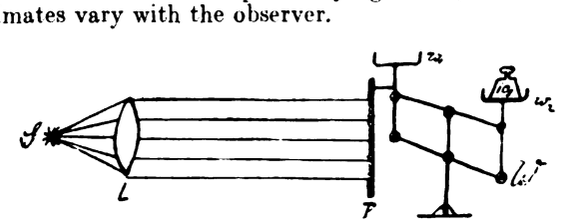
The Pacific Light and Power Company has been reincorporated at $40,000,000, in order to make considerable enlargements and be prepared to meet the demands that will be made upon it. The Redondo plant is to be enlarged at once to six units of 7,500 h.p. each.

For supplying the motor-driven pumps of its municipal water filtration plant, the city of Cohoes, N.Y., has installed two Westinghouse gas-engine driven, direct-current generator sets, using producer gas as fuel. Both engines are of the three-cylinder type, 15 in. × 14 in., and develop 125 h.p. They are direct-connected to two 75 kw., 125 volt Westinghouse direct-current generators. The producer gas for this installation is derived from two 125 h.p. Westinghouse gas producers.

PROPOSED ABSOLUTE PHOTOMETER.

By DR. ST. PLIVELIE.

It is well known that the lighting industry suffers from the want of an apparatus with which the intensity of the light from various sources can be measured absolutely. All the existing forms of apparatus, highly ingenious and skilfully contrived as many of them are, estimate the illuminating power of a source of light comparatively only, that is with reference to the light emitted by some arbitrary standard. This is itself not constant in the amount of light which it furnishes, so that the results are theoretically useless and practically unsatisfactory. Then, again, in these photometric measurements the factor of the individual eye comes in. No two persons judge alike, so that the estimates vary with the observer.



These considerations led the writer to endeavour to devise an absolute photometer. It is evident that one must be constructed which was free from the two difficulties above stated, the fluctuation of the standard in the first place and the individuality of the eye in the second. To eliminate the personal equation of the eye is very difficult in optical work of all kinds. The two difficulties disappear, however, if the photometer is constructed on the principle of the absorption of light. Absorbed light can become either heat or chemical energy. As regards the former of these two alternatives we have to recall the fact that a thermometer blackened with soot is heated by the radiations from a source of light and much more by the light belonging to the red end of the spectrum. The thermometer must be a sensitive one, with a scale divided at least into tenths of a degree.

The fact above mentioned affords a principle by which an apparatus could be constructed by means of which photometric measurements might be made with a degree of accuracy hitherto unattainable. Such an apparatus must enable us to produce a rather long and wide rectangular spectrum of the light under examination. If, say, a 5-candle carbon filament lamp gives a spectrum the red end of which heats the thermometer in a given time to 0·4° above the surrounding air, the same part of the spectrum of a 10-candle lamp will, under the same conditions, heat the thermometer by 0·8°, and so on in proportion, a 16-candle lamp heating it by 1·28°, a 50-candle lamp by 4° C., etc.

In constructing a photometer on this principle the unit must be an incandescent lamp, which in one minute will raise the temperature of the thermometer by 0·4°, when exposed to a definite part of the red end of its spectrum. The part of the spectrum is easily fixed by the Fraunhofer lines. The line B is in a convenient situation. If an arc lamp is used a different unit must be chosen.

If now we resort to the production of chemical energy instead of hear we can make an absolute photometer which will now be described and is represented in the diagram. The light is made to act upon nitrate of silver. The chemical action of light on this body is to set free the silver, its other constituents escaping in the gaseous form. Let us imagine that we have a photographic dark room containing a delicate balance loaded with a weight of the salt, say 10 grammes, in one pan and counterbalanced by weights in the other pan. Let us then place the silver nitrate scale at a known distance, say one metre, from the source of light, and let us use a lense to make the rays fall perpendicularly on the nitrate. We shall find that after a short time the salt has lost weight, as shown by the descent of the other scale of the balance. The loss is, of course, estimated by weights put on to the same scale with the nitrate of silver. As a unit we can take any source of light which causes a known loss of weight to the silver salt in a known time. In the diagram S is the source of the light to be measured, L is a biconvex lense with S in one of its principal foci. P is the nitrate and w_1 and w_2 are the pans of the balance W.

The measurements are referred to the CGS system of units, without reference to the variations of gravity at different parts of the earth's surface. If any maker of physical apparatus would try his hand at making a photometer on one or both of these principles Dr. Plivelie thinks he would waste neither his time nor his money.—*Elektrische und Maschinelle Betriebe.*

TATE BIFUNCTIONAL ACCUMULATOR PLATE.

By HARRY H. MORRELL.

In view of the great interest excited by the Edison accumulator, the following abstract of an article appearing in *The Canadian Engineer*, giving details of a new system of accumulator practice, is particularly opportune and deserving of close attention.

The " Bifunctional " plate, as its name implies, embraces two functions, positive and negative, and constitutes within itself a complete element.

An assembled Tate Bifunctional plate or unit and its constituent parts are shown in the accompanying illustrations, Figs. 1 and 2. Fig. 3 illustrates the method of assembling multiples of these units for the purpose of constructing plates of any desired size and capacity. The constituent parts of a unit, eight in number, consist of:

(a) An open insulating sectional frame made of celluloid, hard rubber, or any suitable material. One end of this frame and the three lateral supports are milled to half their depth, and the internal vertical edges are grooved to receive the lead conducting strip. When this strip is drawn into the frame, five pockets are formed for the reception of the active materials. These are about one thirty-second of an inch in depth, representing the distance between the surface of the metallic conductor and the outside faces of the frame itself. On one side of the frame the pocket is continuous; on the other it is interrupted by the lateral supports which break the channel into four pockets, and it is provided with a hole at each end to receive the assembling rods.

(b) A lead conducting strip provided with a relatively heavy-holed end to correspond with the hole at the milled end of the insulating frame.

(c) Two perforated insulating and separating shields, one of which is equipped with a series of interrupted, staggered bearings along its internal vertical edges which hold the par about one thirty-second of an inch apart, provide openings for the admission of the electrolyte, and form a continuous vertical channel from bottom to top for the free circulation of the fluid and the escape of nascent gases. These are also provided with end holes to receive the assembling rods.

(d) Two assembling rods on which the constituent parts are threaded top and bottom.

(e) Two side binders made of hard rubber, porcelain or any suitable material.

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The heavy ends of the lead conducting strips project about ½ in. beyond the sectional frame. In assembling a unit, these frames, carrying the conducting strips and applied oxide, are reversed alternately, so that one series of projections appear at the top and the other at the bottom of the unit. A pair of perforated insulating shields (c) are threaded between the sectional frames, and the top and bottom metallic projections of the latter are turned down in contact and lead-burned after the assembling rods (d) have been headed on the outside of the binders (e). Thus one alternate series forms the positive and the other the negative sections of the plate. A unit may consist of two or more sections. The standard which has been adopted for all purposes other than work of a very light nature, is a unit consisting of 57 sections—28 positive and 29 negative (one split negative). The dimensions are: Height 8⅝ in., width across the face 9¾ in., thickness 9/16 in., and the weight of the unit 4 lbs. The capacity on 8-hour discharge rate is 36 ampere hours, and the average voltage for eight hours 1.94. The total watt-hour efficiency is 70 watt-hour efficiency per lb. weight of unit 17½, and total weight efficiency 40 lbs. per horse-power hour.

To explain the practical operation of a Tate Bifunctional plate it is necessary first to refer to certain features which characterise the operation of storage cells as heretofore constructed through the medium of unifunctional plates, which have a direct relation to the phenomenon termed "sulphating," which place a limitation upon periods of charge and discharge, and through which the life of these cells is defined. These features involve equalisation of current density, transmutation of active material, metallic density and mechanical structure, and after discussing them with relation to unifunctional plates, their relation to the Tate Bifunctional plate will be shown.

There can be no doubt that apart from mechanical structure the most vital feature associated with the efficient operation of an electric storage cell is that relating to the equal distribution of current density over exposed active surfaces. If the oxide surfaces undergoing transmutation are unevenly attacked, the appearance of the phenomenon termed "sulphating" is inevitable. In the following discussion of this subject an effort is made to set forth the

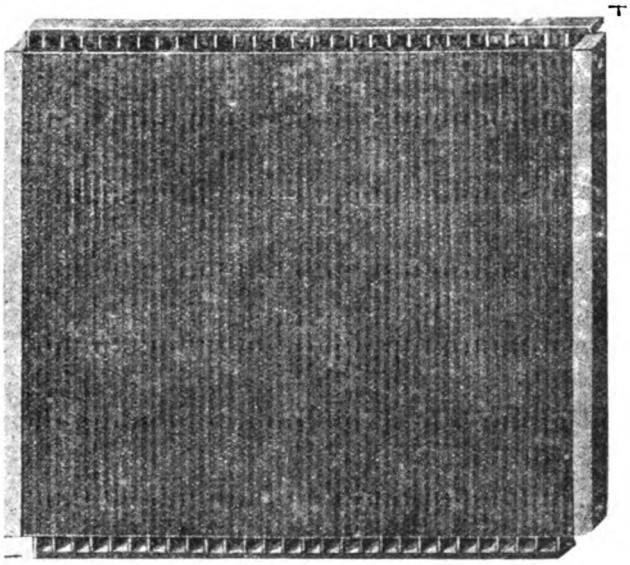

FIG. 1.—TATE BIFUNCTIONAL ACCUMULATOR PLATE.

reasons why equal current distribution can not be achieved through a conducting medium in the form of a plate or grid, more particularly those of relatively large superficial area.

When two unifunctional plates, a positive and negative provided only with upper terminals, are in electrical contact through the medium of the electrolyte, the line of least resistance between them follows a path located above their horizontal centres and along their vertical and horizontal edge areas where so-called extraneous stream lines are given off. That is to say, the flow is heavier above than below the horizontal centres in all corresponding parts of the plates. As the vertical central regions are approached, the densities become relatively lighter through the whole length of the plates, for the reason that current flow, somewhat like magnetism, has a tendency to seek the more extreme or uppermost sections of such conducting media, a manifestation well defined in the process of electro-plating.

The result of these conditions, encountered universally in the present practice of the art, is that with given current flow the superimposed or pocketed active masses are unevenly attacked and, emphasised with each increase of plate area, they probably represent the major cause of "sulphating" in unifunctional plate cells more especially those of large surface capacity, as employed for electric lighting and peak load regulation.

For the purpose of further elucidating this phenomenon, we shall assume a metallic plate of relatively large area wherein the current enters along the upper horizontal edge and finds an exit along the lower horizontal edge. Under

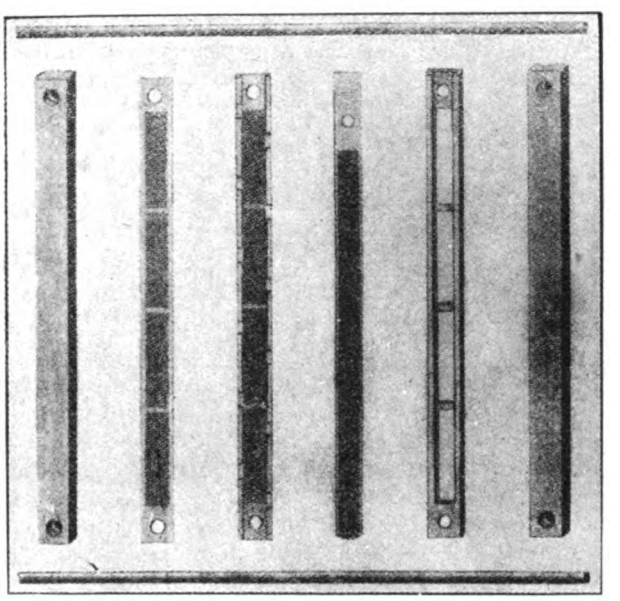

FIG. 2.—COMPONENT PARTS OF THE TATE BIFUNCTIONAL ACCUMULATOR PLATE.

these conditions the line of potential equalisation will follow the exact horizontal centre if metallic resistance throughout the whole of the plate is assumed to be constant; and if current density at one designated section located below the horizontal centre be represented by 10, the density of the corresponding section above the horizontal centre will also be represented by 10. This method of admitting and releasing the current provides for the equalisation of current densities in corresponding sections of the plate located in a vertical line above and below the horizontal centre, but it does not provide for the equalisation of current densities between plate sections which do not correspond with respect to relative location along the same line. Equalisation in this vertical direction is more closely approximated as the distance between the top and bottom of the plate is shortened, for the reason that as the horizontal line of equalisation is approached potential and, consequently, current density must necessarily diminish to the extent of the progressive expenditure of energy required to overcome the resistance of the conducting medium, and this expenditure is in due proportion to the distance traversed. Thus the shortening of a plate or conductor tends to equalise current density in a vertical direction. Again, as previously stated, as the vertical central regions of the plate are approached these densities tend to become lighter through phenomena resembling somewhat the action of magnetism. Equalisation in this horizontal direction is more closely approximated as the distance between the lateral edge areas of the plate is decreased, or, in other words, as the plate is narrowed.

In unifunctional plate cells of the Faure or applied oxide type, and more particularly those of relatively large capacity, as employed in electric lighting and peak load service, the active material is applied to the plates or grids in relatively thick masses. Recent investigations appear to have demonstrated that these masses are inactive beyond a certain limitation of depth under ordinary or so-called normal working conditions.

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Two results of this condition are obvious. First, that the inactive material constitutes a dead resistance to current flow, thus curtailing the useful energy of the cell; and second, that it is a constant menace with relation to the obstructive reaction termed "sulphating." In addition to this, the depth of the active mass appears to bear a direct relation to the time periods required to effect its transmutation under the action of the current. This transmutation appears to be effected progressively in a direction extending outwardly from the area of contact between the active material and the metallic conductor, or inwardly from the active area in contact with the electrolyte, and current density and time in conjunction seem to be the essential factors in effecting transmutation, the latter being regulated by the depth or thickness of the mass. In other words, in the operation of charging, when current flow is raised to the maximum limit of the cell, the element of time enters in, and the duration of the charge is proportionate to the depth of the oxide mass. This deduction appears to receive

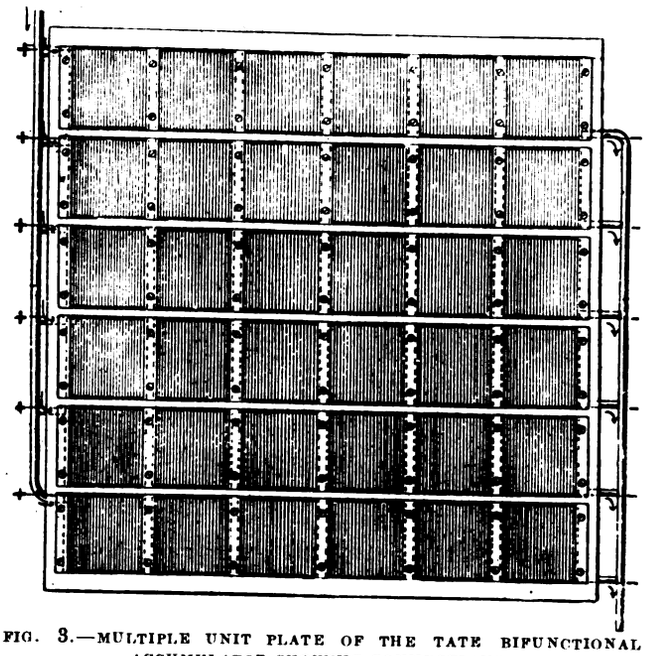

FIG. 3.—MULTIPLE UNIT PLATE OF THE TATE BIFUNCTIONAL ACCUMULATOR SHOWING CONNECTIONS.

ample confirmation in the process of charging a Tate Bifunctional plate wherein the active columns are extremely short and narrow and approximately only one thirty-second of an inch in depth. The details of this process are fully set forth in the continuation of this discussion.

It is well understood that there is appreciable variation of density throughout any metallic mass, and that when such a structure assumes the form of a plate or grid any increase of superficial area has a tendency to amplify such variation. These metallic irregularities present variations of resistance to current flow and corresponding variations in the density of current delivered to superimposed or pocketed active material, and thus contribute towards the hazard of "sulphating." The hazard from this cause, augmented by other causes of unequal current density hereinbefore discussed, is increased proportionately with each increase of conducting area and decreased proportionately as the conducting area is restricted.

In all electric storage cells as heretofore constructed, of the Faure or applied oxide type, with the exception of those employing porous media, which are referred to below, the active material is supported by a metallic plate or grid, and their terms of useful life are determined by the periods which mark the disintegration and displacement of this material. Apart from mechanical jarring and vibration, which may be described as extraneous causes, these disrupting effects are produced by the normal expansion and contraction of the active material, more especially on the positive plate or grids, in response to the phenomena of electro-chemical transmutation under charge and discharge commonly termed "breathing," which have a tendency to loosen and detach the superimposed or pocketed oxide from the supporting plates or grids, and this influence is abetted by the scouring action of the electrolyte produced by circulation. This disintegrating action is continuous and progressive, and is a well recognised condition in the art, as practised to-day. The available energy of these cells primarily is directly proportionate to the quantity or weight of active material in place and in action, and any loss thereof represents a corresponding loss of energy in the cell. It will, therefore, be noted that the life of these cells is not determined by the electro-chemical exhaustion of the active material, if such be possible, nor essentially through deterioration of the supporting plates or grids, but through the mechanical displacement of the material from which the energy of the cell is derived, and which, so displaced, is commonly called "sediment." When unifunctional plate cells reach the point of final exhaustion, the quantity of active material present and in place in association with the positive plates or grids is less than the original quantity, and that which has been displaced is irrevocably lost. Renewal can only be effected and the term of life of the cell extended by providing fresh material in the form of new positive plates or grids.

With regard to periods of charge and discharge which involve so-called "overloads," the relation of time to mass in the process of charging has been referred to above. Another feature which must be considered is the difference between the factors of expansion of the active material and the metallic walls which enclose and support it. These factors are wholly dissimilar, and the metal does not expand to compensate for the expansion or "breathing" of the oxide. The result of this condition is that under the influence of heavy current flow on charge or discharge, the rapid or sudden expansion or contraction of the oxide has a tendency to expel it from its metallic supports or to produce the distorting phenomenon termed "buckling." This indicates one of the reasons why cells of this type can not be rapidly charged and why they are liable to serious injury through the influence of heavy discharges.

Porous media were used in electric storage cells at the inception of the art, and various kinds of diaphragms have been introduced, with the primary object of retaining the active material in place. Several of these, notably porous clay or porcelain, perform this function with mechanical precision, but their practical disability rests in their dependence upon capillary or molecular action in effecting the distribution or circulation of the electrolyte. They have a tendency to appreciably insulate the active material from the electrolyte through adhesive contact with the former, and to filter the solution by passing the water with greater freedom than the acid.

Both of these conditions operate to curtail the useful energy of the cell; the first by rendering a part of the active material inactive, or semi-active; and the second through the production of high and deleterious acidity at the active surfaces under charge and insufficient acidity under discharge. In other words, the specific gravity of the cell does not adjust itself with sufficient spontaneity to the normal and essential requirements of the active material, and this condition is heavily emphasised as periods of charge and discharge are reduced. These conditions explain why porous media, originally employed in the earliest types of electric storage cells, were discarded in the subsequent practice of the art. The structural details of the Tate Bifunctional plate have been previously set forth in this paper, and they will now be considered in their relation to the various conditions noted in the foregoing discussion.

In the Tate plate the current finds entrance at the top and exit at the bottom, or *vice versa*, of a finely sub-divided multiple-assembled unit provided with extremely short conductors, these being only 8 in. in length, and the line of potential equalisation follows, therefore, the exact horizontal centre of the plate. There can be no appreciable variation of current density either above or below this line in a vertical direction, as the distance from ends to centre of the metallic conducting strips is only 4 in., and the drop in potential, therefore, negligible. The width of these conducting strips is seven-sixteenths of an inch. The active columns applied thereto are 7 in. long by $\frac{3}{8}$ in. wide and about one thirty-second of an inch in depth. By thus restricting the width of the metallic conducting media and, correlatively, the active columns applied thereto, the vertical central regions, which in unifunctional plates, as hereinbefore explained, have a tendency to develop lighter current densities than other plate sections, are permanently fixed in close relation to the vertical edge areas of the media, with the result that current density is again equalised, this time in a horizontal direction.

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Business Notes and News.

LIGHTING AND GENERAL—Home.

BRIXHAM.—The Urban Council adopted the Electric Lighting Committee's recommendation: (1) That the application of Messrs. R. A. Lister & Co., of Brixham and Dursley, for a Provisional Order enabling them to supply electricity within the urban district be accepted; (2) to affix the common seal of the Council to a memorial to the Board of Trade asking the Board to revoke the electricity powers contained in the Brixham Gas and Electricity Act, 1906; (3) to affix the common seal of the Council to a contract with Messrs. R. A. Lister & Co. for the public lighting of the town by electricity.

BRIDLINGTON.—The Bridlington Corporation have placed an order for a 350 kw. Willans-Impulse "Disc and Drum" type turbine with Messrs. Willans & Robinson, Ltd., Rugby.

BURY.—The Town Council have decided to extend the scheme for hiring out arc lamps for exterior shop lighting purposes to the use of metal filament lamps, also on the following terms: One lantern with lamps of an equivalent to, say, 300 c.p., £1 per annum, this sum to include the supplying, fixing, and maintenance of lamps complete. In addition to this, the usual charge of 6d. per unit for current consumed to be made.

CAMBERLEY.—At a meeting of the Urban District Council, a letter was read from Mr. H. E. Mitchell concerning the electricity scheme, and stating that the item of £760, estimated for working expenses, included all wages, salaries, and clerical assistance for the undertaking, economy in labour being effected owing to the works adjoining the sewage disposal works, and certain labour saving for both plants. The separate items making up the £760 were: Coal, £150; oil, waste water, and stores, £37; wages, £135; repairs and maintenance, £194; rents, rates, and taxes, £44; and salaries, office expenses, and insurance, £200. The item of 75,000 units estimated to be sold was arrived at from the experience of undertakings in other districts similar to that. The number of houses that represented might be taken at 300 for the district. As there is a certain amount of local opposition to the application for a Provisional Order, a "reply-paid" post-card poll of the ratepayers is being taken. The questions asked are: (1) Are you in favour of the introduction of electric light in this district by the Urban District Council, provided it can be supplied without being a heavy charge on the rates? (2) If it be introduced, would you be prepared to use it in your house or place of business? (3) What number of lamps do you anticipate you will require? Meanwhile, a report from an independent consulting engineer is being obtained.

CARMARTHEN.—At a meeting of the Town Council, it was stated that the agreement of October 30, 1907, to light the borough thoroughfares with electricity had been transferred to the Carmarthen Electric Supply Co. (Ltd.); that the contractors were Messrs. Crompton & Co., Salisbury House, London; and that a notice to supply the current six months hence had come to hand.

DENTON.—The Manchester Corporation being on the point of extending their electricity mains along Market-street, the Urban District Council are considering the question of adopting electric lighting for the Town Hall.

DUNDEE.—Two more works were changed over last week to electric driving—those of the Sycamore Saw Mills, and the Pearl Steam Laundry Co., Ltd. The latter is now completely driven and lit by electricity, the old boiler still being retained for heating purposes. The date for the formal opening of the new works has now been definitely fixed for the 23rd instant.

DUNDEE.—It was agreed at a meeting of the Electricity Committee of Dundee Town Council to apply for borrowing powers to the extent of about £60,000. Treasurer Soutar explained that the department was already over-borrowed to the extent of £14,860, and that they wanted to be in the position of having sufficient borrowing powers to meet capital expenditure as it became necessary. It would be well, he said, that in every department there should always be a margin of borrowing powers instead of having reports made that the powers had been exceeded. Part of the excess is required for the new machinery described in our issue of last week.

GRAYS.—The Local Government Board have sanctioned the raising of £850; £300 for mains, to be repaid in 20 years, £330 for services to be repaid in 15 years, and £175 for meters to be repaid in 5 years.

HASTINGS.—A proposal to extend the electricity mains in Lower Park-road, at a cost of £267 10s., and in Filsham-road, at a cost of £525, has been referred back to the Electricity Committee, for the districts to be canvassed, the extensions to be postponed until paying support was assured.

HEMEL HEMPSTEAD.—An application was received from the Chesham Electric Light and Power Co., Ltd., for the consent of the Council to the grant of a Provisional Order, under the Electric Lighting Acts, 1882 and 1888, to the Company in respect of an extension of their existing area of supply to include the Borough of Hemel Hempstead and the parishes of Bovingdon and Kings Langley, in the Rural District of Hemel Hempstead. The Council decided to give their consent, subject to the sealed agreement from the Company being received under which they gave certain undertakings which the Council asked for at the last meeting.

LONDON: HAMPSTEAD.—The Borough Council have decided to lay mains for the supply of electric current to private consumers in Lawn-road and Barby-avenue; to make alterations (owing to the low pressure of the current) in the network of cables supplying Agamemnon-road, Gondar-gardens, and Ulysses-road; to underpin four of the boilers in the south boiler house at the Central Station; and to improve the lighting of the yard at that station by the erection of two magazine flame arc lamps at the entrance and the substitution of a similar lamp for the existing arc lamp in the centre.

LOWESTOFT.—Application is to be made to the Local Government Board for powers to raise a loan for the purpose of laying down a complete condensing plant. Mr. J. Arthur Nicholson, solicitor, having written to enquire whether the Town Council intended to apply for a Provisional Order to supply Pakefield with electric light, and if not, whether they would raise any objection to an Order being applied for by a private company, it has been decided to consider the possibility of extending the town supply to both Pakefield and Kessingland.

MACCLESFIELD.—The Town Council have decided not to proceed under the Provisional Order for the supply of electricity, the Corporation's Gas Engineer having reported that the undertaking would entail a heavy loss. The Council will, however, offer every facility for a company to be formed.

READING.—The Town Council have decided to oppose the Reading Electric Supply Co.'s Bill in the House of Lords, in order to gain a *locus standi* and be able to watch proceedings, which is all the more necessary as eventually the Corporation would have the right to acquire the concern.

REDDITCH.—The rateable value system of charging is being tried.

SANDGATE.—After negotiations with the Folkestone Electricity Supply Co., Ltd., it has been decided to substitute Osram for the Nernst lamps for street lighting.

WALSALL.—The statement of accounts just issued by the borough electricity department for the year ending December 31, shows a gross profit of £6,783, and after deducting interest and sinking fund contributions, a net profit of £652. The sale of current for lighting brought in £8,097, for power £1,635, for tramways £5,311, and for street lighting £551. The public lamps comprise 19 arcs, 12 Nernst, and 10 tantalums.

LIGHTING AND GENERAL—Overseas.

BUENOS AIRES.—The Government will shortly call for tenders for the supply of 20 electric cranes, lifting capacity 1 ton, for the warehouses on the east side of Docks 1 and 2, Port of Buenos Aires.

BRAZIL.—The Ministry of Justice and Home Affairs is authorised to expend: Up to 400,000 milreis (currency) for the supply of furniture, upholstery, electric and hygienic installations for the new police building in the Federal District; 300,000 milreis (currency) for the same purpose in respect of the new Law College at Recife (Pernambuco). The milreis (currency) is worth about 1s. 3d.

CALCUTTA.—An equipment of electric plant for the saw mills in the Khargpur workshops of the Bengal-Nagpur Railways is expected out from England shortly.

CARIACO (Venezuela).—The Government have authorised Messrs. J. Ariza & Co., of Cariaco, to construct a telephone line between Cariaco and Villa Frontado.

LUCKNOW.—Five years ago the Municipal Council gave a concession for the generation and supply of electricity for lighting, power, and traction purposes; but it was not financed, and the concession was annulled. It is now proposed to employ an expert to draw up a schedule and to advertise for tenders.

OTTAWA.—By an order of Council recently issued, the following appears among additions to the free list of the Canadian tariff: "Metallic elements and tungstic acid when imported by manufacturers for use only in their own factories in the manufacture of metal filaments for electric lamps."

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CALCUTTA.—The Calcutta Electric Supply Co. have, on the recommendation of their Consulting Engineers (Messrs. Kennedy & Jenkin), placed an order for a 1,000 kw. Willans-Impulse "Disc and Drum" type turbine with Messrs. Willans & Robinson, Ltd., Rugby.

PRAGUE.—The municipal authorities have decided to procure 20 motor tramcars and 40 ordinary cars for the electric tramways, at a cost of 908,000 kronen (about £38,000). Powers have also been obtained by the same authorities to contract a loan of 2,000,000 kronen (£83,300) for enlarging the city's electrical works.

TURIN.—A decree has been issued empowering the communal authorities of Turin to construct nd work an extension to the Corso Racconigi of the Ponte Regina Margherita-Barriera San Paolo electric tramway; an extension of the Barriera di Casale-Piazza San Martino tramway to the Barriera di Francia; and to carry out alterations of the line which runs through the Via Carlo Alberto and the Via San Martino.

VICTORIA (British Columbia).—Mr. Matthew Hutchinson, city electrician, reporting on the street lighting department, urges immediate extensions to the lighting plant.

TRACTION—Home.

CARDIFF.—The Electric Lighting and Tramways Committee are asking for an expenditure of £8,000 on tramway track upkeep and repairs. It is contemplated next year to spend not less than £11,000, partly on track upkeep and partly on relaying of the lines.

EDINBURGH.—A proposal is under consideration by the Corporation to lay down an electric tramway line from Ardmillon-terrace to Slateford-road. The option of working this line would be given to the Edinburgh Tramway Co.

HASLINGDEN.—The Corporation tramway cable collapsed for a distance of about half a mile, luckily at night-time. The accident incidentally demonstrated the use of the patent cable fasteners which Mr. Barnes Kay (the Tramway Manager) invented. His grip, which does away with soldering, prevented the mishap extending, the fall being arrested at the points where his fasteners were placed.

PERTH.—Mr. Peter Fisher, of Dundee, has gone closely into the affairs of the Corporation Tramways, and he considers that the price for current charged by the Electricity Department must be reduced. When the tramways were electrified, the price of current for lighting was reduced from 4½d. to 3¾d., and then to 2½d. per unit, it is contended, at the expense of the Tramway Department.

TRACTION—Overseas.

CALCUTTA.—Half a dozen Ferranti ampere hour electric meters have been given a six months' trial on the East Indian Railway, and, having been found quite satisfactory, it will probably lead to their more extended use on this and other Indian railways.

VANCOUVER (British Columbia).—Some 10 miles of new car lines will be constructed in South Vancouver and Point Grey municipalities by the British Columbia Electric Railway Co. within the next five years. Two of these lines will run direct from the heart of the city throughout the length of thoroughfares which will become great arteries in the transportation system of Greater Vancouver. The trio of southerly lines will be laid on Granville, Bridge, and Oak streets; a trunk line will also be constructed eastward from Granville-street to Westminster-avenue along King Edward-avenue, which is the southerly boundary of Shaughnessy Heights. The plan is the outcome of a recent agreement made between the C.P.R. Co. and the B.C. Electric Railway Co., which provides for an extension of the lease of the Vancouver and Lulu Island Railway by the former company to the latter for a period of 21 years from last October, with the option of renewal for a like period. The construction of the new car lines will open up a large area of valuable residential property.

CONTRACTS OPEN.

Home.

BRISTOL.—The Electricity Department invite tenders for (*a*) yellow flame and white open type arc lamp carbons; (*b*) A.C. house service meters; (*c*) arc lamps, globes, (*d*) joint, junction and fuse boxes. Particulars (deposit £2 2s. for each section) from the City Electrical Engineer. See page X.

DUBLIN.—The Corporation invite tenders for the supply of extra high pressure and low pressure cables (*a*) delivered at their Fleet-street Stores, Dublin; (*b*) laid complete on site in Dublin. Particulars (deposit £1) from the City Electrical Engineer. Feb. 21. See page X.

LONDON: BATTERSEA.—The Borough Council invite tenders for supply of stores and sundries for the Electric Lighting Station, from April 1 next. Particulars from the ELECTRICAL ENGINEER. February 28. See page X.

LONDON: ISLINGTON.—The Guardians of St Mary, Islington, invite tenders for general supplies for twelve months, including electrical fittings and sundries. Particulars and tender forms from Mr. Edwin Davey, Clerk to the Guardians, Guardians' Offices, Upper Holloway. March 1.

LONDON.—County Council Tramways Department invites tenders for the roadwork and platelaying required for the construction on the underground conduit system of the Council's authorised tramway in Mitcham-lane and Southcroft-road (from Streatham High-road to Mitcham-road), and in Wimbledon-road (from Garratt-lane to the county boundary), and certain paving works for street widenings. The route is equivalent to about 3·63 miles of single track. The contractor will be required to use the track rails, with their fastenings, the slot rails and conductor rails, and the special work for the cross-overs, etc., which will be provided by the Council under other contracts, but all the remaining metal work and other materials will be included in the contract. Particulars from the Chief Engineer, County Hall, Spring-gardens. Deposit £5. Feb. 22.

LONDON.—The County Council invites tenders for the electric lighting of the following public elementary schools:—The Barnsbury-park, Barnsbury; Lauriston-road, South Hackney; Manor-lane, Lee; The Reay, Brixton. Persons desiring to submit tenders may, on and after February 14, 1910, inspect the drawings and obtain the specifications, bills of quantities, forms of tender, and other particulars on application to the Chief Engineer of the Council, Mr. Maurice Fitzmaurice, C.M.G., at the County Hall, Spring-gardens, S.W., upon payment to the Cashier of the Council of the sum of £1 in respect of each school. Feb. 23.

Overseas.

CHRISTIANIA.—The Commercial Intelligence Branch of the Board of Trade have received from His Majesty's Consul at Christiania copies of the conditions and specifications in connection with the following Norwegian Government contracts: (1) The supply to the Norwegian State Railways' Administration of fencing; tenders, marked "Anbud paa Gjardematerialer av jern," will be received at "Styrelsens Expeditionskontor," Christiania, up to 3 p.m. on February 25. (2) The supply to the Norwegian Naval Authorities of linoleum; tenders, marked "Anbud paa Linoleum," will be received at "Marinens Intendantur," Horten, up to 1 p.m. on March 3. The above-mentioned copies of the conditions and specifications may be seen by British firms interested, on application to the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, London, E.C.

CONSTANTINOPLE.—The Ministry of Public Works for the construction and working of an electric tramway between Niaousta Town and Niaousta Station, H.M. Consul-General at Constantinople (Mr. H. C. A. Eyres) reports that tenders for this concession will be received up to February 28.

TECUCIU (Roumania).—The Commune for the supply of electricity to the towns, at a cost of £485,000 francs (about £19,400). The tenders must include two 160 h.p. Diesel motors. March 28.

TENDERS ACCEPTED—Home.

BRIDLINGTON.—The Council having decided to instal a mixed pressure turbo, the undermentioned are the firms who tendered for same: Tender being accepted by Council, February 7, 1910. Willans and Robinson, Ltd., Rugby, £2,185; British Westinghouse E. & M. Co., Ltd., Manchester; Belliss & Morcam, Birmingham; Howden & Co., Ltd., Glasgow; Richardson Westgarth & Co.; P. J. Mitchell & Co.; Parsons, Ltd., Newcastle. The accepted tender is for a 300 kw. mixed pressure turbo of Messrs. Willans & Robinson's make (disc and drum), coupled to a Siemens' generator, and the price is inclusive of pipework and switchgear.

LONDON.—Metropolitan Railway Co. have accepted the General Electric Co.'s tender for the annual supply of Osram lamps for the current year.

LONDON: STEPNEY BOROUGH COUNCIL.—Electricity undertaking extensions: C. A. Parsons, Newcastle, at £19,091, for supply and erection of turbo-generator and accessories, converting machinery, switchgear, etc.; E. Danks & Co., Oldbury (Ltd.), at £13,761 10s., for boilers and accessories; Henley Telegraph Works Co. (Ltd.), at £8,095 10s., for cable to December 31, 1912; and Siemens Bros.' Dynamo Works (Ltd.), at £3,158 for conduits, troughs, and covers to December 31, 1912.

LOWESTOFT.—Tramways Committee. Tender for an apparatus for fixing to a car for removing rail corrugations, by the National Tramway Appliance Co., Liverpool, at £25 the set. Accepted.

Overseas.

MELBOURNE.—The City Council have accepted the tender of the Sloan Electric Supply Co., Ltd., for the supply f.o.b. London of 40,500 flame arc carbons at £1,946.

COMPANIES' MEETINGS AND REPORTS.

CENTRAL ELECTRIC SUPPLY.

The report of the Central Electric Supply Co., Ltd., states that energy has been supplied to the Westminster Electric Supply Corporation, Ltd., and the St. James' and Pall Mall Electric Light Co., Ltd., throughout the year to an amount of 17,282,370 units. After making a full allowance for sinking fund and depreciation, the net balance for the year to December 31 is £5,012, which, with the balance brought forward of £23, makes an amount now to be dealt with of £5,036. The directors propose to pay a dividend at the rate of 5% on the Ordinary shares for the year, and to carry forward £36.

GREAT NORTHERN AND BROMPTON.

The directors of the Great Northern, Piccadilly, and Brompton Railway Co., in their report for the half-year ended December 31, 1909, state that the gross receipts on revenue account amounted to £152,340, being an increase of £9,106 on the receipts for the corresponding half of last year. The working expenses amounted to £70,142, being a decrease of £2,326. After providing for interest, rents, and preference dividend, and reserving £3,000 for contingencies and renewals, there remains a balance of £37,574 available for ordinary dividend, and the directors recommend that a dividend at the rate of 1¼% per annum be declared on the Ordinary shares, leaving a balance of £6,024 to be carried to next half-year's account. The directors propose that the dividends shall be payable on February 19.

CENTRAL ELECTRIC SUPPLY CO., LTD.

The annual report for the year ending December 31 has been issued. The directors state that energy has been supplied to the Westminster Electric Supply Corporation, Ltd., and the St. James' and Pall Mall Electric Light Co., Ltd., throughout the year, to an amount of 17,282,370 units. After making a full allowance for sinking fund and depreciation the net balance for the year 1909 is £5,012 15s. 11d., to which must be added balance brought forward from 1908 £23 10s. 1d., leaving an amount now to be dealt with of £5,036 6s. The directors propose to divide this amount as follows:—(*a*) By payment of a dividend at the rate of 5% on the ordinary shares for the year, £5,000; (*b*) amount to be carried forward, £36 6s. The extension of the buildings and plant of the Grove-road Works has been completed, and they now have an effective capacity of 12,830 kw.

CHARING CROSS, EUSTON AND HAMPSTEAD RAILWAY.

The directors, in their report for the half-year ended December 31 last, state that the gross receipts on revenue account amounted to £105,138, being an increase of £11,072 on the receipts for the corresponding half of last year. The working expenses amounted to £58,289, being an increase of £1,046. After providing for interest and rents, and reserving £1,500 for contingencies and renewals, there remains a balance of £16,825 available for Ordinary dividend, and the directors recommend that a dividend at the rate of ¾% per annum be declared on the Ordinary shares, leaving a balance of £603 to be carried to next half-year's account. The directors propose that the dividends shall be payable on February 19. The directors have been engaged in settling with the Underground Electric Railways Co. of London, Ltd., all outstanding matters arising under the contracts for the construction of the company's railway. The outcome of the settlement is that, subject to the authority of Parliament being obtained for the creation and issue of additional capital for the purpose, this company are to issue to the Underground Co. £400,000, in fully-paid Ordinary shares, in discharge and liquidation of a balance of account amounting to £242,094 for extra works. The agreement providing for the settlement between the two companies will be submitted to the shareholders for approval.

BAKER-STREET AND WATERLOO RAILWAY.

The directors, in their report for the half-year ended December 31 last, state that the gross receipts on revenue account amounted to £88,578, being an increase of £2,222 on the receipts for the corresponding half of last year. The working expenses have amounted to £42,643, being a decrease of £2,019. After providing for interest, rents, and preference dividend, and reserving £2,000 for contingencies and renewals, there remains a balance of £18,165 available for ordinary dividend, and the directors recommend that a dividend at the rate of 1½% per annum be declared on the Ordinary shares and an additional dividend at the rate of 1½% per annum (making 3% per annum in all) on the Ordinary shares other than those held by the Underground Electric Railways Co. of London, Ltd., or their nominees, leaving a balance of £2,719 to be carried to next half-year's account. The directors propose that the dividends shall be payable on February 19. The obligation of the Underground Co. to guarantee the payment of dividend at the rate of 3% per annum on the Ordinary shares of the company ceased on the abandonment of the Paddington extension in August last, but the Underground Co. have agreed to the dividend at the above rate being continued for the past half-year on the Ordinary shares other than those held by the Underground Co. or their nominees.

BRUCE PEEBLES & CO., LTD.

The annual report states that the debenture and share capital has been issued in accordance with the scheme of re-construction as follows:—To the debenture holders: 5% debentures, £75,000; to the creditors: Unsecured debentures £45,809, 76,450 preference shares at £1 each, fully paid £76,450, making £122,259; to the shareholders: 48,301 preference shares at £1 each, 13s. 4d. paid, £32,200 13s. 4d., 3,256 ordinary shares of £1 each, 10s. paid, £1,628, making £33,828 13s. 4d., or a total of £231,087 13s. 4d.

The trading for the period after deducting maintenance, general charges and expenses of administration, shows a loss of £5,683 0s. 7d., to which has to be added the interest on the first and second debentures, less interest received, increasing the balance to £12,981 5s. 11d. Although the company was registered on December 5, 1908, it was not until towards the end of January, 1909, that the directors were able to secure the services of Mr. Lee Murray as general manager, and to actively prosecute the business of the company. The past year has been one of extreme difficulty and acute competition both with home and foreign manufacturers. The directors and general manager have given constant attention to the business in order to obtain and deal with future work. They consider that great progress has already been made. Endeavours have been made to obtain licences to construct and develop new manufactures, and certain arrangements have been completed which it is anticipated will materialise in the near future. Great progress has been made during the period in the satisfactory settlement of contracts left uncompleted by the old company.

NATIONAL TELEPHONE CO., LTD.

In their report for the half-year ending December 31, the directors state that the income accrued in respect of the business of the half-year amounts to £1,599,989 19s. 11d., as compared with £1,498,431 11s. 6d. for the corresponding period of 1908, being an increase of £101,558 8s. 5d. The working expenses for the half-year amount to £922,692 11s. 4d., as compared with £858,566 2s. 1d. for the corresponding period of 1908, being an increase of £64,126 9s. 3d. The net result for the half-year (after deducting the Post Office Royalties amounting to £153,856 16s. 5d.) is a profit balance of £523,440 12s. 2d., as compared with £495,638 14s. 3d. for the corresponding period of 1908, being an increase of £27,801 17s. 11d. The rentals carried forward for unexpired terms of running

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contracts amount to £1,324,915 15s. 8d., as compared with £1,245,350 16s. 8d. at the corresponding period of 1908, being an increase of £79,564 19s. Out of the available balance of £400,433 0s. 2d. shown by the net revenue account (No. 3) the board will recommend the payment for the half-year of a dividend at the rate of 6% per annum on the first and second preference shares, 5% per annum on the third preference shares, 6% per annum on the preferred stock, and 6% per annum on the deferred stock, less income tax in all cases. The board also propose to transfer £170,000 to the reserve fund account, and to carry forward the balance of £11,683 0s. 9d. The sum of £255,361 3s. 10d. has been expended on capital account during the half-year in the erection of 13,896 additional exchange and private stations, and in the construction of underground works.

CAMBRIDGE ELECTRIC SUPPLY CO., LTD.

The directors submitting the accounts for the past year to be presented to the ordinary general meeting to be held at the company's offices, on February 22, point out that during the year 1909 there have been connected 175 additional consumers, having the equivalent of 6,407 (30 watt) lamps, making a total to date of 65,979, whereas in 1908, 102 consumers were connected with 3,924 lamps. In spite of the great increase in the number of new consumers, the number of units supplied during the year has been only 621,448, a decrease of 38,710 units. Owing to the greatly increased use of the new metallic filament lamps (referred to in the last report of the directors), which consume much less current than the old carbon lamps, the company's receipts for the year have been greatly reduced by reason of the decrease in the number of units sold. The consequent cheapening of the electric light has, however, been the means of obtaining a record number of new consumers. These include Emmanuel, Pembroke, Corpus and Magdalene Colleges, Ridley Hall and the General Post Office, most of whom have, however, only been connected three months of the year. Your directors have, therefore, every reason to believe that the prospects of the company are encouraging. A number of premises are now being wired and the supply mains have had to be extended in several directions.

The directors, after very careful consideration, have taken out an insurance policy for the redemption of the leasehold property of the company at the expiry of the lease. The accounts of the company show a total profit for the year of £7,349 18s. 9d. which, added to £122 12s. 10d. brought forward from 1908, makes £7,472 11s. 7d. After deducting debenture and other interest £1,754 5s. 9d., placing £1,000 to depreciation fund account, which will bring up the total placed to the credit of that account to £14,000, and writing £500 off suspense account, there remains a balance of £4,218 5s. 10d. An interim dividend of 2%, absorbing £1,696 2s. 10d., has already been paid and the directors recommend the payment of a further dividend of 2%, making 4% for the year. This will absorb £1,696 2s. 10d., leaving a balance to carry forward of about £826.

WESTMINSTER ELECTRIC SUPPLY CORPORATION, LTD.

The directors, in presenting their report and the accounts for the year 1909, state that the supply of current, which on December 31, 1908, was provided for the equivalent of 31,525 kw., had increased by December 31, 1909, to the equivalent of 32,567 kw. The length of roadway in which continuous current mains have been laid now exceeds 87 miles, making about 346 miles of ways, into which upwards of 267 miles of copper (strip and cable) have been drawn. In addition, six miles of trunk mains (35 miles of ways) are laid in the company's area to connect the stations with the Central Electric Supply Co.'s station at St. John's Wood. A copy of the accounts of that company is enclosed herewith for the information of shareholders. During the year the directors have created a deposit fund to encourage thrift among their employees, the maximum subscription being 5s. per week. Interest is allowed at half the current rate of ordinary dividend, with a minimum of 4% per annum, and the fund is, therefore, to some extent, a profit-sharing scheme. The balance in the hands of the company at December 31 was £915 10s. 9d., and the directors feel sure the scheme will commend itself to all shareholders. The cash award in the arbitration with the London County Council in connection with their acquisition of the company's Millbank-street station under the London County Council (Improvements) Act, 1900, was exclusive of the exchange of site, £184,471, which sum has been applied towards the cost and equipment of the new and larger station in substitution in Horseferry-road. The capital expenditure on Millbank-street, and the amount paid to the City of Westminster Electrical Syndicate for the lease, etc., have, therefore, been written off as shown in the capital account, No. 3. Horseferry Station is rapidly approaching completion, the plant and machinery will shortly be in operation. The site of this station is entirely the freehold property of the company. An interim dividend, at the rate of 10% per annum on the ordinary shares, and the dividend on the 4½% preference shares, for the half-year ending June 30, 1909, has been distributed. After allowing for depreciation, sinking fund and other charges, the net balance is £55,622 1s. 11d., from which must be deducted the second half-year's dividend on the preference shares, which absorbed £8,610 4s. 5d., leaving a balance of £47,011 17s. 6d. Out of this the board recommend the payment of a dividend at the rate of 10% per annum, less income tax, for the past half-year, carrying forward a balance of £21,116.

NORTHAMPTON ELECTRIC LIGHT & POWER CO., LTD.

The twenty-first annual report states that the results of the past year's working have been in every way most satisfactory. Lamps have been added to the number of 4,391, and motors (reckoned as 8 c.p. lamps) 7,800, together 12,191; the horse-power of motors having increased from 1,003 to 1,263, and of this 1,044 h.p. are hired from the company. The mains a year ago were 21 miles 664 yards in extent, and are now 23 miles 1,251 yards, besides two feeders laid during the year, totalling 1 mile 1,528 yards. The current sold for lighting has increased 9¾%, and for power 50%, the total units amounting to 1,418,790. Maximum load on plant, 957 kw. (8% increase); load factor, 16·7. During the past year there has been a considerable extension of buildings and plant; a boiler and economiser house, with coal bunkers, for two boilers, one of which has now been installed—a new chimney double the capacity of the old one, and 1,000 h.p. engine and dynamo. The year is marked by the change over from non-condensing to partial condensing, the bulk of the output having been dealt with by the new condensing plant and a considerable reduction of working costs has been thereby effected. To provide funds for the capital outlay, 10,000 Ordinary shares were issued, and also debentures to the amount of £2,100. The depreciation account has been increased by £3,000 (out of which £500 has been written off accumulators), £500 has been added to reserve, and £300 has been written off motors. The sum of £626 will be required for the half-year's dividend on the 5% Preference shares, and the directors propose that 6½% per annum should be paid on the Ordinary shares for the half-year (making 5¼% for the year). This will amount to £1,480 9s. 2d., and there will be £1,053 2s. 3d. to be carried forward. On January 1 next the 4% debentures will be redeemable, and it is proposed that "Four per cent. Debenture Stock" shall then be created, and that all debenture holders shall have the opportunity of taking stock in exchange for their debentures. Notice of these proposals will be sent out in due course. The directors cannot conclude their report without alluding to the loss they have sustained in the death of their colleague, Mr. Richard Cleaver. One of the founders and first directors of the company, and active in many spheres of work, his name will long be remembered and esteemed.

COMPANIES REGISTERED.

STANDARD OXYGEN LIGHT AND POWER CO., LTD.—Capital, £25,000, in £1 shares. Objects: To take over as a going concern the interest of B. P. Maisel and the rights of a business of gas electrical and general engineers, manufacturers of oxygen and other light and power machinery, general merchants and importers, etc. Private company. The first directors (to number not less than two nor more than five) are to be appointed by the signatories. Registered office, 34, Mansell-street, Aldgate, E.

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WEST NAPLES TRAMWAYS AND VALFORTORE RAILWAY CO.—£50,000 (£1). To acquire a concession granted to A. Capuano, for the construction and maintenance of a light railway or tramway with electric traction, between Naples, Soccavo, Pianura, and certain other places, with a deviation to Camadoli, together with the benefit of certain resolutions passed and grants made in favour of a further concession applied for by the said A. Capuano, for the construction and maintenance of railway between Benevento, San Bartolomeo in Galdo, and San Severo, Lucera, and extensions to other places. First directors (not less than two nor more than seven), the Right Hon. Lord Templemore and A. Capuano. £250. Remuneration (except managing directors) £100 each per annum (chairman, £150). Purchase consideration £10,000 (£3,000 in cash and 7,000 in shares) 57, Gracechurch-street, E.C.

PERSONAL.

Mr. J. A. McCrossan has been reappointed City Electrician of Vancouver, succeeding Mr. McCullough, who resigned the position on January 1, after a year's service.

Mr. G. A. Sekon, the well-known railway writer, and Editor of the *Railway Magazine* and *Railway Year-Book*, who inaugurated those publications nearly 13 years ago, and has conducted them up to the present time, has severed his connection with them. Mr. Sekon is producing on popular lines a new illustrated 6d. magazine—*The Railway and Travel Monthly*—which, as its title indicates, covers the whole field of locomotion, and will doubtless be welcomed by all interested in railways and railway engineering and operation, as well as by tourists and travellers generally.

The partnership between Messrs. Peers & Dewhurst, electrical engineers, 59, Bridge-street, Manchester, has been dissolved, Mr. Dewhurst carrying on the business at that address. Mr. G. R. Peers, A.M.I.E.E., is now acting as consulting electrical engineer, as well as carrying on an agency for the disposal and purchase of electrical and mechanical businesses. His new address is 33, Manchester-chambers, Market-street, Manchester.

TRADE NOTES.

Newtons Ltd., of Taunton have issued their 1910 catalogue, which should be most useful to every electrical engineer and contractor. This is one of the most compact and useful lists we have had under our notice for some time, and the style and printing is everything that can be desired. Messrs. Newtons Ltd., will be pleased to forward a copy to any of our readers on request.

Messrs. Thermit, Ltd., have a number of tramway rail welding contracts in hand at present, and anticipate being very busy in this direction for some little time. Besides welding the whole of the rails on the newly electrified system at York, which work will shortly be completed, they have contracts in hand for: The Wallasey U.D.C. Tramways; Bolton Corporation Tramways; Metropolitan Electric Tramways, per Dick, Kerr & Co., Ltd.; The L.C.C., Woolwich to Eltham, per Alex. Stark & Sons; The Gateshead Tramways, per W. Griffiths & Co., Ltd. The Thermit joint has also been specified for the Linthwaite U.D.C. Tramways (Huddersfield), and the Whitworth U.D.C. Tramways. In addition to which, Birmingham, Manchester, Leeds, Bristol, and many other systems are carrying out welding with their own staff.

FINANCIAL NOTES.

ROSARIO ELECTRIC CO.

A circular has been sent to the shareholders stating that the Board, on February 11, signed an agreement with the Société Financière de Transports et d'Entreprises Industrielles of Brussels (subject to the confirmation of meetings of the shareholders of this company), under which the Brussels Co. have an option up to July 1, 1910, of acquiring the company's concession, assets and undertaking in consideration of a payment of £518,000, the Brussels Co. taking over the liabilities of the company. In the event of the purchasers desiring to keep the present company alive, the Brussels Co. undertake, as an alternative, to offer to purchase the holdings of individual shareholders (provided that holders of not less than 80% of each class concur) on the following terms, viz.: £6 10s. for each first Preference share, £9 for each second Preference share, and £9 for each fully-paid Ordinary share, and a premium of £4, in addition to the amounts paid up on each partly paid Ordinary share. If this alternative is not acted on, the purchase price of £518,000 would, subject to the approval of meetings of the Preference and Ordinary shareholders, be distributed on a similar basis. Meetings of the shareholders will be called at an early date to consider the agreement, which will be laid before the meetings.

Holders of 6% preference share warrants to bearer of the Adelaide Electric Supply Co., Ltd., will on and after March 1 receive payment of a dividend at the rate of 6% per annum for the half-year to the 28th inst., less income tax, on presentation of coupon No. 8 at the bankers of the company, Messrs. Glyn, Mills, Currie & Co., 67, Lombard-street, E.C.

Holders of 7% first preference share warrants to bearer of the Melbourne Electric Supply Co., Ltd., will on and after March 1 receive payment of a dividend at the rate of 7% per annum for the half-year to the 28th inst., less income tax, on presentation of coupon No. 1 at the bankers of the company, Messrs. Glyn, Mills, Currie & Co., 67, Lombard-street, E.C.

DIARY.

FRIDAY, FEBRUARY 18.

NORTHAMPTON INSTITUTE ENGINEERING SOCIETY.—At the Northampton Institute, Clerkenwell, "Hydraulic Presses," by Mr. H. Webb.

SATURDAY, FEBRUARY 19.

ROYAL INSTITUTION OF GREAT BRITAIN.—At 9 p.m., Professor Sir J. J. Thomson, F.R.S., on "Electric Waves and the Electromagnetic Theory of Light" (Lecture II.).

TUESDAY, FEBRUARY 22.

INSTITUTION OF ELECTRICAL ENGINEERS (Manchester Section).—At the Physical Laboratory, University of Manchester, at 7.30 p.m., "The Present Aspect of Electric Lighting," by Messrs. H. W. Handcock and A. H. Dykes.

NATIONAL ELECTRICAL MANUFACTURERS' ASSOCIATION.—Annual general meeting, at 2.30 p.m., at Balfour House, Finsbury-pavement.

WEDNESDAY, FEBRUARY 23.

INSTITUTION OF ELECTRICAL ENGINEERS (Leeds Section).—At the University, Leeds, at 7.15 p.m., "Notes on Overhead Lines," by Mr. W. B. Woodhouse.

FRIDAY, FEBRUARY 25.

INSTITUTION OF ELECTRICAL ENGINEERS (Manchester Section).—Annual dinner, at the Banqueting Hall, *Midland Hotel*, at 6.45 p.m.

NORTHAMPTON INSTITUTE ENGINEERING SOCIETY.—Visit to the Western Electric Co.

PHYSICAL SOCIETY OF LONDON.—At 5 p.m., at the Imperial College of Science, Imperial Institute-road, South Kensington: (1) Prof. J. Perry, F.R.S., "Telephone Circuits"; (2) Prof. C. H. Lees, F.R.S., "On the Laws regarding the direction of Thermo-electric Currents enunciated by M. Thomas"; (3) H. R. Nettleton, B.Sc., "A new Method of determining Thermal Conductivity."

METERS.

It has been brought to the attention of the British Thomson-Houston Co., Ltd., that certain statements are being made to the effect that the B.T.H. Type M.H. Mercury Meter for continuous current circuits, and types A.C.T. and R.H. for alternating current circuits, are manufactured abroad. They desire to state that these are all manufactured at their works at Rugby, and any report to the contrary is false.

MUNICIPAL AND COUNTY CLUB.—Sir Richard Melvill Beachcroft, Chairman of the L.C.C., will be the guest of the evening at a house dinner to be held at the Municipal and County Club on the 28th inst. Mr. H. Percy Harris, M.P., will be in the chair on this occasion.

L.C.C. ELECTION.—The Municipal Reform Party, in their address issued in connection with the forthcoming London County Council Election, declare that one of their main objects will be the development of the electric tramway system.

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ISLE OF WIGHT RAILWAYS.

The conference of representatives from the various public bodies in the Isle of Wight to consider proposals for the electrification of the railways or the construction of a system of electric tramways between the chief towns, while approving both schemes, postponed further action until the railway companies had been approached. This was done by Mr. Gray, solicitor, representing the promoters of the schemes, who conducted the negotiations. At the resumed conference it was announced that the directors were willing to consider any financial proposals made to them by the County Council, but they were unable to carry out any such scheme as that proposed themselves in consequence of their financial condition, and partly because they considered that the advantages of electrical working of a mixed traffic of passengers, goods, and minerals had not yet been demonstrated by the experience of other railway companies in this country. The representatives of the public authorities, therefore, were not prepared to recommend the County Council, whose financial support was desired, to take any action with regard to the schemes, although they were prepared to advise their councils to give their hearty approval and moral support to any satisfactory scheme that might be submitted to them for the electrification of the island railways.

Locally, it is considered that the island has now the choice of two alternatives. Either it may guarantee, through the County Council, a minimum rate of interest on the capital required for electrification of the railways, or it may adopt a system of tramways. The whole matter is to be referred to the County Council after the March elections, and a definite decision ought to be reached during the summer in time for the promotion of an Act of Parliament next year.

Mr. H. Upton Marshall, M.I.E.E., who is the engineer putting the above proposals forward, was the resident engineer at Portsmouth for five years, under Messrs. Preece & Cardew, the consulting engineers responsible for the electrical equipment of Portsmouth Dockyard.

HYDRAULIC PRESSES.*

By H. WEBB.

The object of the paper is to describe in general terms, rather than in detail, the construction and working of hydraulic pressing plants.

The general scheme for any such installation depends upon the nature of the material it is desired to press.

Thus, the details of a plant for the purpose of extruding metals, will differ largely in detail from that used for the extraction of vegetable oils.

The superiority of the hydraulic press over the steam hammer for forging propeller shafts, guns, etc., and for plate bending is evidenced by the increase in its use since its introduction by Sir Joseph Whitworth for such purposes.

The types of pumps employed are so numerous that it is impossible to speak of them in a paper of this description in more than general terms.

Accumulators, as the name implies, are for the purpose of storing a quantity of water at constant pressure, and differ only in detail. The first press cylinders that were manufactured were of cast iron, and had to be made very thick in order to stand any appreciable pressure. With the introduction of steel cylinders, however, the dimensions have been considerably reduced, and the allowable pressures increased.

The paper concludes with a short description of some of the varied applications of the hydraulic press.

FARADAY HOUSE.—We are informed that the annual dinner of the Faraday House Old Students' Association will be held at the *Queen's Hotel*, Leicester Square, on Thursday, March 17 (St. Patrick's Day). The President for the year—Mr. Reginald S. Downe—general manager of the Brompton & Kensington Electricity Supply Co., Ltd., will be in the chair. All Faradians who wish to be present are asked to communicate with Mr. Foulds, Faraday House.

* Abstract of paper to be read before the Northampton Institute Engineering Society, Feb. 18.

PATENTS.

Controlling Mechanism for Electric Motors.

13734.—1909. F. BISSELL Co., Ohio. In controlling mechanism for electric motors of the kind, comprising a hollow spool in which is mounted a switch with connected resistance windings, whereby the motor to which the switch is applied may be run at variable speeds and instantaneously stopped when desired, the improvement consists in the provision of means inside the spool for returning the switch to its normal position, and in a brake mechanism for overcoming the inertia of the motor. Fig. 1 is a front elevation of the controlling mechanism in connection with the motor to which it is applied; Fig. 2 is a longitudinal section; and Fig. 3 is an elevation of the rotary cap. The invention is particularly designed for use in connection with small

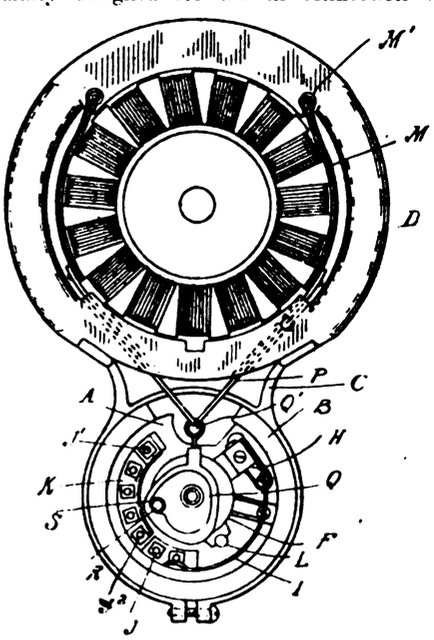

FIG. 1.

electric motors; for instance, sewing machine motors, where only a limited space is available, and it is, therefore, an object to condense the mechanism by arranging the parts as compactly as possible. It is a further object to produce a control in which the circuit closure, the rheostatic switch, and the mechanical brake mechanism are all operated in proper sequence by a single actuating connection, and also to render the stopping of the motor automatic upon the release of the control. A is a hollow drum, formed of insulating material, and B are resistance conductors, mounted about the drum in a peripheral groove. The member A is mounted in an annular frame member C; E is a post arranged concentrically within A, and having revolubly mounted on it the member F. This member is in the form of a hollow drum, within which is arranged a coil spring G, one end being secured to the post E, and the opposite end to the member F. H is a travelling contact arm projecting from the member F, and I is a spring contact carried by this arm. This contact member I successively engages with a series of contact

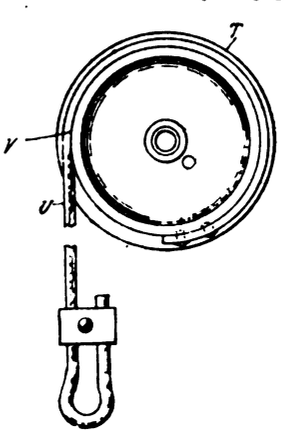

FIG. 3.

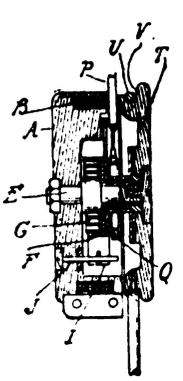

FIG. 2.

pins J, arranged in a segmental path within the hollow member A, and the member I engages the outer faces of the pins. K is a contact spring connected to one of the contact pins J1, and extending into proximity with another pin of the series J2. L is an insulated arm on the member F, which during the rotation will bear against the spring contact K, and move it into connection with the contact

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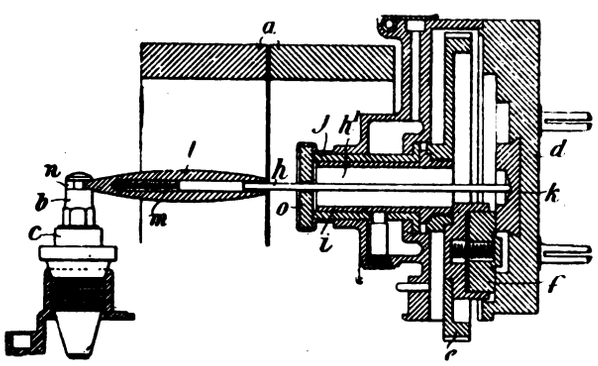
pin J^2, with the arrangement above described; the member F is normally held by the tension of the spring G in a position where the motor circuit is open, but upon the rotation of the member the contact I will successively engage the contact pins J, first closing the electric circuit with all the resistance windings B, and then successively cutting out portions of the resistance. During this movement, the insulated contact member L will also be rotated, and, at a certain point in the operation, will press against the spring K, effecting a coupling between the contact pins J_1 and J^2, this occurring when the contact member I is in connection with the pins of the series midway between the pins J_1 and J_2. As a result, portions of the resistance windings B will be connected into the motor circuit in parallel, thereby lowering the resistance, while distributing the heating effect in the windings. Thus the speed of rotation of the motor may be controlled by varying the position of the rotary member F. To effect a quick stopping of the motor and the mechanism driven thereby, a mechanical brake is necessary. This brake M is applied directly to the periphery or pole face of the rotor; and, as shown, is arranged between the rotor and stator, and in the space intermediate the poles of the stator. With the above described construction in the normal position in which the member F is held by the tension of the spring G, the crank pin R, through its engagement with the bearing S and the stirrup Q, will draw downward upon the members P and hold the brake shoes M in frictional contact with the periphery of the rotor so as to prevent rotation of the latter. As shown, however, as the member F is rotated against the tension of the spring G, and in the direction for closing the motor circuit, the pin R will be withdrawn from its bearing, permitting the tension of the brake shoes M to move them out of contact with the rotor so that the latter is free to revolve. In the reverse operation, the tension of the spring G will move the member F to open the motor circuit, and at the same time the pin R is drawn downward to again bear against the stirrup Q and draw the shoe M into contact with the rotor. During this movement, the pin R is constantly gaining leverage as it approaches the dead centre, and, consequently, the power applied to the brakes is greatest at the completion of the movement. An adjustment may be effected at any time by disengaging the stirrup Q from the pin R and rotating it one way or the other, whereby it is longitudinally adjusted upon the threaded shank of the screw eye Q^1. For operating the member F, a pulley T is secured to it, and this pulley is employed to form a closure for the recess within the hollow member A.

High-Tension Magneto-Electric Apparatus.

1263.—1909. F. R. SIMMS, Willesden-lane. In this improvement on high-tension magneto-electric apparatus of the well-known Simms' type, used in connection with electric ignition gear for internal combustion engines, a safety spark gap is provided between a part of the conductor, which connects the high-tension terminal of the collecting brush-holder to the distributor and the hollow spindle of the gear wheel for rotating the distributor brush, which encloses the part of the conductor. The conductor part, which is in the form of a rod, bears by spring pressure at one end in an insulated bearing with which the brush of the distributor makes contact, the pressure being obtained by a spring within a sleeve, which embraces the other end



of the conductor rod and bears at one end against the terminal of the high-tension collecting brush-holder. The bearing for the spindle is provided at one end with a window to render the spark in the spark gap visible, the conductor rod passing through a hole in the window. The diagram represents a vertical section of a portion of a high-tension electro-magnetic apparatus of the well-known Simms' type, with these improvements: *a*, *a* are the magnets; *b* is the high-tension terminal of the collecting brush-holder *c*; *d* is the current distributor; and *e* is the gear wheel carrying the brush *f* of the distributor; *h* is the rod forming part of the conductor between the terminal *b* and the distributor *d*. All the parts are of known construction: *i* is the hollow spindle of the wheel *e* carried in the bearing *j*, through which spindle the rod *h* passes, thus providing the spark gap h_1 between the outer surface of the rod *h* and the inner surface of the hollow spindle *i*. The rod *h* bears at one end against the bearing *k* with which the brush *f* of the distributor makes contact; *l* is the sleeve embracing the other end of the rod *h*; and *m* is the spring to make good contact with the bearing *k* and terminal *b* respectively, the sleeve being forked as at *n* to embrace the terminal; *o* is the window of mica or glass for viewing the spark which will be formed between the rod and the interior surface of the rotating spindle *h*.

Dynamo Electric Machines for Operating Searchlights.

6949.—1909. SIEMENS BROS. Dynamo Works, Ltd., Westminster. In arrangements known hitherto of a somewhat analogous character, the fulfilment of the steep characteristic at the normal working range has only been attained by sacrificing the condition of a relatively low value of the open circuit voltage, and, as a consequence, certain undesirable features result. For example, the generator must be designed for a greater output, and is, consequently,

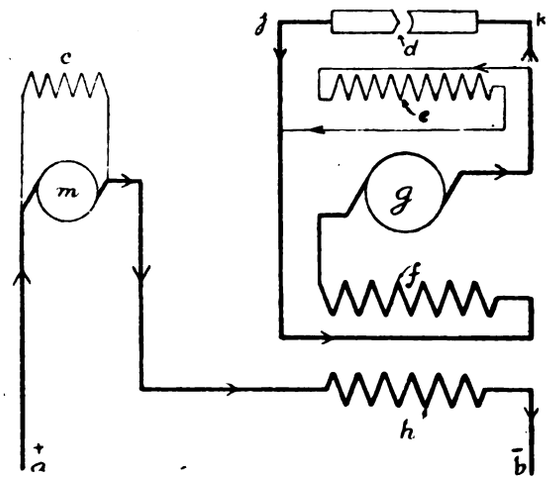


FIG. 1.

larger and heavier, and, therefore, not so suitable for use on board ship. The feeding mechanism of the lamp must be made specially strong to withstand the strain produced by the high open circuit voltage, and is, consequently, more expensive. Further, if the open circuit voltage is much greater than the normal voltage, a great change in magnetic flux in the generator is involved, which may have an undesirable retarding effect on the operation of striking the arc. Also, in the case of partial transformation, the voltage across the motor terminals will vary over a very wide range, with a result that a tendency to in-

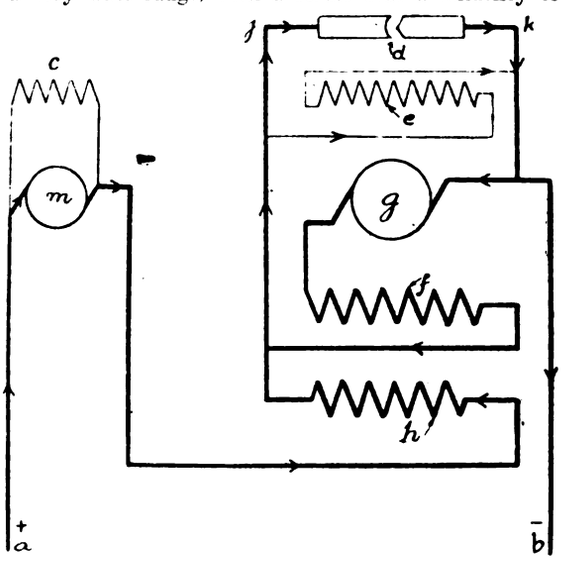


FIG. 2

stability of speed may result when the load comes on so that special means may have to be provided to prevent the motor from racing. The object of this invention is to obviate these disadvantages by so arranging the motor generator that both the conditions for satisfactory working of the searchlight above referred to are secured. The diagram shows a motor generator set, arranged and connected in such a manner as to produce the desired result (Fig. 1), referring to complete transformation, and (Fig. 2)

to partial transformation. In both figures the armature of the motor is indicated by *m*, and that of the generator by *g*; *a* and *b* denote a pair of constant potential supply mains, and *j* and *k* the secondary mains, to which the arc lamp *d* is connected. The motor *m* is provided with a plain shunt winding *c*, connected across the armature alone, or across the latter and the series coil *h*. The generator is provided with three-fold windings: *e*, *f*, and *h*. Of these, *e* is a self-exciting shunt-winding connected either across the generator terminals, or across the generator armature alone; *f* is a series winding, carrying the main generator current in such a direction as to oppose the ampere turns in *e*; and *h* is a series winding, carrying the main motor current in such a direction as to assist the ampere turns in *e*. In Fig. 1 the secondary circuit is completely independent from the primary circuit, and in Fig. 2 the two armatures with their respective series windings are connected in series across the primary mains. If the polarity of the supply mains is as shown in the drawings, the current will travel in the direction indicated by the arrows; and in the case of Fig. 2, the lamp *d* is fed with the sum of the generator and the motor current. The same effect as with series coil *f* may, of course, be produced by giving the armature brushes of *g* a lead, and in this case *f* may, therefore, be dispensed with if desirable. The action of the improved motor generator is as follows: As the two series windings *f* and *h* act in opposition to each other, their resultant action on the generator field will depend on the relative values of the motor and the generator current. It can be shown that the motor current reaches its maximum value and begins to decrease before the generator current reaches its maximum value, and if, therefore, the number of turns in the respective windings are properly proportioned, the back compounding effect of winding *f* will first be practically cancelled by the forward compounding effect of winding *h*, so that the machine has a flat characteristic, similar to that of the plain shunt wound machine; whilst when the load current approaches the normal working range, the winding *f* will more and more overpower the winding *h*, thus turning the generator into a back compounded machine, having a steep characteristic. Moreover, the light load motor current which flows in the winding *h* is especially useful in preserving the electrical stability of the system.

Varying the Connections of Electrical Apparatus.

10550.—1909. Siemens & Halske, A.G., Berlin. In order to make a compact arrangement for varying the connections of electrical apparatus, the separate windings are connected to two rows of contact studs in such a manner that the two ends of each separate winding are in connection with contacts opposite each other. Auxiliary contact studs are fixed between these two rows of main contact studs. These auxiliary studs are placed half-way between diagonally opposite contacts, the distance between the main and auxiliary contacts being the same as the distance between the two adjacent main contacts of the same row.

Electric Switches for Telephones.

4173.—1909. W. Aitken, Liverpool. This is a multiple contact switch operated by a lever in combination with an electro-magnet. When the lever is moved in any one direction to operate a set of springs, a plunger rises behind the lever extension and prevents the lever from returning to the normal position until current is removed.

Electrodes for Arc Lamps.

8150.—1909. G. Senften, Berlin. It is found that electrodes composed wholly of a pyrophoric metal alloy, or having a pyrophoric metal alloy added to their composition, gives an exceedingly brilliant light. In order to produce these electrodes, 30% iron and 70% of a rare earth metal are mixed together and pressed with a binding powder to form an electrode. Powdered carbon may or may not be added. This process forms the subject of English patent 8150.—1909.

Electric Insulators.

6161.—1909. P. Rutsky, Crefeld. The insulating member has a convex top surface, which deflects condensed water collected beneath the cap. A channel is formed on the raised portion of the insulator surface for the leading cable. This prevents contact between the cable and condensed water. The insulator has nuts and screws for the simple attachment of the wires and leading-in cable. A groove is formed in the insulator for leading the condense water to a channel through which it is discharged.

Electrical Controllers.

3560.—1909. J. B. Tannahill, Greenock. The object of the invention is to provide by an arrangement and disposition of winding of resistance coils a travelling variable blow-out effect at different blow-out poles and wipers in rotation or as may be desired, which varies from a minimum at full on position to maximum at the point of break off position.

Electrical Torsiometer.

3814.—1909. A. Denny, Dumbarton. The invention comprises a device for creating a magnetic field, a device in which that magnetic field induces a current, means for varying the inductive effect of the first device upon the second in accordance with the torsion in a shaft or with other dimension being measured and an instrument for indicating the induced current and also the torsion or other measurement.

Electrical Switches.

3877.—1909. J. H. Tucker, Birmingham. This is an improvement in switches of the tumbler type, in which the switch is operated by a rocking handle. The object is to impart a quick fly on and fly off action so as to obtain a more decided make and break and greatly lessen the danger of sparking. A tension spring is so arranged and combined with a catch as to cause the latter to retain the contact arm in its on or off position until the proper tension has been put on the spring by the movement of the tumbler lever to cause the contact arm to fly to its opposite position.

Electrical Insulating Material.

2128.—1909. British Thomson-Houston Co., Ltd., London, E.C. In order to make sheet insulating material, suitable quantities of powdered silica and a hydrate with asbestos fibre are mixed together. The mixture is thoroughly agitated and formed into sheets and finally treated with steam to produce a hydrous silicate.

Electric Motor Control.

2176.—1909. Siemens Schuckertwerke, G.m.b.H., Berlin. Electric motors, the speed of which can be varied by inserting resistances in the armature circuit, have been frequently employed for driving various kinds of machinery. This system has not hitherto been applicable, however, for driving ships' screws. The improved apparatus is intended for driving ventilating fans and ships' screws, and consists in the employment in a particular manner of either two shunt or separately excited motors coupled together mechanically or of a shunt or separately excited motor having two separate armatures, each mounted on a common shaft.

Electrical Traction System.

2933.—1909. B. D. Fox, London, E.C. In systems in which railless vehicles are provided with power from overhead conductors, the negative of which is at or about earth potential, provision is made for ensuring that the earthed conductor shall always be connected to the frame of the vehicle, even if the polarity of the conductors is reversed. This is accomplished through the action of electrically controlled apparatus of the polarised type which operates as an indicator, a circuit breaker or a circuit reverser when the polarity of the trolley contact changes.

Electric Motors.

758.—1909. F. Bissel Co., Toledo, U.S.A. The motor and its control mechanism can be mounted on the shaft to be driven and detached at will. The motor is specially suitable for driving sewing and other small machines, and does not require special skill to manage.

Traction Systems.

764.—1909. E. M. Munro, London, E.C. The object is to construct a trolley arm of greater flexibility and range than those hitherto made so that a railless vehicle may be able to vary its position relatively to the conductors, freely without danger of disengaging the contact shoes from the conductors. The trolley arm is controlled by springs so that when the vehicle turns out or in, that is, alters its position relatively to the conductors, the side strain usually set up between the shoe and the conductor is counteracted.

Arc Lamps.

1813.—1909. P. Hanisch, Cologne. This is an improvement in arc lamps mounted side by side and in which the forward feeding of the carbons is effected by the aid of a brake which in the normal position of the carbons holds fast and when necessary is loosened so that the carbons can be fed forward as they are consumed. According to the invention the brake is actuated by a movable piece, which rests against the lower end of a carbon and is connected to the brake in such a way that the almost imperceptible movement of the contact piece resulting from the consumption of the carbon is transmitted to the brake.

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NOTES.

ELECTRIC CLOCKS.

Modern electric time service, on which Mr. F. Hope-Jones discoursed before the Institution of Electrical Engineers last week, proved a most interesting topic in his competent hands, and attracted a keenly critical audience. Mr. Hope-Jones is no doubt correct in stating that the comparatively small advance made by electricity in this direction has been due to the fact that for a long time two classes of men were engaged in the matter: the horologists who knew nothing about electricity, and the electricians, who were indifferent mechanicians having but an outside knowledge of the niceties of horology. Hence many mistakes were made, and Paris was driven to seek a solution to the synchronisation of its time-keepers by the aid of pneumatics. It is possible, as the lecturer said, that if this matter of electric time service is taken up seriously it may provide a by no means insignificant opening for makers of electrical appliances and for young electricians.

HIGH PRESSURE LINE CONSTRUCTION.

As Mr. W. B. Woodhouse pointed out in his paper on overhead line construction, read before the Yorkshire Local Section of the Institution of Electrical Engineers, the whole question of construction and cost of high-pressure overhead system is one which closely concerns the public generally, for cheap electrical power means economy of factory management, lessening of the smoke problem. He complained that in Great Britain and Ireland progress in this direction was gravely restricted owing to the onerous conditions imposed. Before we can make much advance we must have (1) modification of the veto possessed by local authorities, (2) compulsory wayleaves, (3) less stringent Board of Trade regulations. The arguments put forward in support of these contentions were sound, and, on the whole, moderate. But we hope to return to this aspect of the question shortly, because it is one of really vital moment, not only to the electrical industry, but to the industrial, and, to some extent, the sanitary well-being of the country at large.

CONDUCTORS.

Mr. Woodhouse does not consider that the difficulties of construction in this country are great, owing to the comparatively short distances of transmission. Certain points have to be taken into consideration. In order to avoid excessive outlay on wayleaves, he advocates bold variations of spans, to allow of single poles (not A or H poles) being placed in hedges, fences or walls, where they cause the least inconvenience. As regards conductors, only two metals deserve consideration at present: copper and aluminium. In spite of copper having been in use for many years, the specification for hard-drawn wires is still debatable. The lecturer considers that the sizes of single wires required range between 18 to 15 and from 7 to 4/0, these being for stranded cables. The conditions to be insisted upon in a specification being (1) breaking stress, (2) ratio of stress at the elastic limit to the breaking stress, (3) ratio of stress to strain within the elastic limit, (4) behaviour of the metal under torsion and under repeated bending. His formula for breaking stress expressed in pounds is $F = A - Bd$; A and B being constants and d the diameter of the wire. His constants are these: A = 70,000, B = 40,000, which compares with the B.O.T. rule for safe stress: F = 14,000—8,000 d. While this figure should be high, it should not be so at the cost of elasticity Mr. Woodhouse has an ingenious way of testing elasticity, which is described in another column. Torsion and bending are rather apt to be neglected, but they are important, as kinking during erection and bending under the swaying caused by wind have to be considered.

ALUMINIUM CONDUCTORS.

Aluminium, Mr. Woodhouse considers, is penalised by the present factors of safety required by the B.O.T. When aluminium is used, he prefers stranded cables to solid wires, because this gives greater flexibility and tensile strength (the weak points of the metal, by the way), and lessens mishaps from scratches and kinks. This, of course, involves a drawback, because naturally the cable has a greater cross-section diameter than the solid wire, and so is exposed to greater strain from sheer weight and wind pressure. He gives the ratio of the diameter of an aluminium cable to that of a solid copper wire of equal resistance per unit length (for copper wire ranging from 8 to 4/0) as 1·44 : 1. After giving most useful formulæ for calculating wind pressure resistance, sag at any temperature, allowing for wind pressure and elasticity, and the breaking load of poles, he strongly advocates flexible supports, because being elastic in the direction of the wires they reduce tension and the danger of breakage. In conclusion he points out that the total cost of an overhead line may be divided into four parts: (1) cost of wire, (2) of supports, (3) of labour, (4) of wayleaves capitalised. The first is, of course, entirely an electrical matter; the other three largely a matter of mechanical skill and economical considerations. In fact, it is a matter chiefly of long or short spans, which governs the number and character of the supports. He says: "In practice one finds that over a considerable range of span variation the cost is fairly constant and the actual span length is decided by local conditions such as the position of hedges, boundaries, roads, etc. Using single poles under the present Board of Trade rules, a span exceeding 100 yards is not economical. The limiting conditions may be found in the same way for any other type of support A poles, H, or steel towers."

STEAMSHIP REPAIRS BY ELECTRIC WELDING.

Speaking before the Institution of Engineers and Shipbuilders in Scotland, Mr. A. Scott Younger, B.Sc., said that steamship repairs by electric and autogenous welding was common in Continental ports, though hardly recognised here. He deplored this fact, because electric welding was an immense source of economy, saving both time and material. His tests were made with the Swedish electric welding process of Mr. O. Kjellberg, of Gothenburg. The apparatus at headquarters was installed on a barge, which could be towed alongside any ship.

It contained, said Mr. Younger, a complete welding outfit, with sufficient cable to pass on board the steamer and long enough to reach inside of the boilers if necessary. The cables were in duplicate, so that repairs could proceed at two places at the same time. This floating workshop was about 80 ft. in length by 20 ft. in breadth, fitted with a small marine type of boiler which supplies steam to a de Laval turbine driving two direct-current dynamos and exciter, and exhausting into a jet condenser. The turbine made 12,500 revolutions per minute, and the dynamos 1,250. The voltage could be varied from 50 to 120. At the fore end of the barge there was a workshop having an anvil and vice benches, and

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generally suitable for carrying out small repairs. There was also a steam driven air compressor for supplying compressed air to pneumatic tools which were used for preparing the surfaces for welding, or dressing off after the operation. The barge at Stockholm is self propelling, and the engines which drive the propeller are disconnected on arrival, and are then used for driving the dynamos. The anvil block is a slab of steel 10½ in. wide by 2½ in. deep, laid across two wooden trestles, and the negative terminal from the dynamo is clamped to it. The positive pole is the holder, and is held in the left hand of the operator. The handle is insulated, and the current passes through the tongs in the jaws of which the steel rod used for welding is held. This rod is about $\frac{3}{16}$ of an inch in diameter, and is specially prepared, being coated with a substance, the composition of which is secret, but which appears to be of the nature of a flux. The operator, whose right hand is free to use a hammer, must be provided with spectacles having dark coloured glass. The operation of welding one of the test pieces was as follows: The edges to be welded were chamfered, and the two pieces were then laid on the anvil block and secured in position by welding a small part of each to the anvil block, much in the same way as one would use sealing-wax on paper. This operation was very quickly performed, and did not last more than a minute. The rod was then touched against the point to be welded, and on being withdrawn a suitable distance an arc was formed producing intense light and heat. The point of the rod was raised to welding heat and pressed against the work, which had also risen to welding heat. A drop of the rod adhered, and after withdrawing the rod the part was well hammered. The repetition of this process completed the welding of the test pieces, which lasted about 20 minutes. It was then roughed down by the pneumatic tools and finally machined for testing.

Mr. Younger saw pitted boiler plates made good, rudder parts, propeller and tunnel shafting and stern parts repaired. On testing it was found that the tensile strength was nearly equal to the original. In the bending test, the radius of the bend was found to be the thickness of the plate. Electricity gave infinitely better results than the oxy-acetylene process. The enormous importance of saving time in carrying out repairs should have the effect of bringing this, or some similar process of electric welding, into power in all our home and colonial ports.

CLINICAL RESISTANCE THERMOMETERS.

Professor H. L. Callendar devoted his annual address before the Physical Society of London to a consideration of resistance thermometers in recording clinical temperatures. He pointed out that Dr. Gamgee had obtained records by the use of thermo-couples in conjunction with sensitive recording instruments. The Professor held that there were two objections to this. The E.M.F.'s developed being small, the recording instruments must be too sensitive for ordinary use. Then, difficulties arose with the thermostat which is necessary to maintain one of the junctions of the thermocouple at a constant temperature. A difficulty in connection with the use of resistance thermometers for this kind of work lies in the heating effect of the current. But this can be overcome. In considering the conditions upon which the sensitiveness of a Wheatstone's bridge depends, the Professor pointed out that in platinum thermometry, in order to obtain accurate compensation for the resistance of the leads, it is necessary that the ratio arms of the bridge should be equal, and he showed that this condition reduced the sensitiveness, which could be obtained by suitably varying the resistances by about 30%. In joining up a bridge in work with resistance thermometers, Maxwell's rule for the positions of the battery and galvanometer which give maximum sensitiveness is seldom applicable. While Maxwell's arrangement actually gives the greater sensitiveness, the heating effect of the current is so much greater that the trouble arising from this cause more than counterbalances the increased sensitiveness. The problem to be solved in designing a suitable thermometer for clinical work is, with a given galvanometer and resistance-box, to find the resistance of the thermometer which will give the most accurate results for a given heating effect of the current. This is given by the equation R = √(G S), where G is the resistance of the galvanometer and S that of one of the ratio arms. It is important in the construction of a thermometer for clinical work to secure quickness of action and to reduce the heating effect of the current. An ordinary tube-form of thermometer is good for laboratory work with sensitive galvanometers, but unsuitable for use with recorders. An ordinary form of thermometer takes about 1½ min. to reach a steady temperature when taken from water at the temperature of the room and placed in water at 0° C., whereas a thermometer suitably designed will take up a steady temperature in about 10 secs. The pattern of the thermometer must also be suited to the purpose for which it is intended. Special designs are required for mouth, rectal, and surface work. On the medical side there is a vast field for research which may eventually result in important additions to knowledge.

A GROWL FROM GLASGOW.

Our Scottish correspondent voices a complaint from members of the Glasgow Local Section of the Institute of Electrical Engineers who, apparently, desire more freedom of action. One cause for annoyance was the reading of the "Equitable Charges for Tramway Supply" in Glasgow after it had been read and discussed in several other centres. But this was rather an exceptional occurrence and an exceptional paper and it touched upon a subject upon which it was well to gather as many opinions as possible. In some ways, no doubt, it would be better if the papers could be read simultaneously; but that would involve the obvious disadvantage of not having the authors to reply to discussions. The good which results from testing opinions all over the country is obvious. It is rather more difficult to meet the criticisms as regards the appropriation of locally written papers for headquarter's consumption. Too much importance, however, should not be paid to these little differences, for it is always an excellent thing when local branches show signs of restiveness, for that means that members are taking a real interest in its concerns.

GALES AND CABLES.

From all parts of the country tales of the terrible havoc caused by the series of gales come to hand. An enormous aggregate mileage of telegraph, telephone and tramway wires and cables has been blown down, luckily without serious personal injury to anybody, but to the confusion of much business. It will take a good deal to repair the mischief. No doubt the cable and wire people will think, if they do not say: "It's an ill wind that blows nobody any good." They, at least, will have plenty of employment.

INSTITUTION OF ELECTRICAL ENGINEERS.

Mr. E. Garcke informs us that he has received the following letter from Mr. P. F. Rowell, secretary of the Institution: "Your letter of February 3 has been considered by the Council, and I am instructed to inform you that while the Council, as pointed out in my letter of January 28, will continue to do all in their power to promote the general advancement of electrical science and its applications, they are of opinion that it is not within the proper scope of the Institution to provide the special organisation suggested by you at the end of your letter."

METALLIC FILAMENT LAMP SITUATION.

It is unlikely that the decision come to at the second Conference of Filament Lamp Manufacturers, recently held at Berlin, to lower prices after March 10, in accordance with the disturbing action of the Allgemeine Elektrizitats-Gesellschaft will have any influence on the British market. The conference, which was attended by all the German manufacturers except the A.E.G., by the leading Austrian and Dutch firms and the Continental Westinghouse Co., declared that it was impossible to do otherwise than follow the lead set by the A.E.G., but, on the strong representation of the Union of Installers and other middlemen associations that enormous stocks of lamps were still held in the wholesale and retail trade, the revision of prices was, as indicated above, postponed to March 10. Siemens und Halske A.G., whose wolfrom lamp works are just beginning to become active, have agreed that the prices of their tantalum and wolfrom lamps shall correspond.

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PUBLICITY & ELECTRIC SUPPLY UNDERTAKINGS.

There is no doubt that the necessity for a good campaign in advertising on the part of supply undertakings is just at present of primary importance. The economy of the new lamps have made huge inroads on the revenue. This is the dark side of the question. Fortunately, however this by no means exhausts the significance of the new lamps. On the contrary, supply authorities have in this something really worth and demanding all the resources of the completest advertising. To gain benefit from it, this great decrease in cost of lighting must be dinned into the ears of the public. Persistent advertising and circularising is the only way to make an impression. The question of success, however, depends on the methods employed in the carrying out of the work. The matter is obviously one that can best be dealt with by co-operation among supply authorities. All supply undertakings are engaged in working on the same lines, and by concerted action there is obviously the economy resulting from saving the same work being reduplicated by each. It is to meet this need that the work of the Joint Publicity Committee comes to the fore. This committee, representing the leading London companies and municipalities, together with some outside the London area, has been organised to deal in systematic manner with all matters relating to publicity, and to invite the co-operation of all undertakings throughout the country. Some preliminary newspaper advertising has already been done, and the present action of the Committee is the issuing of a poster and circular, copies of which have been sent to all undertakings. Assuming that the scheme obtains the support of the undertakings as a whole, there is every promise that the organisation will be a most effective means of developing the commercial aspect of electric supply. The scheme ought certainly to recommend itself.

MODERN ELECTRIC TIME SERVICE.*

By F. HOPE-JONES.

When I read a paper before this Institution just ten years ago, electric clocks were at a very low ebb in this country. The review then given showed that practically all the work of English inventors, including that of Bain and Wheatstone, had been futile, the survivals of the Victorian Era being the two forms of synchronisation, the Ritchie sympathetic pendulum, and the Lund minute hand clip, both of them limited in their applications, while every attempt to introduce foreign systems had failed.

This was the position when I introduced the "Synchronome" system to your notice. Someone had to prove that electric clocks, if constructed on sound principles, would work, and for five years it was left to me to do so. In that period three hundred or four hundred installations were erected, and these restored confidence and attracted others into the field. In 1905 no less than five systems sprang into active competition, and the business of electric time service which could hardly be established by one firm alone, however successful, was fairly launched as a branch of our profession.

The systems of electrical impulse dials which are of commercial importance to-day and which practically arrived in the year 1905 are those of Lowne, Aron, Perret, Magneta, and Gent. The systems of Campiche and Palmer (both of which arrived in that year also) are omitted because the amount of work yet done by them is hardly enough to justify their inclusion, but they should be mentioned because they were the first to give impulse to the pendulum in one substantial thrust every half-minute and to rotate a count wheel by the pendulum for that purpose, a method adopted by Lowne, "Synchronome," and Gent, and likely to be generally followed.

Describing the time transmitter of Messrs. R. M. Lowne and Son, of Catford, the author says a flywheel is linked to the armature of the pendulum movement to slow its motion in order to make sure that contact remains closed until the most sluggish dial has operated. The shunt coils in the dials, by cutting out the resistance of each magnet as soon as it has operated, increase the current through those that require more, and thus it can be truly said that the current consumption is exactly that which the dials require. As an alternative to the inertia device to prolong the duration of the contact, two subsidiary transmitters may be used on the alternate circuit system where one makes and the other breaks. This is an elaboration of the electrical interlocking system and it involves a device for halving the number of vibrations of the armature lever.

Though the propulsion of the pendulum might not satisfy the purists in that the pendulum is never absolutely free, that it does work at the end of its swing, and that all the energy for contact making is derived from it, it is nevertheless no surprise to me to hear of its excellent time-keeping performances as the details are of fine design and workmanship.

The Aron system is based upon Dr. Hermann Aron's self-winding action long successfully used in the meters of the Aron Electricity Meter Co., Ltd. The driving click, mounted on an armature, drives the main wheel of the clock by means of a spring. The carrier, with insulated blade and contact blade, is in a state of unstable equilibrium, and is adapted to be flung in one direction or another by a spring when the contact pin on the armature has moved it past the dead centre. It is used to self-wind what may be described as an ordinary striking clock in which the striking part has the sole duty of turning a commutator every minute, sending an impulse to the dials and reversing the polarity of the battery every time. In this respect they follow standard German practice which, in such systems as Grau-Wagner, of Wiesbaden, has entirely justified itself.

In the self-winding action of Perret's system, though the contact is of the "touch-and-jump-away" sort, instead of "touch-and-follow-on," the functions are divided and the contact that jumps away is the one which was made substantially and at leisure when the circuit was open elsewhere. All the energy for contact purposes is derived from a wheel or the armature which drives it, but little is required for a contact of this nature and fluctuations of driving force are small. It is limited to small currents and low voltage, relays being used for circuits of dials, which are of the simple one-wheel step-by-step type.

Ten years ago, when describing Wheatstone's induction system and the abortive attempts to use it in the Houses of Parliament and the Royal Institution of Great Britain I little thought that the method was on the eve of a great revival, but at the very time I was recording the history of a failure, Herr Martin Fischer, of Zurich, was making history, and a success, by his applications of Wheatstone's principles which produced the "Magneta" system.

It will be recollected that Wheatstone generated alternate currents by means of the pendulum bob of his controlling clock, which was, in fact, a magneto-electric machine driven by an enormously heavy weight wound by hand. The armatures in his dials revolved once for every complete vibration of the pendulum of the master clock, and were geared to the minute hand through a train of wheels. It is easy for us to see that his method could not hope to succeed in view of the flagrant violation of the rule, that the time-measuring function should never be combined with other duties. In Wheatstone's system the entire energy required to operate a circuit of propelled dials is derived from the one timing pendulum itself, an unwarrantable interference with the free action of gravity. The energy so obtained could never be sufficient to operate even a small group of dials with certainty. Fischer made two radical improvements straightway; his magneto-electric generator was driven by a separate train of wheelwork, let off by the going train of a key-wound clock which was otherwise uninterfered with, and he generated his impulses once a minute instead of every second. In 1903 the Magneta Co. were good enough to send me a report of a most exhaustive series of laboratory tests imitating extraneous induction interferences—a fine example which deserves to succeed—and I quote from a translation of it as follows: "As compared with Wheatstone's, the inductor possesses a high degree of efficiency, the magnetic field being completely enclosed in iron. It works at a much higher speed, and a space available for the motion of the armature is unlimited. The duration of the impulses vary from 0·1 to 0·2 seconds according to self-induction, etc."

The by no means easy matter of measuring time accurately for long periods does not affect the magnetic system

* Abstract of paper read before Institution of Electrical Engineers, London, Feb. 17, 1910.

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as it does automatic systems. Certainly the accurate measurement of time for long periods by automatic means is a difficult yet alluring scientific problem. The motor would first convert current from the mains into foot-pounds in raising the weights of the master clock. In falling a little way every minute, the energy is reconverted into electricity for transmission to the dials, where it is once more converted into mechanical energy to move the hands. This roundabout method, with the heavy loss of efficiency involved in each stage of piecemeal conversion, would be necessary to enable the system to accomplish the same automatic result achieved by the modern battery system, which takes electrical energy from any convenient source, converting it into mechanical power in one simple operation wherever required. The justification claimed for the induction method is that the dials are in a permanently closed circuit, no contact being required to chop up an outside source of electricity into impulses.

The motto, "No contact and no battery," inscribed upon the Magneta Co.'s banner, was most appropriate in every Continental country and in America, and secured for them an easy victory over the old-fashioned battery-driven systems.

It was precisely from the point of view—faulty contacts and failing batteries—that the author of this paper approached the subject fifteen years ago, recognising it then as the main cause of the backward state of the science at that time compared with telegraphy, telephony, light, power, and other achievements of the nineteenth century.

Contacts operated mechanically by clockwork have the following vices:—What small power is available for making them is robbed from the escapement; they lack precision in the make and break; their duration is arbitrarily adjusted to their supposed requirements, and thus pass what current is available regardless of its sufficiency or insufficiency.

In my paper of ten years ago I described a simple mechanism called the "Synchronome" switch, which had ample power, but took none of it from the pendulum or the escapement which drove it; was perfectly clean and precise in the make and break; gave impulses whose duration was largely dependent upon the self-induction of the electro-magnets they had to energise; and transmitted sufficient current to operate the dials, or else ceased work altogether. In 1904, following Campiche, Palmer, and Lowne, the escapement was dispensed with and the gravity lever was left normally on a catch, withdrawn every half-minute by an otherwise idle count-wheel propelled by the pendulum.

An impulse is given to the pendulum at the moment when it passes through its zero or central position. Thus the pendulum is free at all times except in the middle of its swing. The setting lever serves to stop the dials when moved from normal to retard, or to accelerate them. The method of impelling the pendulum as it passes through its zero position by the falling lever is well known in horology as the invention of Sir H. H. S. Cunynghame, K.C.B., being an adaptation of his detached gravity escapement with free pendulum made as a mechanical clock in 1904.

In addition to the merits of the switch in its old form its two parts have a longer range of movement and sail into contact at the speed of the moving pendulum; when the current falls below a certain predetermined value the pendulum assists the magnet to replace the lever, which action is a valuable indication of impending failure of battery, and if the pendulum stops it holds the switch open.

The dial movements are of the simple reciprocating armature type designed to deal with clock hands of considerable inertia and momentum, and made in five different sizes for clocks ranging from 3 in. to 10 ft. diameter.

The time transmitter of Messrs. Gent & Co., of Leicester, is very similar. The gravity lever is at the bottom with adjustable weight, and the magnet above. The impulse surface is near the centre of the pendulum and the impulse roller is just above it. The pendant armature does not itself make contact, but ends in a trip lever which pushes a lever carrying contact surface, forward enough to reset another lever and then allows yet another lever to fall back. I understand, however, that this was not found beneficial and that they have since adopted the pure momentum break of the "Synchronome" system.

The dial movement of the Gent system is also very similar to that previously referred to in its earlier form; in fact, most uni-directional current systems have now adopted the electro-magnetic time counter described in the 1899 paper.

From the first inception of the "Synchronome" system in 1895, the dominant idea was to design these dial movements for quick action and the switch for slow action, giving the latter both mechanical and electrical inertia. The dials are made to work with less current and with a contact of shorter duration than is required to operate the switch, but it was obviously desirable to measure the extent to which the current rate and the duration of the contact exceeded in ordinary practice that required by the dials. And it is well to demonstrate in a convincing manner how short is the duration of impulse necessary, because nothing less than a whole second was previously used, and most systems of electric clocks on the Continent and in the United States of America still have impulses whose duration is from fifty to one hundred times longer than necessary.

Thanks to Mr. Duddell's oscillograph, I have now been able to investigate the precise nature of the impulses transmitted by the "Synchronome" switch and exactly what happens in circuits of electrical impulse dials of varying number and size. The precision of the make and break has been demonstrated and compared with the intermittent nature of the mechanical or relay contacts previously used for such purposes. It has also been possible to determine precisely the most efficient arrangement of electric time circuits with regard to duration of impulses and voltage, and to lay down rules whereby full advantage is taken of the compensatory effects of increased duration of impulses consequent upon decline of battery.

We can now lay down some general rules which will be applicable to all time circuits controlled by a "Synchronome" switch. The switch magnet should be wound with that number of turns which will just fail to enable it to work on the current rate which will work the dials. The mass of the two moving members of the switch and their travel in company must be sufficient to endow it with the ordinary qualities of a reliable switch, yet small enough to enable the break to occur very shortly after the dials have operated within the time constant of the circuit, and before the current has risen to its full value. If this is done full benefit will be obtained from the compensatory action, which is of such value when primary cells are used as the source of supply. The voltage should be well above that required to produce the current rate necessary to operate the switch. The only objection to excess is noise, and the more you have the greater is the margin of safety and the less is the consumption of current.

The smallest curve obtained had an area of 0·012 coulombs = 3·5 ampere-hours per annum, and the largest about 0·36 coulombs = 10·5 ampere-hours per annum; they can be greatly reduced if desired without fear of the break occurring before the dials have had enough current. At 1-volt drop per dial, which is ample for all ordinary sizes for interior use, the consumption of current should not be more than 3·5 watt-hours per dial per annum, this low figure being due to the small contact time factor of only ten hours per annum. Now if we are using a primary battery we cannot hope to get out of it any reasonable amount of energy during its natural life if we have only ten hours in the year in which to do it. We have seen the great advantages of arranging time-circuits in series, and it is impracticable to increase the discharge rate much further; consequently we shall not achieve much economy by shortening the impulses, nor is it particularly desirable. It is true that 1 watt-hour (equivalent to 2·654 ft.-lbs.) should be ample to run a clock of this size for twelve months, and that a good dry cell is capable of yielding, say, 100 watt-hours on a suitable load in a suitable time, and should therefore run, say, 33 clocks for three years. It cannot do so because the energy it contains, though sufficient in measured units, is not in a form suitable for expenditure on the work in hand. No such degree of efficiency is possible in any system which uses current for so short a period, yet the balance of convenience in other respects is entirely in their favour.

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Brief mention should be made of two more systems which have appeared since 1905—Bowell's and Murday's. The vibrations of the pendulums of the master clocks in each of these systems are maintained by the Foucault-Hipp electric "Butterfly" escapement. A little trailer, pivoted freely on the pendulum swings clear of a notch in a block until the arc falls to a certain predetermined minimum, when it jams in the notch and presses two counterbalanced levers together, making a reliable contact and causing the magnet below the pendulum bob to restore the arc.

In both systems a count-wheel is used to select the semi-vibration at each half-minute when contact shall be made for the operation of the dials.

In G. B. Bowell's system (made by the Silent Electric Clock Co.) the pendulum charges into contact springs at the end of its swing, making a comparatively long contact to operate dial movements with rotary armatures in a permanent magnetic field.

In T. J. Murday's system (made by the Reason Manufacturing Co., Ltd.), the contact is a passing one made at zero, and the dial movements have reciprocating armatures pivoted between the poles.

For twenty-five years Mr. Murday has been the principal exponent of the Hipp Butterfly escapement in this country, and had made many useful and original applications of it. In 1901, with the Standard Time Co., Ltd., he applied it to the heavy pendulums of turret clocks with perfect success and inaugurated a method of turret clock driving which has a great future before it.

Looked upon simply as a method of conversion of electrical energy, this is probably the most efficient motor ever designed, and it must be remembered that, unlike ordinary motors, it is at its greatest efficiency when working at its slowest speed, rotating its driving wheel at the rate of, say, 1 r.p.m. There is no theoretical limit to the amount of power which may be developed by this means, and it increases the frequency of its impulses automatically in exact proportion to their lack of strength and in proportion to the work demanded of it.

By the addition of a third contact lever below the other two the Standard Time Co. provide an alternative source of electrical energy which comes into operation if the first one fails. Gents, of Leicester, have recently introduced a simple means of bringing a Hipp-driven clock under the control of a half-time circuit, similar in principle to that used by the Standard Time Co. for synchronising it.

There may be some limit as to the size of a turret clock which can be dealt with by this method, and I offer a constantly running motor controlled by a "chaser" switch as being suitable for the "Big Bens" of the future.

A motor with a double-worm reduction gear, reducing the speed from, say, 1,800 r.p.m. to 1 revolution in 5½ min., carries a disc rheostat on its slow-moving axle. A switch arm mounted freely on this axle is driven by an electrical impulse dial movement in a standard time-circuit of half-minute periodicity on to the contact studs, cutting out resistance in the motor or armature field. These resistances are so proportioned that the motor is constantly running at a speed dictated by the half-minute progression of the chaser switch.

Existing turret clocks may be relieved of their dangerous and cumbersome driving weights and the necessity of winding them (which often has to be done daily) by means of small rotary motors. The Huyghens endless chain is admirably adapted for the purpose of connecting a motor to the "going" train of any ordinary turret clock. All that is wanted is bicycle gear-wheels and chain supporting a small weight which switches the motor in at the bottom of its fall and out at the top. Bell hammers may be directly driven without the intermediary of any *remontoire*.

It is satisfactory to note a recent tendency to more enlightened inventive work in this field—really progressive improvement based upon such of the work of other inventors as has been proved to be sound.

The experience of the last ten years has shown that the principles then formulated before this Institution are necessary to the success of any system of electrical impulse dials with simple movements for operation by uni-directional currents. The most important of those principles were the transmission of energy through the surfaces of the contact and taking it from the electromagnet instead of from the clock or its pendulum; the immense economy of current and the certainty of its sufficiency obtained by short duration contacts dictated by the self-induction of the whole system; and the momentum stop in the dial movement.

Since then the application of Sir Henry Cunynghame's free detached gravity arm and the extended range of battery warning given by the pendulum's assistance to the magnet in resetting the switch have given a great impetus to electric time service.

Circuits of electrical impulse dials will always take the premier position as the most generally useful application of electricity to horology because that method is the most simple and direct means of attaining absolute uniform time with a high degree of accuracy. Now that we have succeeded after so long a fight in breaking down the prejudice aroused by the failures of so many systems, let me urge manufacturers and contractors not to kill the goose that laid the golden egg by cutting prices and by putting in electric-bell wiring.

I have always claimed for electric time service a position as a reputable branch of our profession, and I can do so with more confidence now, thanks to the enterprise of others firms who have taken up the business of electric clocks and the healthy competition which has resulted.

DISCUSSION.

Mr. H. R. Kempe: The author refers in the earlier portion of the paper to the futile efforts made by Mr. Ritchie and others. I think that to Mr. Ritchie is due the honour of being the pioneer of the electric clock system. One cause of the failure of electric clocks up to within the last few years has been the difficulty as regards batteries. In my opinion the success of electric clocks is very largely due to the Leclanché battery and also the dry battery. I mention Ritchie as being the pioneer, but I can safely assert that by no man has the advantages of electric clocks been brought forward with such success as by Mr. Hope-Jones. He tells us that nothing of importance in synchronisation has been achieved since he first referred to the matter ten years ago. I think the Post Office has done a very large amount of work in the last year or two and are continuing to do so. Our chief reason for synchronising up to the present in preference to adopting electrically driven clocks is that we have a very large number of clocks in various offices and it would hardly be economical to scrap the lot for the purpose simply of putting in electrically driven clocks. The synchronisation system which we adopt is extremely simple, costs very little, and, so far, has answered very satisfactorily. One point in favour of synchronisation as compared with the electrically driven clock is that in the latter you get impulse every half-minute or every minute and you cannot tell for a few seconds exactly what the time is: you have to wait till the impulse comes. Mr. Hope-Jones casually alluded to the use of non-inductive shunts. That matter ought to be made more of. It is a very extraordinary thing that, while these non-inductive shunts have been largely used in telegraph manufactures, makers of electric clocks do not seem to refer to it. It is really the salvation of the system. There is no doubt that the lack of expert handling is an important point. In all mechanism of the kind it is important that the adjustments should be as few as possible and that once put right they should be firmly fixed—even the application of the soldering iron would be an advantage. The author mentions that contacts operated mechanically by clockwork pass what current is available regardless of its sufficiency or insufficiency. A good deal too much may be made of the fact. The total amount of current necessary to keep an installation of about 100 clocks going hardly exceeds 2s. 6d. per annum and in an effort to bring the amount down to sixpence it is quite possible that you may incur a capital expenditure, the interest on which would be greater than the sum saved.

Mr. A. C. Brown: In regard to the dials, it is quite possible—and it has been done—to dispense with the second or the locking click and with the consequent amount of adjustment required with its use. The inertia of the hands is ample to prevent recoil of the wheel when the driving

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click is pulled up. Coming to the more important subject of the pendulum, I want to try and induce makers of electric time systems not to perpetuate that fearful blunder that has been made by good class clock makers up to the present in the mechanical way, *i.e.*, to get out of the three degree arc—that relic of barbarity. I appeal to the makers of all electric clock systems to abandon the conventions and give their pendulums a good long swing; they will find that by this means they get a very much greater accuracy of time-keeping than they would possibly expect if the synchronism of the pendulum is only feeble. Accuracy of time-keeping is the one thing wherein an electric system stands to gain over individually mechanically wound clocks. At the present moment, although we are very careful in the putting in of power we very often neglect to take precautions to get rid of it in the best way. The best place to put the pendulum is down in the basement as near to mother earth as you possibly can.

Mr. E. T. Cook: The question of keeping current consumption down has been much over-rated. One might spend ten shillings a year in current and if you get the advantage of a better system the money is well spent. With regard to Murday's system, at the East London College some students worked out a pendulum of this kind and we adopted it because of its great simplicity in connection with the Hipp switch. The result was a simple and mechanical job which has operated satisfactorily for four years. This kind of contact is capable of being made very clean and very precisely. The pendulum has a good healthy swing.

Mr. J. N. Alty: One is struck by the relative simplicity of the recent forms of the synchronome switch. It seems that with good wiring and a reliable battery satisfactory operation can certainly be expected. Electric clocks use so little current that batteries rot out rather than wear out. That objection might be partly removed if batteries were connected in parallel.

Mr. W. W. Duddell: Whether a battery is going to be a trouble or not depends upon the number of cells you have in series. Mention has been made of the expense which would be entailed if a new system of clocks were adopted by the Post Office. If you capitalise the cost of sending winders round it may come to a much larger sum than throwing the clocks away and then replacing them with some of these simple clocks with small dial movements. It appears that the curves taken, you can calculate the efficiency of these clocks as you can that of a motor.

Mr. A. E. Ball (Messrs. Gent & Co.) spoke of his early productions in electrical clocks. Twenty-five years ago he produced a dial and it had been going ever since. He finally hit upon a very happy combination, which he started making in 1903 and finished early in the following year.

Mr. A. E. McCloskey: It is very disquieting to hear that the master clock is so very easily upset and with it all the other clocks in circuit. Is it possible to arrange so that the current from Greenwich or any other Observatory might synchronise not only the master clock but also all the other clocks in circuit?

Dr. Gisbert Kapp: It is very desirable that our journal should contain a full record of the condition of the electric clock industry at the present moment. Mr. Hope-Jones very naturally did not like to go to rival makers and say, "Give us all your information!" It was a difficulty which he had to overcome by discussing patent specification and other printed matter, which is open to the "man in the street." But now that we have all heard with what fairness he treated his competitors, I would appeal to them as Mr. Duddell has suggested, to supply all the information which they think they can do without prejudicing their own trade interests so that our proceedings may contain a really complete account of electrical clocks.

Mr. Hope-Jones (in reply): Dealing first with the remarks by Mr. Kempe, on the subject of synchronising, I hope I have not done any injustice to the excellent work at St. Martin's Le Grand during the last year or two. It has been a joy to see the magnificent network of wiring at the Post Office should at last be used for the purpose for which it is peculiarly capable—physically synchronising actually instead of merely sending signals once a day which in the various Post Offices are noted at ten or one o'clock and a boy sent to move the hands. I have always argued that we do not make use of the splendid telegraphic network all over the country as other countries use their telegraphic systems. In the United States six years ago I found the Western Union Telegraphic Co. in the same position as our own Telegraph Department—the Government were using the lines for the purpose right from the Pacific to the Atlantic. On the subject of non-inductive shunts I entirely agree with Mr. Kempe. We have invariably used non-inductive shunts for absorbing sparks and they have a great advantage. In a really important time circuit of perhaps 100 or 150 dials in series the strength of the chain is as the strength of its weakest link. It is nice to have a shunt as an alternative path. We do not use Leclanché cells: we happen to prefer a higher rate of current. We use good, big dry cells. The reason is there is low resistance and they are long lasting properties and do not require any attention. The bogey of battery failure does not amount to very much in actual practice. At half-a-dozen well-known buildings in London, with a record of these circuits of ten years, the average life of these batteries is four years. The great point is to make electric clocks, as the Americans call it, foolproof. They have to go to people who do not know how to work them and who are sure to make mistakes. Neglect will usually result in any system being left without sufficient battery—not weak enough to stop the master clock, but weak enough to make it "go anyhow," thus making it a laughing stock. I would sooner have the thing stop, provided it kept synchronising up to the last moment. I should like to refer in writing to the question Mr. Brown raised in regard to three degree arcs. Mr. Cook gave you the impression that I condemned a method of making contact off the pendulum. I said that was the best way you could do it if for other reasons you have to interfere with the pendulum at the end of its swing. It should be done in the middle. In Mr. Murday's system the contact is given at the centre. The point is that you have to be careful of the duration: it is a question whether you want a quick contact or not. The right thing is to get your interference in the middle only. As to Mr. Alty's remarks about putting electric time circuits in parallel I may say that the whole spirit of the paper—the oscillograph part of it—is that you want self-induction. Noise does not bother us in the least except in the rotary form of dial movement.

THE ELECTRIC INCANDESCENT LAMP.

ITS CONSTRUCTION AND APPLICATION.*

By Mr. JAMES FINDLAY.

It is now thirty years since Swan and Edison made the incandescent electric lamp a commercial article. During that time many changes have been made in the methods of manufacture, and while the efficiency of the lamp has steadily improved, only one radical change has been effected, and that is the substitution of a tungsten filament for the carbon filament. The tungsten filament lamp has not yet entirely supplanted the carbon filament lamp, each has its own particular field. I intend to try to explain some of the methods adopted in the manufacture of both these types of lamp, and will thereafter speak as to the conditions under which each type will give the best results.

Tungsten occurs in Wolfran or tungstate of iron, and in scheelite or calcium tungstate. The native calium tungstate is digested in hydrochloric acid, and the soluble calium salt washed out with water. The resulting tungstic acid may be dissolved in ammonia evaporated to dryness and heated in contact with air. Tungstic oxide is thus obtained. With this yellow powder the work of making the filament for incandescent lamps begins. A common method is to take tungstic oxide, mix it to a stiff paste with glucose or starch, or any material which will bind the powder together. The paste is put into a mould in the bottom of which is a diamond die, and pressure is brought to bear on the paste to extrude it through the die. Difficulty is encountered in the first place in getting the tungstic oxide powder in a fine enough state of sub-division. When it is remembered that the aperture of the die is sometimes less than two thousandths of an inch in diameter, it will

* Paper read at the Birmingham and District Electric Club, Feb. 12.

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be readily understood that the powder must be very fine indeed before it can be made into a paste which will pass through. Then it is a comparatively easy matter to mix this powder into a paste, but the paste must be wet enough to pass through the die, and yet dry enough to hang together in thread form after it has passed through. The usual practice is to catch this thread on cardboard or similar material as it comes from the die. The board is passed back and forth beneath the die so as to spread out the thread in long hair-pin form. The filaments or threads are then dried in a gas oven, after which they are placed in boats and put into a furnace tube, through which hydrogen gas is allowed to flow. Sometimes the air is exhausted from this tube by means of a vacuum pump before the hydrogen is introduced, but the hydrogen is generally left to displace the air. A considerable heat must be maintained in this furnace for several hours, the result of which is to partially reduce the tungstic oxide to tungsten metal. The next step completes this reduction. The filaments are supported under a bell jar, which is evacuated-hydrogen; gas is admitted, and the electric current passed through the filament.

A current equal to four or five times that which the filament will take when made into a lamp is passed through the filament—the strength of the current varying with the pressure of the gas under the bell jar. The effect of this strong current is to burn off any remaining portion of the binding material; to complete the reduction of the oxide; and to sinter or melt the particles of metallic tungsten closely and solidly together. In order to give the filament a symmetrical shape, it is customary to hang a small weight on it during this sintering process. The weight pulls the filament straight, and makes the bend small, so that filaments may be placed close together. Care must be observed to have a weight which, while heavy enough to give the desired shape to the filament, is not too heavy, else while the filament is very hot the weight will drop through. The weight must also be of a material that will withstand the very high temperature of incandescent tungsten, otherwise the weight will be melted to the filament. The filament is now ready to be attached to the leading-in wires. Owing to tungsten being very soft while incandescent, it is necessary to support the filament at both ends, and to provide such a means of support so that when the filament becomes soft and extends one limb will not come into contact with another limb. This, and the low resistance of tungsten, renders necessary a much more expensive internal construction for the lamp than is necessary for carbon filaments. The various steps in the manufacture of the filament support are as follows:—

The leading-in wires consist of a piece of copper wire, to which is welded a very short piece of platinum, which again is welded to about half-an-inch of nickel wire. The purpose of the short piece of platinum wire is, of course, to prevent any air leaking along the wires and so impairing the vacuum. Many substitutes for platinum in this connection have been suggested, and while some of the proposed substitutes equal platinum in having practically the same co-efficient of expansion as glass, none of them is quite equal to platinum in freedom from oxidization in the flame used to melt the glass around the wires. A piece of glass tube is rotated in a gas flame, a carbon pencil is inserted in the end which the flame has softened, and by a slight movement the end is flanged out. The flanged glass tube and the leading-in wires now go to a machine where they are sealed together.

This machine has four heads which rotate around a common centre, so arranged that each head comes in succession opposite the operator who puts the glass tube and wires in place, then into a preliminary fire to heat up the glass, then into a final fire where the glass is melted, and while in this condition the operator by means of a foot pedal, pinches the molten glass around the wires.

Another movement of the machine brings the part into a position where it may cool down before it comes again in front of the operator who removes it and puts in position the new parts of another. The central glass rod is placed in position. The enlargement in which the wires are embedded is made by rotating the rod in a pointed flame, at the same time gently pushing the ends together. After the wires are inserted, the filaments are secured in place. In a carbon filament lamp the carbon is attached to the leading-in wires by a little carbon cement. This method however, will not answer with a tungsten filament. Carbon is a very bad thing to have inside a tungsten lamp. The ideal way is to have an all-metal connection. This is very neatly effected as follows: A paste of nickel oxide is used to hold the filaments to the wires. The mount is pushed up into a bottle through which a stream of hydrogen gas is made to flow. The leading-in wires of the mount are connected to one pole, and a platinum point, which is inserted through the side of the bottle, is connected to the other pole.

Current is supplied through a small step up transformer, so that when the push button is touched a high tension arc is made between the point at which the filament is pasted and the platinum point. The heat of this arc and the hydrogen, reduce the nickel oxide to metal, which forms a small globule around the filament securely welding it to the leading-in wire. The mount is turned around, bringing each joint in front of the platinum point, so that the joints, sometimes over twenty in one lamp, are all made in a few seconds. The mount is now ready to be sealed into a bulb, but some preliminary work must first be done on the bulb. As received from the glass house, the bulb, of course, has no pip, and it has a long neck. The first operation on the bulb, after washing it, is to make a small hole in the centre. This is done by playing a very pointed flame against the centre of the bulb, at the same time bringing air pressure to bear inside the bulb, so that when the flame has sufficiently softened the glass the air pressure blows it into a hole.

A short tube is now sealed on over the hole. This tube is afterwards used to connect the lamp to the exhaust pump. The bulb is now held upright in the centre of a ring of pointed gas flames, arranged so that the flames play on the neck at the point at which it is wished to cut it off. The bulb is slowly rotated, so that the neck may be equally melted all round. As the flames soften the glass, the neck is pulled down by its own weight, so that in a few seconds it drops off and the thin glass closes over the opening. Air pressure is at once introduced into the bulb and the thin glass burst outwards. The bulb and mount are sealed together on a machine which has a spindle to carry the mount and frames to support the bulb. The mount is first put in position, and then the bulb is placed over it, great care being necessary to avoid breaking the very fragile filaments. The mount spindle and bulb frame rotate together as one piece, and the machine consists of four arms, with a mount spindle and bulb frame on each arm. This arrangement allows the operator to place the mount and bulb in position, rotate the machine, and thus bring the lamp parts into the fire at the same time, bringing another arm with its mount spindle and bulb frame in front of the operator. When the parts of another lamp have been placed in position, the machine is given another quarter revolution, and the original mount and bulb are now brought into a hotter fire, where the sealing of the two together is completed. When the lamp is removed from this machine, it is placed in an annealer to prevent it cooling too rapidly, and so obviate as far as possible the danger of cracking. The lamp is now ready to be exhausted. In most of the operations up to this point, the methods of procedure have been closely similar in the carbon and metallic filament lamp, except where the physical appearance shows them to be different. Different methods, however, are followed in exhausting the two types of lamps, with, of course, nothing to show for it in the finished lamp.

A carbon filament lamp is exhausted on a mechanical pump with oil flooded valves, which is capable of giving quickly a vacuum of about 0·3 mm. of mercury short of absolute vacuum.

The lamps are connected to the pump by rubber joints, so that a lamp can be very quickly put in place and removed again. Only one lamp is connected to the pump at one time, so that each lamp gets individual attention. Before the lamp is connected to the pump, a little red phosphorus dissolved in alcohol is placed in the glass tube. The bulbs are heated before or during exhaustion. At the same time that the lamps are connected to the

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pumps the wires are connected to an alternating current supply. So soon as the lamp has been long enough on the pump to have a fair vacuum, the current is turned on low at first, but quickly raised to a point much in excess of the pressure for which the lamp is designed. This causes a blue glow to spread out from the filament and the joints, and to fill the bulb.

When this glow assumes the proper quality, the operator applies the heat of a hand torch to the glass tube containing the red phosphorus, this heat volatilises the phosphorus and it combines with the residual gases in the bulb, the result of this chemical combination being a practically perfect vacuum, or, at least, a space free from oxygen or other injurious gases. This chemical combination is evidenced by the disappearance of the blue glow. When this happens the operator switches off the current, and by means of the hand torch seals the lamp off. As there is a vacuum inside the lamp and tube when the heat of the hand torch has softened the walls of the glass tube, the atmospheric pressure outside forces the walls of the tube together. As this is being done, the operator pulls the lamp away from the tube, drawing the tube down to a thread, which is melted off by the hand torch, and the pip of the lamp is the result. It may take a minute or two to explain this operation, but if every necessary facility for quick work is provided, an expert operator will exhaust lamps at the rate of one in forty seconds, and should have a weekly output at the rate of one lamp per minute. When exhausting carbon lamps, it is not customary to use a gauge of any kind. If the pump is in proper working order it will give a good vacuum just as quickly as the operator can place the lamps in position and manipulate the switches, etc.

To exhaust tungsten lamps, different methods and different pumps are employed. A pump which is coming into very general use for this work is the Gaede rotary mercury pump, although some manufacturers prefer to use the old style Sprengel mercury pump. The rough and ready means of connecting the lamp to the pump by the means of a rubber joint, which is found highly satisfactory for carbon lamps, will not answer for tungsten lamps. The only entirely satisfactory method is to seal the lamps to the pump by means of the torch. Six lamps are generally put on a pump at one time. The lamps are so arranged that in addition to being connected to electric supply they can be enclosed in a heater and brought up to a good heat while they are being pumped. Very few manufacturers use any chemical to assist the exhaustion of tungsten lamps in the way that red phosphorus is used in carbon lamps. The lamps must, therefore, be left much longer on the pump, and for this reason they are not connected up singly, but in batches of six or more. A tungsten lamp requires a much more careful exhaustion than a carbon lamp, and it is necessary to use a gauge of some sort to indicate when the vacuum is good enough to permit the lamps to be lit up. For this purpose some manufacturers use a spark gauge. As the exhaustion proceeds, the discharge is first ribbon-like and then spreads into a luminous glow. The glow then disappears, and the glass flooresces, the discharge finally refusing to pass. As the degree of vacuum indicated by these changes varies with the size and condition of the spark coil used, some manufacturers prefer to depend entirely on a McLeod gauge. In this gauge, the highly rarefied gas in a bulb which has been connected to the lamps and pump, is compressed by allowing mercury to flow in, the compressed gas or air being collected into a carefully calibrated tube over the bulb. The total capacity of this tube and bulb being known it is easy by Boyles law to calculate the pressure in the bulb before the mercury was admitted. This pressure is, of course, also the pressure in the lamps. Some hard things have been said about the McLeod gauge, but I think many of these things must have been said about gauges which were not properly designed. It is possible to make a McLeod gauge so that it will give uniform readings day after day, so that it will be easy to operate and not liable to inordinate breakage in factory work. These gauges can be so made and calibrated that it is easy for a young girl to take quite accurate readings. It is good practice to have a vacuum of about ·0006 mm. of mercury before lighting up the lamps.

The lamps are on the pumps about 40 or 50 min., and a vacuum equal to about ·0002 mm. of mercury should be obtained before sealing the lamps off.

It is usual to test the quality of the vacuum by means of a spark coil, but this is of doubtful benefit. Tungsten lamps may not show the slightest glow on the coil, and yet have a good enough vacuum. The coil test is, however, quite good enough for carbon lamps. All lamps are tested on the photometer for candle-power, and most of them are also read for current consumption. In well-made high voltage carbon filament lamps it is not necessary to do more than read the amperes of sample lots, because if the lamps are selected for candle-power it will generally be found that they are within a close enough range in amperes for all practical purposes. The photometer most used in factory work is the common Bunsen grease spot, and it is very hard to beat this for steady work. A Lumner Brodhum photometer is good for more careful work and for checking the work done on the Bunsen. The factory is no place for a flame standard, and now that Great Britain, France and the United States have agreed upon a unit of candle-power, the only right course is for each factory to provide itself with reference lamps, seasoned and certified by the National Physical Laboratory. Lamps are tested as follows :—A working standard is set up at one end of the photometer. This should be an incandescent electric lamp, burning at an efficiency which will match in colour with the lamps which are to be tested on this photometer in largest quantity.

It is sometimes advisable to have more than one working standard so as to be able to more closely match the colour of the different types of lamps to be tested. The working standard requires no preliminary seasoning or calibration. The reference standard is placed in position at the other end of the photometer bar. This lamp should have marked on it the voltage at which it gives its rated candle-power, the amps. at this voltage, and also marks to indicate the part of the bulb which should be nearest to the spot box. Many reference standards are used which do not have the amps. marked on them, but I prefer to have both the volts and amps, certified, so that if anything goes wrong with the measuring instruments used on the photometer, the lack of agreement between all the qualities of the lamp will indicate the trouble. The reference standard is carefully brought up to voltage necessary to give its rated candle-power (say 16 c.p.), note is then made that the amps. indicated by the ammeter agree with the marks on the lamp. The reference standard now giving 16 c.p., the resistance in series with the working standard is varied until the working standard and the reference standard gives a balance on the photometer head, which is placed exactly mid-way between the two lights. The one lamp giving 16 c.p. when a balance is obtained, so must the other lamp be giving 16 c.p. The reference standard is now withdrawn, and a lamp to be tested is put in its place. This reference standard is used several times each day to keep the working standard true. It should also be used each time the operator at the spot box is charged, as it is a rare thing to find two operators who set the photometer exactly alike, therefore each operator is made to set the photometer for himself or herself. Lamps are tested either at candle-power for voltage, or at voltage for candle-power. In the first case, for voltage, the spot box is fastened in place for the candle-power desired, and the voltage over the test lamp is varied until balance is obtained. In the other case, for candle-power,the voltmeter needle is held steady at the voltage desired, and the spot box is moved back and forth until balance is obtained. The photometer is furnished with a scale based on the law of inverse squares, which shows the candle-power of the lamp under test for different points on the photometer bar. In this way the operator can at once call off the candle-power of the lamp under test. Two girls are required at each photometer, one puts the lamps in place and watches the meters, the other reads the spots. On account of the shape of the carbon filament, carbon lamps show a marked difference of candle-power, according to the manner in which they are placed with reference to the spot box. In some positions all the separate threads of the filament are allowed to shed their light on the spot, but in other positions one thread will be shadowed by

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another thread. In this way it is found that in one position a lamp will give more than 10% over the candle-power it will give in another position. It generally requires a turn of but a small part of a circle to make the change from maximum to minimum. To overcome this it is usual to test carbon filament lamps while rotating at a speed of about 200 r.p.m. In this way, the average candle-power of all possible positions around the circle is obtained. This is referred to as the mean horizontal candle-power.

Whilst long experience enables manufacturers to design lamps which will average very close to what is wanted, yet it is impossible to make all lamps of a batch exactly alike. This is the reason why all lamps must be photometered. Suppose lamps are wanted which will be 16 c.p. at 220 volts with an efficiency of 4·1 w.p.c. The manufacturer knows from his experience what diameter filament he must use, and what length he must cut that filament in order to strike the correct average, but on account of slight differences in the diameter or the length, or even in the specific resistance of individual filaments, it will be found that probably not one half of them are 16 c.p. at exactly 220 volts. Some may take a volt more or a volt less, but some will come up to candle-power at as low as 210 volts, whilst others will take as much as 230 volts to bring them up to candle-power. These lamps are all sorted out and marked with the voltage at which they will give best results, but it is impossible for any manufacturer to supply lamps which will all be exactly 16 c.p. at 220 volts. Even though for some special purpose they were most carefully selected to be all exactly 16 c.p. at 220 volts, a re-test by different operators would probably show a goodly percentage which varied from 16 c.p. For this reason the specification prepared a few years ago by a sub-committee of the Engineering Standards Committee provides that 16 c.p. lamps may be from 14 to 18 c.p. when tested at marked voltage. In like manner, it is impossible to supply tungsten lamps which shall all at their marked voltage give exactly their rated candle-power. This leads to a consideration of the effects of change of voltage on candle-power, etc. If we take a carbon filament lamp, which at exactly 220 volts gives 16 c.p. and consumes 65·6 watts (4·1 watts per candle), and burn it at 225 volts, we find the candle-power will be approximately 18·1 the watts 69 (3·8 watts per candle), and if the lamp is of a quality to give a life of 100 hours at its rated voltage, it will give a life of only 640 hours at this higher voltage. If the pressure is increased to 230, the candle-power goes up to 20·2, the watts to 71·9, while the life goes down to 430 hours. This may be shown in tabular form thus :—

16 C.P 4·1 W.P.C. CARBON FILAMENT.
Lamp at Different Voltages.

Volts.	C.P.	Watts.	W.P.C.	Life. Hours.
240	25·2	78·3	3·1	190
235	22·6	74·9	3·3	285
230	20·2	71·9	3·55	430
225	18·1	69·0	3·8	640
220	16·0	65·6	4·1	1,000
215	14·1	63·0	4·47	1,600
210	12·5	60·2	4·74	2,500
205	10·9	57·4	5·26	4,100
200	9·5	55·4	5·83	6,700

It will be noticed that the candle-power goes up at a quicker pace than the watts, and that, therefore, the higher the voltage the more light we are getting for the energy consumed. It will be also noticed, however, that the life goes down even more rapidly than the candle-power goes up. It becomes an interesting calculation to find out what is the most economical efficiency at which to burn a lamp. This, of course, depends upon the price of the lamps and current. Take the case of one who pays the regular rate of say 4d. per unit for current and 9d. each for lamps; take also the case of an industrial establishment generating its own current at a cost of say 1d. per unit, and buying lamps at 6d. each, and take also the case of an industrial establishment which wishes to consider only the cost of the fuel which might be saved by using high efficiency lamps. The cost of lamps and current for each one thousand hours is shown in the following table :—

COST PER THOUSAND HOURS. 16 C.P. CARBON FILAMENT.
Cost of Lamps and Current for each one thousand hours when the prices are as stated.

Efficiency Watts Per C.P.	Total Watts Per Lamp.	Lamps, 9d. each. Current, 4d. per unit.			Lamps, 6d. each Current, 1d. per unit.			Lamps, 6d. each. Current, ½d. per unit.		
		Lamp.	Current.	Total.	Lamp.	Current.	Total.	Lamp.	Current.	Total.
3·1	49·6	47·4	198·4	245·8	31·6	49·6	81·2	31·6	24·8	56·4
3·3	52·8	31·6	211·2	242·8	21·1	52·8	73·9	21·1	26·4	47·5
3·55	56·8	21·0	227·2	248·2	14·0	56·8	70·8	14·0	28·4	42·4
3·8	60·8	14·0	243·2	257·2	9·3	60·8	70·1	9·3	30·4	39·7
4·1	65·6	9·0	262·4	271·4	6·0	65·6	71·6	6·0	32·8	38·8
4·47	71·5	5·6	280·1	291·7	3·7	71·5	75·2	3·7	35·7	39·4
4·74	75·8	3·6	303·4	307·0	2·4	75·8	78·2	2·4	37·9	40·3
5·26	84·2	2·2	336·6	338·8	1·5	84·1	85·6	1·5	42·0	43·5

It will be noticed that it is only where current is obtained for the bare cost of the fuel that there is any economy in using lamps having a life as long as 100 hours. For those numerous persons who have to pay through the meter, the lamp having a life of about 300 hours is really the most economical to use. Of course, these figures are based on the supposition that the lamps are burned at the exact voltage for which they are made, but as it rarely happens that the voltage of actual supply is the declared voltage, allowance for any difference of this sort must be made when buying lamps. The figures quoted only apply to lamps made for voltages of 200 or over. Carbon lamps made for voltages under 130 are usually made from filaments which have undergone a flashing treatment, which renders it possible to burn them at a higher temperature, and consequently with greater economy.

It is well known that tungsten lamps do not change as much in candle-power, etc., with change of voltage, as do carbon filament lamps, but these figures show that even here the change is considerable.

TUNGSTEN LAMPS.
25 C.P. 220 V. 35 WATTS = 1·4 W.P.C.

Volts.	C.P.	Watts.	W.P.C.	Life. Hours.
240	34	40	1·10	500
235	31¾	38¾	1·22	700
230	29½	37½	1·27	900
225	27¼	36¼	1·33	1,000
220	25	35	1·40	1,000
215	32¾	33½	1·47	
210	21	32¼	1·54	
205	19	31	1·63	
200	17½	30	1·72	

Of course, much longer experience has been had with carbon lamps than with tungsten lamps, so that while we can say with tolerable certainty how a batch of carbon filament lamps will average in performance under different circumstances, we cannot be so precise in our statements regarding tungsten lamps. The following figures are probably very nearly right.

A comparison of the figures given for tungsten lamps and carbon lamps shows that while it certainly pays to

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use tungsten lamps where the current has to be paid for at ordinary lighting rates, it is not clear that any advantage is to be gained by using tungsten lamps where current is cheap, at any rate, not where high voltage lamps have to be used.

On high voltage direct current circuits where transformers cannot be used to get lower voltage, lamps are sometimes burned in series to get smaller and cheaper units. This may often be done successfully, but it generally sooner or later, leads to trouble. Very few people realise how carefully lamps must be matched for current consumption before they will give satisfactory service in series. I do not remember seeing in England any specification for tramway lamps which took sufficient account of this point. Some years ago, I took two lamps such as are used for tramway lighting. Each gave 15½ c.p. at 100 volts, but one took ·625 amps., while the other took ·65 amps. I connected these two lamps in series and applied 200 volts. One lamp gave 17 c.p., while the other gave only 14 c.p. This means that if the two lamps were of the same quality, the one giving the higher candle-power would last only half as long as the one giving the lower candle-power. It is generally considered that because the candle-power of a tungsten lamp changes less with the same change in volts than does the candle-power of a carbon lamp, that it can stand a great deal more in the way of wrong rating, etc., but when used in series it will be found that tungsten lamps require just as careful sorting as carbon lamps. In carbon lamps the volts and amps. change in about the like per centage, but in tungsten lamps a change of. say 5% in voltage, will cause a change of only about 3% in amps. This means that in all probability a difference of 4% in amps. will make about as much difference in the life of a tungsten lamp. as it does in that of a carbon lamp.

Cost per Thousand Hours of 25 c.p. 220 volts Tungsten Lamps.

Burning at different efficiencies when prices of lamps and cost of current are as stated.

Efficiency Watts Per C.P.	Total Watts Per Lamp.	Lamps, 4/3 each. Current, 4d. per unit.			Lamps, 3/4 each. Current, 1d. per unit.			Lamps, 3/4 each. Current, ½d. per unit.		
		Lamp.	Current.	Total.	Lamp.	Current.	Total.	Lamp.	Current.	Total.
1·18	29½	102	118	220	80	29½	109½	80	14¾	94¾
1·22	30½	82	122	203	57	30½	87½	57	15¼	72¼
1·27	31¾	57	127	184	44	31¾	75¾	44	16	60
1·33	33¾	51	133	184	40	33¾	73¼	40	16½	56½
1·4	35	51	140	191	40	35	75	40	17½	75½

ARGENTINE CENTENARY EXHIBITION.

In commemoration of the centenary of the Argentine Republic, an International Exhibition of Railways and Land Transport is to be held at Buenos Aires from May to December of this year, and in connection therewith a series of scientific and technical conferences will take place. In view of the wonderful progress made by the Republic and the continual expansion of enterprise, these celebrations assume special significance and importance from the engineering and business points of view. That this has been recognised is seen from the fact that Great Britain has secured 20,000 square metres at the exhibition, which compares with Germany's 6,000, and 5,000 square metres each for the United States, France, Italy, and Austria. The British Minister to the Republic (Mr. S. E. W. B. Townley) is the hon. chairman, Mr. A. Carnegie Ross, chairman of the British Committee at Buenos Aires. Section II. is devoted to electric railways and tramways, and is divided up thus: Group I.—Installations for production of power (plans and details): (*a*) steam power stations, (*b*) hydro-electric power stations. Group II.—Electric materials for production of power: (*a*) steam engines and boilers, and their fittings; (*b*) turbines and their fittings; (*c*) dynamos and motors; (*d*) auxiliary electric apparatus for station work. Group III.—Permanent way and rolling stock: (*a*) rolling stock and accessories; (*b*) permanent way; (*c*) electric lines; (*d*) signalling apparatus; (*e*) general construction. Group IV.—different applications of electric traction: (*a*) transport in mines; (*b*) industrial transport. Group V.—Reports and printed matter on the above and on workmen's protection. Section I. relates to railway and tramway systems other than electric; Section III.—Automobilism; Section IV.—Cycling; Section V.—Post office, telegraph and telephone services, and other methods of communicating, including telegraphic, telephonic, and "wireless" apparatus; Section VI.—Transport by means of beasts of burden; Section VII.—Roads and road-making; Section VIII.—Military transport; Section X.—Municipal transport; Section XIV.—National mechanical appliances relating to transport; Section XVI.—Aeronautics. The exhibition is to be held in fine buildings, surrounded by beautifully planned pleasure grounds. Awards will be made, consisting of diploma of first class, diploma of merit, and gold, silver, and bronze medals. No customs dues will be charged on exhibits, but guarantees will be demanded for the payment of such dues in the event of sale. During the course of the exhibition there will be an International Congress of South American Railways. This in itself will prove very useful to exhibitors, as it will bring together the majority of those responsible for the running of railways and tramways in all parts of the Southern Continent.

ELECTRICITY IN AUSTRALASIA.

Mr. H. G. Such, the Australasian representative of the Union Electric Co., of London, has, after a lengthy tour, been giving his impressions to the *Australian Mining Standard*, and they are certainly instructive. He considers Sydney the headquarters of electricity, partly because of its better situation for prompt delivery to New Zealand. He spoke very highly of Mr. Forbes McKay, the City Chief Electrical Engineer, but considers that Melbourne is better equipped, having more modern machinery and fittings. Melbourne is the best lighted city in the Antipodes, with no less than eight types of flame arc lamps illuminating its streets. Western Australia thoroughly appreciates electricity. Not only its mines, but its factories in Kalgoorlie and Perth are electrified. Heavy stocks of appliances are carried, but much of the mining equipment is quite out of date and requires scrapping. In New Zealand electricity is doing well, but it is rather dear, dearer than in Australia, with the exception of Dunedin, supplied from the hydro-electric station at Waipori, and Waihi, another water-power scheme. As a rule the sources of water-power, Mr. Such considers, are too far away from the places of demand for the cheap power to effect the problem, outside of purely mining districts. As regards the trade aspect, Mr. Such deplores the tendency to cut prices all round.

In this connection it is interesting to refer to the recent report of the Launceston, Tasmania, City Council, by Mr. St. John David, their engineer, and Mr. R. J. Strike, the city electrical engineer. They have gone into the hydraulic question very thoroughly, and considering the variation of the dry season flow over a period of 17 years, they do not see that a heavy peak load could be economically provided for. They do not consider that they could rely upon a 10,000 cubic feet flow per minute, but only one of 5,000 cubic feet per minute minimum if a dam is erected to regulate flow. In this case they think the electric plant might be designed to give an average summer e.h.p. of 1,925, with a maximum winter load of 3,840 e.h.p.; and a maximum summer load of 2,845 e.h.p. If this plan is adopted, they consider that special inducements should be made to manufacturers, over a period of probably 20 years, in order to induce them to go to Launceston, and, of course, that would involve a heavy fall in the estimated revenue of the electricity department.

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TILLAGE BY ELECTRICITY.

That in spite of our paucity of great rivers and big falls much water is daily running to waste, from the power generating point of view, is a truism to be kept well in mind. Two very apposite examples of recent hydro-electric installations on the Continent deserve more than a casual mention in this connection. Writing about the utilisation of waves and tides for power production we pointed out (ELECTRICAL ENGINEER, Vol. XLIV., 565) that along our coast, especially where estuaries or creeks were to be found, by the construction of a series of sluices and reservoirs the rising and falling tide could be made to drive turbines, driving dynamos connected with storage batteries, and last week our Berlin correspondent announced a project of this kind to be carried out in Schleswig Holstein. In the same issue our Paris correspondent gave a few brief particulars of how electricity was generated and utilised on a farm near Arcachon. Now, as both of these schemes are quite feasible for fairly wide application they deserve consideration. As regards the French installation we are in possession of many details, which demonstrate at once its extreme simplicity and the economy realised thereby. It will be remembered that a short canal is utilised, which runs between the Cazan Mere to Arcachon, passing through the Villemarie Pond, which is converted into the regulating reservoir. This reservoir is 83,421 ft. square and 393 ft. deep, and a sluice 72 ft. long and 11 ft. $\frac{3}{4}$. wide conducts the water to a turbine on the "American principle" of French construction. The fall is about 8$\frac{1}{2}$ ft. and the capacity of the turbine 50 h.p. The Canal des Usines has an average flow of 30 cu. ft. per sec., ranging from a maximum of 41 cu. ft. to a minimum of 20 cu. ft., but as it is necessary to have a flow of close upon 64 cu. ft. per sec. to obtain the maximum of 50 h.p., the Villemarie Pond is required as a storage tank. The small hydro-electric generating station (52 ft.

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by 13 ft.) is built of reinforced concrete, the installation is all on the ground floor, but there is a first floor over part of the building which is ultimately to be used as an electrically driven flour mill. The equipment comprises two D.C. dynamos, of a total capacity of 33 amp., 600 volts. The current is transmitted over a copper wire one-fifth in. diameter, for a distance of rather over 1,000 yards, about a third of the ultimate total length. The land being farmed is practically forest land, which requires clearing. Two covered-in motor winches, operate a plough. The motors weigh nearly 4½ tons, and the plough about 9 cwt. Each winch is fitted with an automatic winder attached to a drum, which will take up about 1,000 ft. of cable seven-tenths in. diameter. The plough is followed by a four branched harrow weighing 3 cwt. The work of clearing the land, heavy with roots of trees, undergrowth and reeds, has been arduous, but it was found possible to do with five men, one being on attendance at the hydro-electric station, one on each of the motor winches, and one at the plough, accompanied by an assistant armed with a pick in order to free the plough from any big roots. In this way about 12 furrows per hour are ploughed, each 902 ft. long, 12 in. wide and 16 in. deep. The plough travels at the rate of about 3 ft. 9in. per sec., and on an average one minute is taken up in readjustment at the end of each furrow. In practice it has been found that on the lighter land about one hectare (2·47 acres) can be ploughed in a day of 8 hours. In order to achieve this result 15,750 watts were required, as registered at the switchboard, but there is considerable rheostat and cable loss, which has not, however, been estimated. For harrowing about 8,100 watts are required. In spite of the heavy nature of the work on this farm, the experiment has given satisfaction, and the simplicity of the installation gives an idea of its easy application. The flow and fall above described do not appear to present many difficulties in most parts of the country, and practically none over a vast area of our colonies. The experiment, therefore, deserves to be noted, both as an encouragement to agriculturalists and for its suggestiveness to electrical engineers, who may be in a position to place projects of this description before those responsible for the development of land at home and abroad. Brief as are the particulars available at the moment, it is evident that the Arcachon scheme is capable of many modifications to suit local needs and peculiarities. It has the merit, however, of being a practical experiment brought to practical conclusions, which places it in the category of safe and useful examples for educative purposes.

ELECTRIC MOTORS AND SWITCHES IN MINES.—A meeting of manufacturers of electric motors and switches for use in mines, convened by the National Electrical Manufacturers' Association (Incorporated), has been held for the purpose of appointing witnesses to appear on behalf of the Association as representing the manufacturing industry at the enquiry which is to be held by the Home Office for the purpose of modifying, if necessary, the rules for the installation and use of electricity in mines. Nearly all the principal makers of this class of machinery were present. Six witnesses were provisionally appointed, and various resolutions passed for the purpose of guiding them as to the evidence which is desirable.

RUGBY ENGINEERING SOCIETY.

CONVERSAZIONE.

The Rugby Engineering Society held their second Conversazione at the Town Hall, Rugby, on Friday last, the 11th inst., which was attended by upwards of 400 members and friends. This Conversazione has become one of the functions of the winter season, and was carried out in such a manner and on such a scale as to make it compare favourably with similar functions organised by the leading technical societies in the kingdom. The exhibits, of which there were a large number, were scientific in character and popular in form, and appealed equally both to members and their non-technical friends. Among so many exhibits which reached a high standard of interest and ingenuity, it is perhaps impossible to select any for particular mentions but to give some idea of the field which the members of the Rugby Engineering Society covered by the various exhibits and demonstrations given, we may mention that by the courtesy of the Humber Co. a full-size Bleriot monoplane was on exhibition. The design and development of aeroplanes in the form of models of completed planes of various designs and also of the various component parts showed the great interest which this development has aroused in the minds of engineers even when they are only able to devote to it their leisure time, as a large number of models were exhibited by various members of the society of their own design and construction. In addition to the above there were working models and demonstrations of gyrostats, a working model of the Brennan mono rail car, a demonstration of the optiphone, also a foucault pendulum in operation, demonstrating the rotation of the earth, which aroused considerable interest on the part of visitors. Among other interesting exhibits were harmonographs of original designs, illustrating very intricate and beautiful diagrams, a series of models illustrating the development of sun dials, a collection of beautiful examples of coloured photography, X-Ray apparatus, spectroscopes, a large exhibition of microscopes of various interesting subjects, a large collection of British beetles, butterflies and moths; a howitzer and field gun, kindly lent by the 5th Battery, 4th South Midland Brigade, which was fully explained by members of the battery; also a machine gun, lent by the courtesy of Messrs. Vickers, Sons & Maxim; and many other exhibits, the whole forming a most interesting and instructive exhibition of a scientific character, which were fully explained by various members of the society to the visitors interested.

In addition to the exhibits, there was a series of lectures, of from 15 to 20 minutes' duration each, during the evening on the following subjects:—Lantern demonstration, "Optical Illusions," by Mr. H. W. Taylor (member); lantern lecture, "Halley's Comet," by Lieut.-Col. C. H. Seabroke (F.R.A.S.); lecture, "Heads and Tails," or "Toss Halfpenny," by Mr. E. B. Wedmore (member); lantern demonstration, "Polarized Light," by Mr. L. Cumming, M.A., (member); lantern lecture, "Aeroplanes," by Messrs. J. P. Chittenden and L. R. Robinson (members).

These were fully attended, the lecture room being crowded on every occasion. Incidental music and light refreshments also formed a part of the programme.

The organisers are to be congratulated on the success which attended their efforts in providing an entertainment of this character, which, as already mentioned, reached a standard that was in no respect lower than that of the leading and more prominent societies, which naturally have at their command much greater facilities for promoting a function of this character. Many expressions of regret were heard that it was not considered possible to continue the exhibition over a second evening, and this in itself is eloquent testimony as to the appreciation of those attending.

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TATE BIFUNCTIONAL ACCUMULATOR PLATE.

By HARRY H. MORRELL.

(*Continued from page* 210.)

It will thus be seen that these extremely short and extremely narrow conducting strips and active columns, assembled in close multiple relation, achieve the equalisation of current density over all the active surfaces of the unit with as great a degree of precision as it is possible to attain in the exercise of practical mechanical art. Furthermore, as the lateral edges of the conducting strips are insulated from the electrolyte by the sectional supporting frames, and as access to the vertical edge areas of the active columns is largely curtailed by the closed bearings of the intervening perforated shields, the extraneous stream lines in a working unit have been reduced to an absolute minimum, and current flow confined and concentrated upon those parts (the active columns) from which useful energy is derived. Thus the probable major cause of "sulphating" (unequal current distribution) in electric storage cells as heretofore constructed, has been eliminated in these bifunctional plates. The accompanying illustration, Fig. 3, shows how these conditions are maintained throughout all the ramifications of practice.

Reference has been made above to the limitation of depth of active material and to the progressive nature of transmutation involving the element of time.

It would appear that the depth of the active material bears a direct relation to available charging periods, and that the rapidity with which a Tate Bifunctional plate can be charged is due to the film-like nature of the active columns, augmented, without doubt, by the equalisation of current density and concentration of current flow. It must further be noted that the active material is not enclosed by metallic walls. It rests against the faces of the conducting media, and means have been provided to effect perfect amalgamation between the metal and the applied columns during the process of "forming." The factor of metallic expansion does not have to be considered. The elasticity of the intervening perforated shields which rest against the faces of the active columns, provides amply for the expansion of the oxide in the positive sections of the plate.

The extreme shortness and narrowness of the metallic conductors in a Tate unit would in themselves reduce to an appreciable minimum the hazard of unequal metallic density, but the method of preparing these strips effects a further reduction. They appear first in the form of a continuous lead ribbon half an inch wide and one-sixteenth of an inch thick, formed by forcing the metal through a die. This ribbon then enters the rolls of a specially designed automatic machine in which the conducting strips are formed ready for use, and in which that portion which carries the active columns is reduced in thickness to about ·015 in. These two processes tend to equalise metallic density and eliminate all risk of unequal current distribution through inequality of metallic resistance.

The Tate Bifunctional plate originally embodied porous separating media in the form of relatively thin diaphragms made of porous clay and various other porous materials. It was in testing these that the obstructive conditions relating to circulation, filtration and non-adjustment of specific gravity, were encountered and noted, and as these defects are inherent in this form of media they were discarded in favour of the perforated shields described in the first part of this article. The functions of these perforated mechanical separators are threefold. First, they constitute shields or retaining walls which permanently support and conserve the active columns; second, they provide unobstructed flues or chimneys for the liberation and ascension of nascent gases and the circulation of the electrolyte; and third, they aid, through their closed bearing sections, in cutting off extraneous stream lines, thereby concentrating current flow along and over the path lines described by the face areas of the active columns.

The active material shows no tendency whatever to adhere to these shields, so that the electrolyte, entering through the perforations, finds a relatively free passage between them and the active faces against which they rest. An exhaustive series of tests has demonstrated that the active material can not, or at least does not, sub-divide in particles sufficiently fine to enter and escape through the perforations, while the scouring action of the electrolyte is expended against the exposed faces of these shields and not against the faces of the inclosed and protected active columns. Comparative curves of units equipped with porous media and with the mechanical separators just described, showing the marked improvement effected by the latter, are embraced in the illustrations accompanying Tate's United States Patent No. 926710, June 29, 1909. This improvement is not alone due to the freer circulation of the electrolyte, and the automatic adjustment of specific gravity, but must be attributed in part to the elasticity of the perforated shields which permits the active material to expand freely and naturally under all conditions of current flow.

It is well understood that the total efficient energy of an electric storage cell of given size can be increased only by decreasing the internal resistance of the element. In the Tate plate the width of the exposed lateral faces of the sectional frames is only three thirty-seconds of an inch and 57 of these assembled in close multiple relation constitute a standard bifunctional unit. It will thus be seen that the factor of internal resistance has been brought to the lowest point possible of attainment through the application of mechanical methods involving the sub-division and multiple grouping of all those parts which in action are electrically interrelated, and that the capacity of the unit for given weight has been raised to an absolute maximum in so far as mechanical methods are concerned. It will further be noted that in constructing plates of relatively large dimensions and capacity (Fig. 2) the individual units composing it are also assembled in multiple relation, each being independent of the other and readily detachable and replacable in the event of injury. This is a marked advantage in the case of large installations, as the seats of possible trouble through any cause are localised within spaces of about 80 sq. in., representing the superficial areas of the individual units.

In view of the permanent conservation of the active material, the terms of useful life of these bifunctional plates must be determined, in the first instance, by the time periods which will mark the deterioration of the anode conducting strips, through oxidation, to degrees that will so impair their conductivity as to render them unserviceable. This oxidation is caused by the process of charging, and is progressive with relation to time. When this point of exhaustion is reached the quantity of active material present and in place in association with the anodes is greater than the original quantity for the reason that a portion of the anodes themselves has been raised to an oxide to reinforce the active material originally applied. As this condition is progressive throughout the useful life period of these plates, they do not exhibit the phenomenon of gradual deterioration which characterises cells as heretofore constructed. On the contrary, and up to the point where loss of metallic conductivity becomes a factor, their capacity increases progressively through the acquirement of additional energising material from the sources named. It will readily be seen that the useful life periods of these bifunctional units may be largely controlled by adjusting the weight of the anode strips, through the regulation of their thickness, to compensate for the effects of oxidation. This is a distinct and unique advantage, the value of which can hardly be over-estimated from the viewpoint of practical utility.

The above discussion contrasting phenomena associated with the storing of electricity through the media of unifunctional plates or grids with phenomena associated with the Tate Bifunctional plate shows why the inventor of the latter departed from mechanical methods heretofore universally employed in the art, involving active surfaces of relatively large superficial area, and substituted therefore the extremely restricted areas provided by the short, narrow conducting media and active columns which differentiate his plate from all others hitherto introduced into practice.

In conclusion, it may be stated that the results thus far revealed in the operation of these bifunctional plates appear fully to justify the mechanical innovations which characterise their structural features. Their evolution may be traced, from inception to perfection through the records embraced, in the United States Patents to Alfred O. Tate, Nos. 880420, 880421, 880422, 880423, 880424, and 880425, issued February 25, 1908, and 926710, issued June 29, 1909.

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HIGH TENSION TRANSMISSION.

TESTING THE ELASTICITY OF WIRES.

By W. B. WOODHOUSE, Assoc.M.I:E:E.

Two wires of the size and material under observation are stretched between three supporting points in a straight line, spaced so as to form two equal spans. The wires are adjusted to have equal sags as measured as points midway between supports, and are then firmly fixed at one end and clamped together at the other, the clamp being connected to an adjusting screw by means of which the sag of the wires may be adjusted to any convenient amount. One wire is then lifted from the intermediate support and allowed to hang freely. If the supports have moved due to the change of tension the sag of the other wire will be altered. Adjust, if necessary, the sag of this wire to its original value and measure the sag of the wire having the long span. Then from the observed sags the stress corresponding may be calculated and also the elongation due to the difference of stress.

The calculation is as follows :—

Let—

f = stress corresponding to sag s.

f_1 = stress corresponding to sag s_1

Then—

$$f = \frac{p\,l}{8\,s}, \text{ and } f_1 = \frac{p\,(2\,l)^2}{8\,s_1}$$

$$f_1 - f = \frac{p\,l^2}{8}\left(\frac{4}{s_1} - \frac{1}{s}\right).$$

Let—

L = length of wire on span l.

e = elastic elongation of length L, due to an increase of stress, in inches.

Then—

$$L - l = \frac{8\,s^2}{3\,l} \text{ and } 2\,(L - l) + 2\,e = \frac{8\,s_1^2}{3\,(2\,l)}$$

$$\therefore e = \frac{2\,s_1^2 - 8\,s^2}{3\,l} = \frac{2}{3\,l}\left(s_1^2 - 4\,s^2\right).$$

Note that if the wire were inelastic e would be zero and $s_1 = 2\,s$, and therefore the stress on the double span also doubled. As an example the results of a test on a No. 6 wire are given below :—

TEST OF ELASTICITY OF No. 6 H.D. COPPER WIRE.
Ultimate Strength, 61,000 *lbs. per Square Inch. Span*, 1,320 in.

Initial Sag, s	Final Sag, s_1	Difference of Stress.	Elongation per Single Span.
Inches.	Inches	Lbs. per Square Inch.	Inches.
5	18·0	1,558	0·110
9	26·0	2,780	0·177
12	31·5	3,050	0·210
17	40·0	2,887	0·184

The average elongation for a stress of 40,000 lbs. per square inch from the above is 0·2%.

"EFFECTIVE EARTHING."

DETAILS AS TO THE ITALIAN PRIZE.

Particulars have now come to hand concerning the prize offered by the Italian Government, as recently announced in our columns, for a system of effective earthing. Mr. S. J. A. Churchill, M.V.O., H.M. Consul at Naples, reports that the Italian Minister of Agriculture, Industry and Commerce, has laid down the following conditions for the competition :

Prize for a theoretical and experimental design to "ground" industrial electric plants. In the scheme particular attention must be paid to (*a*) the phenomena which occur when any point of an electric circuit touches the floor ; (*b*) the influence of the nature and composition of the floor on these phenomena ; (*c*) the influence and the form of currents and of their tensions on the phenomena ; (*d*) the efficiency of the "earths" either as permanent to or consequent upon the phenomena of over tension ; (*e*) the means of maintaining and testing the "earths."

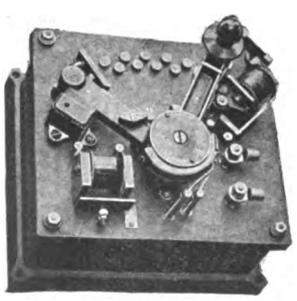
The prize will be 10,000 lire (about £400) ; the competition will close on December 31, 1911.

REINFORCED CONCRETE POWER HOUSE.

A separate unit type of reinforced concrete wall construction was used last year in building the power-house of a small hydro-electric plant at Newton Falls, Ohio, says *Concrete*. The pilasters are of monolithic concrete, while the walls between them are hollow and are built of inside and outside thin concrete slabs, which were set before the pilasters were poured, so as to be keyed into them. The slabs were reinforced with No. 28 gauge expanded metal and were made in sizes that could be handled conveniently. Their outer surfaces were corrugated by laying $\frac{5}{8}$ in. round rods in parallel lines on the surface of the fresh concrete when the slabs were cast and pulling them out after the mixture had taken its initial set. These corrugations were designed to give a good bonding surface for the plaster coat which was applied to the walls after they had been erected. The slabs were allowed to cure and were then placed on edge in proper position. Vertical form boards were placed for the pilasters, extending beyond the surface for the monolithic work, so that the slabs rested against them. The inside faces of the pilasters were moulded against form boards placed in the air space between the wall slabs, and were wired to the outside forms after the pilaster reinforcement had been placed. The inside boards also acted as spaces to keep the slabs the proper distance apart. This distance varied somewhat, but 8 in. was the minimum.

"LIGHTNING CONDUCTORS."

Owing to the many inquiries that have arisen over Mr. Alfred Hands' two articles on "Lightning Conductors," which appeared in our columns, it has been decided to reprint them in pamphlet form. The neat little booklet is now ready, and can be obtained from our publisher post free for 3½d.



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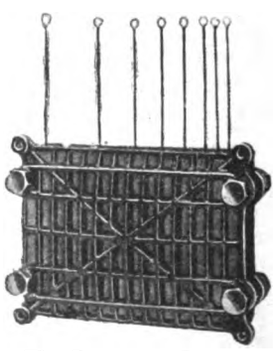

The Resistance Portion of the Starter.

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PUBLICITY.

In this Section of "The Electrical Engineer" we give Publicity to New Inventions and Specialities.

Electric Driving of Planers and Reciprocating Tools.

A new system of driving planers and other reciprocating tools to which reversing electric motors are applicable has been introduced by the Lancashire Dynamo & Motor Co., Ltd., with a view to gain higher speeds and more perfect control. With belt-driven high-speed planer many disadvantages are felt, which may be briefly summarised as follows :—

The belts being overloaded at each reversal slip on the pulleys, causing heating of the pulleys and burning of the belts, particularly when the planer is working on short strokes. This, in addition to the wear by the belt forks, shortens the life of the belts and makes the cost of renewing them very heavy. Moreover, owing to this slip a certain amount of time is lost at each reversal, and this time multiplied by the number of reversals means a very considerable loss each week. It is very important that a large and even variation in the cutting speed should be obtained to suit metals of a varying degree of hardness and for different finishing cuts. Now, in belt-driven high-speed planers a variation in the cutting speed can only be obtained

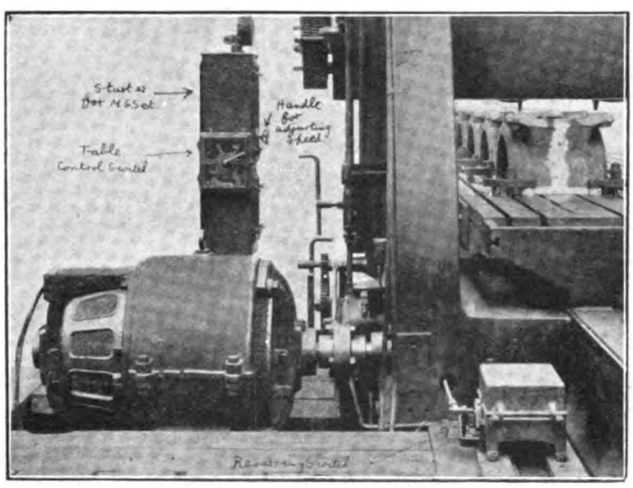

FIG. 1.

by the use of gear boxes, or similar costly and troublesome mechanism; even then only three or four cutting speeds can be obtained. For certain classes of work it is imperative to plane up to a line on belt-driven spring planers. This may only be done when the springs are new; when they are fatigued and there is a heavy weight on the table, the point of reversal varies considerably. This is well shown in the accompanying illustration, contrasting belt-driven and direct electrical drive work. It is to be remembered that the life of the springs is short, which again increases the maintenance charges. Belt-driven spring planers cutting intermittently often give trouble owing to the jumping of the table as the tool leaves the work, and its consequent entrance on the next cut at a much higher rate of speed destroys the point of the tool. The pulleys of large diameter and width which must be used to minimise belt slip as far as possible have a considerable amount of energy stored in them, the stored energy in the pulleys alone being generally many times that in the table and its load. The energy must be stored and taken out again each cycle. In many cases the tool is only actually removing metal during a small portion of the cutting stroke, although the table runs at the same speed whether the tool is cutting or not. Owing to the design of the belt-driven high-speed planer, strokes of less than 3 ft. are not possible for any length of time, due to burning of belts and heating of pulleys.

As a contrast to this, let us consider the Lancashire system of driving a planer or other tool by a reversing motor :

A motor generator running at a high speed is mounted on the upright or in any convenient position, and the motor end is supplied with power from the electricity supply available. Any kind of either alternating or direct current may be supplied, and if no current is available the special generator may be driven from a line shaft. The generator end is connected electrically direct to the plane motor, which is direct coupled or geared to the planer driving shaft. This generator and motor are direct current machines and wound for any convenient voltage. A reversing switch is actuated by a tappet rod from the reversing gear of the planer, and when this is thrown over it reverses

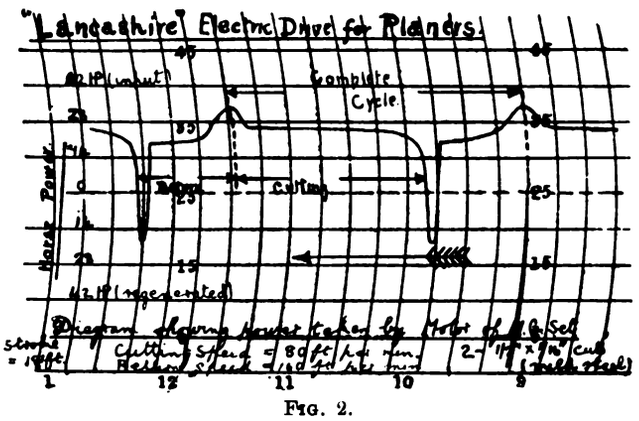

FIG. 2.

the direction of the current in the field winding of the generator, thus reversing the direction of rotation of the planer motor, and at the same time it so regulates the voltage of the generator by which the speed of the planer motor is decided as to cause the planer motor to run at the speed required according to whether it is on the cut or return stroke. The cutting speed may be varied by hand to suit the work being done, by means of a regulating resistance in the generator field, this resistance being put in circuit by the reversing switch on the cutting stroke only. This gives a constant return speed, but if desired the return speed can be varied also. By this means the speed of cutting may be varied by turning one handle from 15 ft. per minute, or even less if desired, to the full return speed of the planer, and any number of intermediate speeds are obtainable. Of course the maximum speed of cutting is limited by the speed the tool will stand. This system is a truly regenerative one, as the energy stored in the planer table and its load, as well as that stored in the revolving parts of the planer and motor, is returned to the circuit at each reversal, by causing the planer motor to become a generator at this

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instant, and to give out energy through the motor generator to the line. This not only results in a considerable saving in power, but a very powerful breaking effect which causes the motor to reverse instantaneously. The switchgear required is simply that for an ordinary variable speed motor, and is made in ordinary starting panel form. The only switch moving at each reversal of the planer is the reversing switch, which only deals with the field current of the generator, this being equivalent to the current required by a few incandescent lamps. There are no switches or resistances in the main circuit except the ordinary starting switches, which are operated only when starting or stopping the machine for the day. If it is desired to control the planer from various points round it, small switches for the field circuit will be supplied by means of which the planer may be instantly stopped and started from any point at which one of these switches is fixed.

We may, therefore, fairly sum up the situation by saying that the Lancashire system has the following principal advantages:

Belts are conspicuous by their absence. Any cutting speed may be obtained by turning one handle between 15 ft. per min. or less if required, and the maximum speed the tool will cut at. This gives not only a wide variation but 20 or more intermediate speeds. Owing to the true regenerative working of this system there is absolute control at the reversal. This control is not by springs or anything which can become fatigued or change its properties. At any given speed, and with the table loaded or unloaded, a planer fitted with this system will plane up to a line. As regards lost time, owing to belt slip, the following table shows the result of a trial on a planer recently electrified on this system:

Test of 6′ by 6′ by 18′ planer.
Weight of table = 8.5 tons.
Weight of castings on table = 2.5 ,,
Total = 11. ,,

Size of Planer under test	Length of stroke taken.	Time of 10 cycles.	Speed of cutting ft.p. min.	Speed of return ft. p. min.	Waste time per cycle.
		M. S.			
18′ by 6′	15·16′	3 56	54	176	1.8 secs.
18′ by 6′	10·25′	2 41	54	176	1.3 ,,
18′ by 6′	5′	1 28	54	176	1.5 ,,
18′ by 6′	2·16′	0 49	54	176	1.7 ,,

It is to be observed that the stored energy in the moving parts is returned to the circuit at each reversal, and not wasted. This makes a considerable saving in the power used. The return speeds obtained are higher than have been obtained with any other system. By a simpler and inexpensive attachment the table can be speeded up to the full return speed during those portions of the cutting stroke when the tool is not actually cutting, and at the same time the control is so perfect that the tool starts to cut again at the proper rate of cutting. This system permits of strokes as short as 2 inches if the mechanical design of the planer is suitable, or it can be reversed by hand if necessary. This makes it possible for work to be done at high speeds which would formerly have had to be done on a slow speed planer. Perfect steadiness without jumping is secured. The switchgear is little more than that required for an ordinary motor. The panel illustrated here is an ordinary starting panel; the hand-wheel in the centre regulates the cutting speed, and the case at the side contains the switch referred to before for starting and stopping the planer motor for changing tools, etc. The reversing switch is also illustrated. The reversing switch is not in the main circuit, and does not have to deal with any heavy current. Best for new planers, as it ensures better work, higher speeds, and lower maintenance than any other system. Best for old planers, as by this system old planers can with practically no structural alterations be converted into high speed planers, the speeds at which they will run being limited only by the strength of the parts. It may, perhaps, be objected that the cost of this system is high. This is not so as the variable voltage control permits the use of a motor with a much smaller frame than the usual variable speed constant voltage machine, and as the motor generator may be a high speed machine, its cost is small. The switchgear is simpler and less expensive than any other system.

In several cases within our own experience the cost of maintaining the belts alone on a high speed regenerative belt-driven planer has been from £80–£100 per annum, so that the "Lancashire" system would pay for itself in two or three years on this item alone.

"TANTALUM" LAMPS IN AN EXPLOSION.

The illustration given below shows a two-light fitting with "Tantalum" Metal Filament Lamps which were found amongst the debris after a terrific explosion. A large still on the premises of Mr. J. E. C. Lord at Salford, which contained carbolic acid, exploded on January 24 and the burning liquid spread the flames in all directions. The fitting and lamps in question were fixed on the outside brickwork of the still and were connected by means of overhead wires on insulators. The whole of the front of the still was blown out and some of the brickwork was hurled a distance of 20 or 30 yards, and, being soaked in the liquid, at the same time caught fire. The wires connecting the fitting, however, did not break and pulled the insulators, fitting, etc., back into the debris where it was found after the fire had done its worst. The remarkable thing about it, is that though the fitting was badly damaged and burnt and had been under water for two hours, the thick outer globe being broken to pieces, both of the "Tantalum"

Lamps were intact when put on circuit. It is stated that after the still front blew out they must have fallen approximately 15 ft. and as they had been in use since June, 1909, the extraordinary strength of the filament was again demonstrated. "Tantalum" lamps are therefore eminently suitable for "rough" as well as "brilliant passages." It would be interesting to compare the fragility of the Tungsten lamps or the incandescent gas mantle in a similar situation. Week by week provides numerous examples of the tensile strength of the filaments used in the manufacture of English "Tantalum" lamps and they may be safely recommended for all positions in which extreme vibration is experienced. Messrs. Siemens Bros., Tyssen-street, Dalston, London, N.E., who are manufacturing large quantities of "Tantalum" lamps at the above address will be pleased to supply any information as to the quality of their lamps to all who are interested in obtaining the most serviceable lamp on the market.

ELECTRICAL ENGINEERS TERRITORIALS (London Division).—Orders for week ending, March 5: Monday, Feb. 28, "A" Company, Recruits Infantry Drill, 6 to 7 p.m.; Technical Drill, 7 to 9.30 p.m.; Tuesday, Mar. 1, "B" Company, Technical Drill, 7 to 9.30p.m.; Wednesday, Mar. 2, Gymnasium, 6.30 to 9.30 p.m.; Thursday, Mar. 3, "C" Company, Technical Drill, 7 to 9.30 p.m.; Friday, Mar. 4, "D" Company, Recruits Infantry Drill, 6 to 7 p.m., Technical Drill 7 to 8.30 p.m., Infantry Drill, 8.45 to 9.45 p.m.; Saturday Mar. 5, No week-end training this week. (Signed) P. H. Campbell, Capt. R.E., Adjutant.

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Electrical Progress at Home & Abroad.

A Review by our Special Correspondents.

TYNESIDE.

NEWCASTLE-ON-TYNE.

I understand that the Newcastle-upon-Tyne Electric Supply Co., Ltd., are experimenting upon a system of flat-rate house lighting for small consumers which may probably be the key to a problem which has hitherto only met with partial solution in this country. A group of small houses, to the number of about 50, at Whitley Bay, are being built, and it has been decided by the owners of these houses that they shall be lighted electrically. For this purpose they are installing wiring and fittings of a plain, yet substantial, type, and also providing the necessary service connections to the company's supply; the houses being grouped in this manner. The Company on its part are supplying energy at a flat-rate and are contributing a certain proportion to the charge of installation work, this proportion being intended to represent the equivalent cost of making service connections. These services will be run on an overhead system, thereby cheapening the cost of connection considerably. Hitherto attempts at systems of this nature have not been uniformally successful, owing to the high capital cost which was involved, but it is hoped that by an arrangement such as is above indicated, the capitalisation of the scheme will not be too great to allow of a working profit on the supply of electricity to small consumers.

Death of Mr. Charles Emmott.

The Cleveland and Durham Electric Power Ltd., have lost one of their directors in the person of Mr. Charles Emmott, of Durham, who was identified with a considerable number of local concerns, some of them engineering, such as Messrs. Robert Stephenson & Co., the shipbuilders and engineers. Mr. Emmott was also a director of the Northern Counties Electricity Supply Co., Ltd., which undertaking has a working arrangement with the Cleveland & Durham Electric Power Ltd. the latter company holding a proportion of the Northern Counties Co.'s shares, and working several of the area which were formerly run by means of independent supply stations. Mr. Emmott was quite a young man, and his decease will leave a serious gap in the engineering activities of the district.

The Coal Trades Dispute.

As an indication of the way in which the labour troubles in this area must have affected the output of electrical power to the collieries in the area, the following figures from the Board of Trade labour returns for January, and abstracted from the *Newcastle Evening Chronicle*, are of interest. In Northumberland the average work of the four weeks ending in January, was 3·77 days per week, or 1·67 days per week less than in December. In Durham the average was 3·96 days per week, or 1·53 days less than in December. In the United Kingdom the average for January was 4·89 days per week. The best return being 5·65 days per week for South Wales and Monmouthshire. It is now pleasant to record that, with the exception of one or two isolated cases, the miners have decided to go back to work, and the opinion appears to be that there will not be sufficient financial support accorded to those who are anxious to hold out to enable a very continued resistance to be made. The Northumberland and Durham coal strike can therefore be considered practically at an end.

THE MIDLANDS.

BIRMINGHAM.

The monthly meeting of the Birmingham Branch of the Institution of Electrical Engineers, held on the 16th inst., was mainly devoted to the reading and discussion of the Paper by Mr. H. E. Yerbury, which we shall deal with fully next week. But a contribution thoroughly appreciated was a paper on "The Influence of Various Cooling Media upon the Rise in Temperature of Soft Iron Stampings," a paper read in abstract by Mr. R. D. Gifford, M.Sc. The President, Mr. R. C. Morcom, testified to the accuracy of the data furnished, mentioning that he had himself been investigating designs of bearings for high speed, and the results he had obtained coincided very closely with those furnished by Mr. Gifford. Mr. Morcom expressed particular interest in the various alternative methods of cooling. Dr. Garrard considered the paper might very well be extended, so as to cover cooling operations in all classes of transformers, and the results would be extremely valuable. He declared his surprise at the extraordinary scantiness of the data available as to cooling resistances and their media. Dr. Kapp added a compliment on the exceedingly careful and painstaking scientific investigation recorded in the paper. He considered that the results would be of the greatest value to designers of transformers. There was a surprisingly small amount of information available, largely because designers had kept their knowledge to themselves.

Birmingham and District Electric Club.

The Birmingham and District Electric Club, while not neglecting the professional interests for the promotion of which it was formed, also keeps in mind the advantages of social intercourse among members of the profession. The annual dinner, held last Saturday evening, and reported in another column, proved a most enjoyable affair, a remarkable feature being the high standard of musical talent among the members. The next social engagement of the club will be on March 19. This will be a ladies' night, and the programme, in addition to musical selections, will include a short lecture by Mr. W. H. Whitehouse on "The Pyramids of Egypt." Mr. Whitehouse, who is in practice as an electrical engineer, is one of the oldest teachers and lecturers on electricity in Birmingham. For some years he conducted classes in telegraphy at the Birmingham and Midland Institute, and he has contributed on many occasions interesting demonstrations at the Institute's annual conversazione. His reminiscences of the reception by Birmingham of the successive developments of electrical science formed a most interesting feature of Saturday's dinner.

Progress in Mill Electrifications.

At the dinner mentioned above, Mr. J. H. Hunt, in proposing "The Electrical Industry," and having reviewed the progress of electricity, spoke of its recent achievements, including the Marconi wireless telegraphy, and mentioned that the United States Government was about to instal a station at Washington, with a range of over 1,000 miles. The present day application of electric power in manufacturing industries, however, was perhaps the most significant advance. On the Continent, there were many installations employing units of 3,000, 4,000, and 5,000 h.p. each. In our own textile trades its use was rapidly spreading, and recently 12 firms in the cotton and woollen trades had put down a further aggregate of from 15,000 to 16,000 h.p. The collieries and the iron and steel trades had realised the advantage of electrical power. A firm in the North employed on their reversible mills 1,200 h.p., with overload ratings of 3,600 h.p. In a large steel works in their own district, electrical installations had been adopted increasingly within the last six or seven years, the result being, for example, that the output which on the engine-driven mills was 70 to 80 tons, was now 180 tons per 12 hours' shift. The present plant represented 2,700 kw., and one week's consumption a quarter of a million B.O.T. units, showing an average over 7 days of 35,198 B.O.T. units per day, the average load factor being ·56, with a maximum of ·88. This plant was being

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augmented to 4,000 kw., and the cost of current was under one farthing per unit. He thought that the proprietors of collieries and large works would in increasing numbers come to see the value of electrical power, not only in obviating the loss of steam on scattered boiler plants, but also in general economical working, flexibility, convenience of operating, saving of ground space, and increased output. In the United States the manufacturers had been more ready to realize these advantages. For instance, there was a rail mill in America having a 30,000 h.p. system, three-phase 25 cycle, with a pressure at the motors of 6,600 v. The main rolls were driven by three 2,000 h.p., and three 6,000 h.p. motors running at speeds of 70–85 r.p.m. and upwards. The motors had enormous overload capacities and flywheel effect. The breakdown torques being 16,000, 18,700, and 20,600 h.p. respectively on the 6,000 h.p. machine. Ingots went through the whole process of manufacture into rails in 18 passes at one heat only. Each ingot weighed 8,000 lbs., and the cycle of operations took 357 sec. An ingot was started through the mill every 90 sec., and the output of finished rails was 166 tons per hour.

Ionisation without Pressure.

Some striking experiments on the ionisation of air were given last week before the Midland Institute Scientific Society. The lecturer, Mr. C. J. Watson, is a well-known amateur investigator, and his son, following the father's bent, is in practice as an electrical engineer in Coventry, under Mr. G. Lister, of the Carlton Works. The experiments shown by Mr. Watson were based upon the work of the Italian electrician, Signor Righi. The object is to demonstrate the ionisation of air at ordinary pressure, whereas the investigation of electrified gases has hitherto been mainly carried on in rarefied enclosures. The electrified particles are shot off from a point charged by Winshurst's machine, and their course is traced by receiving them on a plate of ebonite, and then dusting this over with a mixture of red lead and sulphur. The projected ions are retained on the surface of the plate, and on the plate being shaken cause some of the particles to adhere. By interposing in the path of the ions a metal pattern such as that of a Maltese cross, the pattern, when the plate is shaken, is seen reproduced on its surface. By passing the ions through a perforated plate, it was proved from the fact that the perforations recorded on the ebonite were expanded centrally, that the lines of force of the ions were curved.

Economy of Electricity.

A very satisfactory report has been presented to the Birmingham Health Committee with regard to the electric lighting installations at the Montague-street and Rotton Park-street interception works. These have now been in use a full year, the current being generated at the works by utilising the refuse to be dealt with and the waste heat of the destructors. The introduction of the electric light has not only improved the lighting of the wharves, but has resulted in a saving of about £130 per annum.

LANCASHIRE.

MANCHESTER.

The state of trade here has been well maintained during the past week. It is expected that early in the next month the cotton mills will resume full time working, possibly with a 5% reduction in wages. There is some likelihood of an early improvement taking place in the cotton trade. This will mean more work for the electrical engineering firms, as many mill plants are nearing the end of their days, and owners generally are favourable to the idea of replacing them by the electric drive. The Bolton Fine Spinning Co., which has a capital of some 6 millions, has already several of its mills converted, all with very satisfactory results. At the present moment the Lancashire Power Co. have in hand, among other important installations, the driving of a large bleach-works near Whitefield.

Gas v. Electricity.

Last Tuesday a debate took place between the members of the Manchester Junior Gas Association and members of the local Students' Section, I.E.E., on the relative merits of gas and electricity for heating and cooking, also for power purposes. Mr. B. Nelson Dadge, of the Bradford Dyers Association was in the chair. Mr. C. E. Woodhead opened the debate for gas heating. He said, calculating from the fixed prices in the debate of 1s. and 1d., the following preponderance in favour of gas was got, for 3,425 British Thermal Units (the equivalent of 1 unit) :—

Electricity ..	1,000 watts cost 1d.	per hour.
Gas ..	5·71 cu. ft.	,,	·0685d.	,,

Or one penny would buy 50,000 B.Th.U. from gas, against 3,425 B.Th.U. from electricity, giving an advantage of 15 to 1 in favour of gas. He contended that under such circumstances electricity could only be adopted where novelty was the ruling passion, and expense a matter of indifference. He gave two bills, which he called "true bills" to show the comparative costs of heating for one year. The gas figures were taken from actual tests, the others from catalogues, and were equally reliable :

Gas Fire.

	£	s.	d.
Ornamental Stone	1	12	6
Gas consumed, 15 cu. ft. per hour ..	1	7	4½
Renewals	0	0	6
	3	0	4½

Electric Radiator.

	£	s.	d.
Radiator	4	0	0
Current, 1,000 watts per hour ..	7	12	1
Renewals	0	18	0
	12	10	1

The area of the room was 1,600 cu. ft. Average daily use, 5 hours.

He gave a further example :—

Gas Fire.

	£	s.	d.
Electro-bronzed fire	4	18	6
Gas consumed, 30 cu. ft. per hour ..	2	14	9
Renewals		—	
	7	13	3

"Elevector."

	£	s.	d.
"Elevector"	12	0	0
Current, 3,000 watts per hour	22	16	3
Renewals		—	
	34	16	3

The area of this room was 4,000 cu. ft. Average use, 5 hours. He had been unable to obtain any figures for renewals in the last example, as "electricity was so little used for heating purposes." After giving some figures, in which he made out gas at 1s. per 1,000 to be one-tenth as expensive as electricity at 1d. per unit, he passed on to the question of water heating and gave the following table :—

Heating 120 galls. of water from 60° F. to 120° F.
Heat required, 72,000 B.Th.U.
Electric energy required, 21·02 B.O.T. units.
Cost of current, 1s. 9d.
Gas required (80% eff.), 150 cu. ft.
Cost of gas, 1s. 8d.

This worked out to an efficiency of gas over electricity of 12 to 1.

He further went on to say that the largest size of one of the best known accumulative electric water heaters gave 130 gals. of hot water per day. If more was required, for sudden emergencies, etc., it could not be obtained till next day. An ordinary gas geyser, he stated, would give this in 30 min.

He also gave some equally extravagant figures to compare the costs of cooking by gas and electricity.

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Electric Heating's Advantages.

Mr. A. E. Jepson followed for the I.E.E. At the outset he said electricity at 1d. could not compete in cost alone with gas at 1s. He had, however, out of curiosity, worked out the average figures at which gas and electricity were obtainable, and found that for electricity for heating 1·7d. was the average figure (the actual rates varied from ½d. to 3d.). Gas, for the first 75 places in the Gas Directory, was 3s. 9½d. per 1,000 cu. ft., while for the first 50 places in the list, having a make of at least 100,000 thousands per annum, the average heating rate was 2s. 3d. per 1,000. He then passed on to the consideration of a few processes for which gas could not be used, but in which electricity had proved highly successful. Amongst these applications he mentioned the baking of the famous "Triscuit" Shredded Wheat Biscuits, which is done electrically, the biscuits being fed into a chain, each link of which consists of two hot plates (electrically heated), the biscuits being gripped between each pair of hot plates so as to cook from both sides at once. Where cleanliness and simplicity in operation was required, there electricity would score. Gas-heating was dearer than coal, yet it had had some measure of success over the latter and in the same way electricity would ultimately displace gas for all cooking and heating operations. In spite of the arguments put forward by the gas interests, electric heating was rapidly becoming more popular, and in support of this he gave figures to show the enormous increases in the number of electric heating and cooking appliances turned out by some of the large firms during the past few years. These increased sales could only mean increased demands, which again was indicative of satisfactory service. He pointed to the high efficiencies obtainable with electrical apparatus, room-heaters gave 100% for all the energy was utilised ultimately in producing heat. Water-heaters gave 98%, while for all classes of cooking apparatus the average was at least 85%. The gas fires, on the other hand, gave out only 15% to 25% of the heat energy of the gas consumed, the remainder passing up the chimney with the products of combustion. Taking the average calorific value of 1 cu. ft. of gas as 600 B.Th.U. (or 1,000 cu. ft. = 600,000 B.Th.U.), and allowing 25% efficiency for the gas fire, (although 17% was often quoted) the effective heat in 1,000 cu. ft. of gas was 125,000 B.Th.U.

With electricity there was no such thing as average calorific value; one unit always contained 3,430 B.Th.U. At 85% this gave 2,910 effective units of heat. This gave a ratio :—

$$\frac{\text{effective heat units per 1,000 cu. ft. of gas}}{\text{effective heat units per kw. hour}} = \frac{43}{1}$$

Or at 15% efficiency of gas stove, the ratio was 35 : 1.

On the fixed prices of 1s. and 1d., a 12 : 1 ratio, it followed that at these unusual rates electricity was 3½ times more costly than gas, on the cost price basis. From the average figures of 1.7d. per unit, and gas 3s. 9d. per 1,000, electricity was 1½ times dearer only. In spite of these figures, however, manufacturers outputs increased, and he thought there was no doubt gas would be displaced for all cooking and heating purposes. He thought the gas engineer with the gas fire, stood in the same relation to electric heating apparatus as the horse cabman stood to the taxicab. He advised gas engineers to study electric heating so that as one profession slipped from their hands they could take up the other. The Welsbach Co. already seemed alive to this.

Hygiene and Convectors v. Radiators.

Mr. D. V. Hollingworth, F.C.S., spoke for the gas side, and advocated gas from the hygienic point of view, quoting various authorities to uphold his arguments. He stated that during the last two years in London alone, 1,000 gas fires had been installed by doctors. Radiant heat was the ideal method of heat diffusion, yet a blending of radiant and convected heat gave the most comfortable conditions. He stated that the bulk of electrical apparatus was designed with one avowed object of emitting convected heat, which was the only system by which there was any chance of the electrician's being able to compete. Convected heat could easily be obtained at 200 to 300° F., but for a respectable degree of radiant heat, 1,000° F. was required in the elements. This high temperature had a very destructive effect on the radiator. He mentioned one type in which were 6 glowers containing iron spirals, having a life of 500 hours. In one year, working 9 hours per day, it would cost 18s. for renewals, not to mention the trouble of taking the radiator to pieces once every 10 days to replace the spirals. A gas fire attained 2,000° F. inside. Referring to the practice of putting the electric radiator in the fire-place (which had to be hermetically sealed up to keep every bit of heat in), he said the atmosphere of such rooms became more and more polluted and the slight thermal currents induced by the radiator simply churned up the luke-warm and germ-laden atmosphere round and round, until a particle of air, magnified, would resemble nothing so much as a drop of sewage, while the air in the room would diffuse through the walls, the layer of deadly solid impurities on the walls was ever added to, and the putrefactive decay of this organic matter produced the sourness so characteristic of electrically lighted and heated rooms.

Indirect Savings by Electricity.

Mr. H. A. Carney next spoke for the electrical side. He pointed out that Mr. Jepson's ratio of 43 : 1 really understated the case for the electrical side, and showed that the figure of 35 : 1 was the more correct one. This he supported by quoting ratios obtained in various districts which showed a variation of about 40 : 1 to 24 : 1. Wherever gas was 2s. 10d. or over, and electricity 1d., the question of electric heating and cooking, looked at from cost price alone, should be considered, as alone this rate of electricity gave cheaper working costs. The relative economic values, however, could not be determined from a comparison of cost price alone. He pointed out the undesirable characteristics of gas, and contrasted it with electricity. Quoting from reports of decorators and users, he showed that the life of decorations was at least twice as long with electricity as with gas. "Water of combustion" was another trouble, and in spite of all assertions to the contrary gas fires did not carry off the products of combustion, or this water of combustion; but as the *Gas World*, Jan. 22, 1910, recently said, left it to produce "streaming walls, steamy windows, and a general feeling of clamminess." The electric stove produced no fumes and caused no "stuffiness," inducing headaches, etc. Where an office was to be heated there was a money value in this point, for anything which tended to lower the workers' efficiencies, as the close choking fumes of the gas stove did, lead directly to loss of time and money as well as to unsatisfactory work. He had worked out an example to compare gas and electric heating for a room of 2,500 cu. ft. capacity, the figures being based on actual quotations :—

Gas.

	£	s.	d.
Ornamental Stove (45 cu. ft. per hour)	4	0	0
Fixing	1	5	0
	5	5	0

Electricity.

	£	s.	d.
2 kw. Radio-Convector..	3	7	0
4 lamps for above	0	10	0
Fixing and accessories	2	0	0
	5	17	0

True Running Costs were given as below, for 1 year of 125 8-hour days (rated as 1 hour full, 7 hours half consumption in each case) :—

	Gas at 1s. £	s.	d.	*Electricity at 1d.* £	s.	d.
Energy consumed	1	7	6	4	10	0
Renewals	0	1	8	0	7	6
20% depreciation	1	1	0	1	1	6
Decoration „ per year	1	6	8	0	13	4
	3	17	0	6	16	4

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While on cost of energy consumed, electricity at the rates fixed appeared as 3·4 times dearer than gas, yet even taking in the cost of decorating alone, the result gave electricity only 1·75 times dearer than gas. If the greater healthfulness of electric heating and the effect of gas on the working efficiency of employees were considered, the saving of 4½d. per day in favour of gas would not cover the indirect loss it caused. Where gas was dearer than 1s. there was still less difference in cost. For cooking, electricity was superior to gas in results obtained. Cleaning was easy and there was no risk of explosions such as sometimes occurred with gas cookers. He quoted from a user to show that in an electrically-heated house, employing cookers, etc., two servants could do the work that three would be needed for in the same house under gas conditions. At a very low estimate this meant a saving of £46 per annum, which would allow of an increased consumption of 210 units per week at 1d., which was obviously much more than was needed.

The debate on "Power" followed.

SCOTLAND.

GLASGOW.

The Glasgow Local Section of the Institution of Electrical Engineers is rapidly becoming the most vigorous technical society in Scotland. Its various functions are already regarded as the events of the season. Their annual dinner is second only to the James Watt dinner of the Institute of Engineers and Shipbuilders, and their smoking concerts, which easily fill the banquetting hall of the largest restaurant in Glasgow, are ahead of anything of the kind which takes place in this city. On Saturday, February 12, the Local Section annual "smoker" was held, and was most successful. The Chairman of the Section, Mr. E. G. Tidd, was accompanied to the platform by Professor Maclean, Mr. Robert Robertson, Mr. W. W. Lackie, Mr. Joseph Taylor, Mr. Hamilton McMillan, and others. Members of the profession were responsible for the major portion of the programme. The excellence of the orchestra, composed of nine instrumentalists from the staff of the Electricity Department of the Corporation, was generally commented on.

When one descends, however, from the margin of pleasure to the dry context of business, the outlook is not quite so satisfactory. To a considerable extent the parent body is to blame for this. At headquarters the point of view would seem to be that inasmuch as the local sections are the children of the Institution, it is necessary for their good to keep them strictly under control. Instead of which the local men naturally feel that the interests of the profession in general and the Institution in particular would be more truly conserved if the London Council would extend to Local Section Committees a larger measure of freedom to manage their own affairs in their own way. It is an open secret that the Glasgow Local Section has been hampered and harassed in all sorts of ways through the interference of the London people. At the last meeting of the Section, for instance, the paper was one on "Equitable Charges for Tramway Supply," by Mr. Yerbury. This paper had been already read on more than one occasion in other parts of the country; the discussions on it had appeared in the technical press; and it was felt that to thresh it out all over again here would be like hammering a dead dog. The simile is, perhaps, not so complimentary to Mr. Yerbury as it might be, but one cannot suppress the feeling that there is, to say the least of it, something ludicrous in bringing a gentleman from London to deal with tramway charges, in Glasgow, of all places, where the tramways are acknowledged to be second to none in the world. Apart from that, this idea of sending papers round the country is calculated to discourage original work among members of local sections; it is apt to put a premium on papers which has more than once been ill deserved; and in practice it means tiresome repetition in the discussions, the absence of that breezy interest which comes from men speaking out their own thoughts, and the introduction of a spirit of lazy dependence upon the parent body to fill the gap when papers may not be promptly forthcoming from local members. On the other hand, the Local Section Secretary, after a certain amount of persuasion, may get one of his members to promise a paper. In due time the paper is produced, but before being read it must be submitted to the Papers and Editing Committee, who may decide (a) to reject the paper; (b) to have it read in London before it is read in the section where it has been produced; or (c) to allow it to be read at a local section meeting. It will be seen that for a local man of any standing to have his paper either rejected from London, or appropriated by the London Council, simply means that the Local Section Secretary need not go any more to *that* man for a paper. It has happened more than once in Glasgow that a paper has been obtained from a local member and a date has been fixed for its being read and discussed at a section meeting. In the meantime it has been transmitted to the Editing Committee (who, be it noted, are not to be hurried), and at a date which does not permit of his getting another paper, the Local Secretary has been informed that the paper in question is to be read in London before it is presented to any of the Local Sections. This is, indeed, keeping the local sections under control!

Electrical Contractors' Prices.

Competition may be the life of trade, but not the kind of competition that goes on among electrical contractors in Scotland. To the respectable contractor taking a decent price for his work and giving an honest job for the money, the quotations that come in in response to enquiries for tenders for wiring jobs remain an unsolved mystery where they are not the evident outcome of desperation on the part of a sinking firm clutching at the last straw prior to giving up the ghost. During the last two months one Glasgow firm tendering for a small telephone job were found to be quoting apparatus at net trade prices less all discount, and apparently trusting to the little on cost on the men's time for their profit. In another case quotations for a lighting job worth about £200 brought in prices showing a range of some £60 of difference between the highest and the lowest tender. A firm of standing, who quoted something over £200, gave the assurance that they had cut their price to give their men work; and they were simply dumbfoundered when they were informed that other offers received were £20 to £30 less than theirs. These quotations, be it noted, were sent in to a firmly drawn specification. Of course, this kind of thing can't go on, but in the meantime it undoubtedly tends to the survival of the unfit and the less desirable class of contractor, for, as a rule, the firm that under-cuts in the electrical business, if it sold intoxicants instead of electric fittings, would be called a "tied house." There did seem a hope some years ago that the Electrical Contractors' Association would mend matters, but for the moment this body, so far as Scotland is concerned, seems to be practically a dead letter. It may continue to do clever, high-handed things in the lobby of the House of Commons in guiding legislation, but a little home mission work might be nearer its purpose.

The Metal Filament and the Arc.

For office, shop, and warehouse lighting the metal filament lamp is rapidly taking the place of not only the carbon filament lamp, but of the arc lamp. Its exceptionally long efficient life and the fact that it requires no attention in the way of trimming and cleaning, of course accounts for this change. But it had not been anticipated that even for street lighting in main thoroughfares the metal filament lamp would supersede the older forms of lighting. After experimenting with two lanterns fitted with metal filament lamps in Queen-street, Glasgow, the Corporation have decided to light the whole of Queen-street with Osram lamps. The lamps will be of 100 c.p. for street corners and in pairs of 50 c.p. each for the ordinary two-arm street lamp-post. As experience gives confidence in the larger sizes of metal filament lamp, this movement will undoubtedly be continued.

Lighting of Bandstands.

The Glasgow Corporation have just decided to light two bandstands with electricity, viz., the ones Glasgow Green and Queen's Park. There is, of course, no immediate hurry for the work to be carried out, so that probably little more of the matter will be heard till the beginning of the summer.

Gas versus Electricity.

The amiable nature of the rivalry that goes on between the Gas and Electricity Departments of the Glasgow Corporation was badly exemplified the other day when an employé of the Gas Department, busy unearthing a gas pipe, suddenly drove his pick into a live electricity main. For a moment the air was luminous, but the gas man rose to the occasion: "—— ——!!" he was heard to remark, "I thought I had struck the roof of H——!"

GERMANY.

BERLIN.

The State railway from Magdeburg to Halle, *via* Zerbst and Leipzig, will soon be electrified throughout its entire length, and also the branch line from Dessau to Bilterfeld, which is about 16 miles long. The total length of the line between Magdeburg and Halle is about 96 miles. It taps all the important brown coal fields in the neighbourhood of Mulde, which urgently require better and cheaper means of transport. The power will be provided by a station at the small Prussian village of Muldenstein, which has been selected because brown coal for fuel is abundant there. The current used for the electric locomotives will be a high-tension alternating current, supplied at 10,000 volts. The whole cost will exceed one million sterling at all events, but we hear that it may be considerably more.

Hindrances and Helps to the Propagation of Electric Waves.

Paul Schwazhaupt, writing in *Elektrotechnische Zeitschrift*, calls attention to some very important lessons which can be learnt from recent long distance records in wireless telegraphy, distances ranging from 550 to 1,500 miles. The following is an abbreviated table of the results given by M. Schwazhaupt:—

Communication between	On	At	Over a distance of
SS. Cap Arcona and Scheveningen	Jan. 10, 1909	8 p.m.	1,600 km.
SS. Bremen and SS. Cap Arcona	Jan. 10, 1909	8.40 p.m.	1,400 ,,
SS. Bremen and Scheveningen	Jan. 5, 1909	9.50 p.m.	1,280 ,,
New Orleans and St. Augustine (Florida)	Dec. 24, 1906	p.m.	900 ,,
Guantanamo and Washington	Dec. 24, 1906	p.m.	2,500 ,,
SS. Cap Trio and SS. Cap Villano	Mar. 27, 1908	9 p.m.	1,216 ,,
SS. Cap Verde and SS. Cap Arcona	Sept. 2, 1908	p.m.	1,850 ,,

It will be noted that these distances exceed the normal capacities of the apparatus concerned in each case, and were covered at night in every case. There are also some interesting cases of overhearing. In the evening of December, 1908, the ss. *Konig Wilhelm II.* and the ss. *Cap Roca* were speaking to each other between Lisbon and Teneriffe, and were about 60 miles apart. For some hours their conversation was heard on the ss. *Cap Arcona*, then between Southampton and Boulogne, and 2,400 km. from the other vessels. On January 14, 1909, the ss. *Bremen*, when north of the Haaks lightship in the North Sea, heard distinctly not only messages passing between Marseilles and Algiers, but also between them and American warships coming from Port Said, the average distance being about 2,000 km. These extremely favourable results occur apparently in special places, among which the following have been identified: The Gulf of Lyons, Port Said, the district between Cape Finisterre and Lisbon, the neighbourhood of Schevingen and Haaks lightship, and a part of the Atlantic lying in about 10 W. long. and 48 W. latitude. No explanation of these remarkable facts is known, but it has been suggested that the electric waves pass most freely over land where metallic arcs are abundant. The fact that greater distances are covered at night is probably due to a less degree of tonisation of the ether after sunset. Towards sunrise, the possible distances lessen again.

As regards hindrances to wireless transmission, they may be divided into geographical and aerial, or practically into mountains and thunderstorms. The intervention of mountains is always attended with great shortening of the distance over which messages can be sent. Naturally, the higher the mountains are and the greater proportion of the distance they cover, the greater their effect. Atmospheric difficulties always begin in the afternoon and reach a maximum at about midnight, and have usually completely disappeared by sunrise. They hence partly neutralise the benefit of the absence of sunlight. They are commonest in tropical climates, and are severe during thunderstorms anywhere. They are especially liable to occur in the neighbourhood of mountains, and are particularly common in the Red Sea, and on the coasts of Spain and Italy. Much work remains to be done on this interesting subject, but it is clear that the power of the ether for transmitting electric vibrations depends on many factors.

Electric Railway Improvements.

Some of the latest improvements in the Berlin electric railways, which are partly above and partly underground, may interest your readers. The drivers' cab now forms a part of the guard's van, and the guard's seat is opposite a window looking into the cab, so that each can co-operate fully with the other. If by any chance a train passes a danger signal, its brakes are applied automatically by means of contacts in the permanent way, which actuate the brakes by means of an apparatus on the roofs of the coaches, while at the same time a signal appears in the van showing what has taken place. If signals are overrun at the junction, danger signals—stopping any train on another line which might collide with the first—are automatically exhibited.

Electrical Exhibitions.

The small Dutch town of Nymwegen is showing considerable enterprise in starting an exhibition which, we hear, will be very fully representative of all matters connected with electric working. It is managed by the local Verein fur angewandte Elektrizitat (applied electricity), and will be open from July 2 to August 15, 1910, inclusive. No pains are being spared to make the exhibition a success, and the co-operation of all and sundry, of whatever nation, is cordially invited. All enquiries should be addressed "Verein fur Angewandte Elektrizitat, Nymwegen, Kelftens bosch 18, Holland," and must arrive not later than March 1 next. All information as to space available, conditions of transport, etc., will be gladly furnished. We hear that foreign applications will be received later.

Another exhibition is to be held at Dordrecht, but is concerned chiefly with factories and dwelling houses. It will be open from April 30 to May 15, 1910, under the name of Ausstellung fur Elektrizitat in Wohnung, Gewerbe, und Industrie. This exhibition is held under the auspices of a permanent Exhibition Committee, the Standige Ausstellungscommission fur die Deutsche Industrie. It will be largely represented by firms throughout Europe, including Great Britain. We offer no apology for giving these tremendous names, for all communications by prospective exhibitors or participators in the exhibitions in any way must be addressed so, and in the last case it is a matter of interest to know that there is such a permanent committee. Even Berlin people are, as a rule, ignorant of its existence.

Electrical Ash-Transport.

An electrically driven ash-carrier is in operation at the works of the Bayerische Brownkohlen-Industrie A.G. at Schwandorf. There 26 boiler fires are maintained with an inferior quality of brown coal, so that there is plenty of ash to get rid of. The apparatus under notice does the work of ten men. Iron rakes bring the ashes on to an endless chain belt, where they are slaked with a sprinkler, and carried up into a stroage vessel, which can hold 30 cubic metres of ashes, and is at a height of 10 metres above the furnaces. The distance is 120 metres. The belt is driven by an electromotor, giving 15 hp., at 950 revs. a min., and capable of yielding 19 hp. on starting. If any important obstruction should happen, *i.e.*, if the travel of the belt should be choked in any way, the motor is thrown out of gear automatically, so that there is no injury to any moving mechanism.

Enamelled Wire.

An interesting discovery that may have great consequences both in laboratory and in practical work has

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just been made by R. Gaus. It is that coating wire with enamel for insulating purposes, as is done, for example, by the A.E.G., makes it practically insensitive to a magnetic field. The importance of this for measuring instruments can hardly be exaggerated. We understand that researches as to the nature of the enamel giving the best results are in progress.

UNITED STATES.

NEW YORK.

Electrical engineers throughout the States are taking a keen interest in the first convention of the International Congress of Inventors which is to be held at Rochester, in this State, next June. The Congress was founded in 1906, and already, I am told, numbers on its membership roll the leading inventors of the United States, Great Britain, Germany, France, Austria, and other countries. At the June meeting it is expected that members will be present from all parts of the world, and that a large number of addresses of permanent value will be read and will be followed by profitable discussions. One of the main objects of the Association is to present the solid front of a strong international organisation in any case where it becomes necessary to assert the rights, individual or collective, of its members. In illustration of the need of such an organisation it is pointed out that there are something like a quarter of a million inventors in the United States alone, but hitherto, in cases where it became necessary to appeal to the authorities for the redress of specific grievances, they have been powerless to assert their rights, simply because instead of a united body, they were simply individual units. The president for the current year is Mr. G. F. Gallagher, and the secretary is Mr. R. T. Olcott. The headquarters are at Rochester, New York State.

The Electric Car.

It is a remarkable fact that whereas in Great Britain the electric motor car is, broadly speaking, almost unknown, in this country it is extremely popular. Electrical engineers here make a special study of this form of car, and central stations take special pains to provide facilities for charging accumulators, and the consequence is that an enormous number of people have abandoned the gasolene car with its noise and smell and danger and adopted the silent, odourless, clean electric car. At the recent Automobile Exhibition in this city a splendid selection of these cars was shown, varying in size from the dainty "runabout" for two, easily managed, and even charged, by a lady, to the big six-seater for touring purposes. Of course, the accumulators are a heavy item, but year by year the weight is being diminished, and efficiency increased.

Cost of Running.

With regard to the cost of running, the Waverley Company gives some interesting information. A number of questions were submitted to users of these vehicles requesting information as to the average monthly bill for electricity, approximate monthly distance travelled, experience with life of the battery, monthly allowance for battery renewals and some other queries. The replies to the question as to cost for electricity were divided into two classes, for vehicles kept in private garages and for those kept in public garages. It was found that the cost for private charging in the State of Indiana averaged $6·37 per month; in the Middle West States, $5·67 per month; in the Eastern States, $4·11 per month; in the Southern States, $6·07 per month, and in the States west of the Mississippi, $4·32 per month. The cost of storage, service and current for vehicles kept in public garages averaged for the whole country $21·50 per month. Some typical reports on costs are printed with the names and addresses of the owners. In answer to the question as to the monthly distance travelled 12 owners reported more than 500 miles per month, the highest being 750 miles. The average for the State of Indiana was 352 miles; for the Middle West, 321 miles; for the Eastern States, 390 miles; for the Southern States, 331 miles, and for the States west of the Mississippi, 488 miles. The answers to the inquiry for experience as to the life of batteries gave an average life ranging from two years in the State of Indiana to two years and eight months in the States west of the Mississippi. The average monthly cost of battery renewal was $5·73 in Indiana, $5·01 in the Middle West States, $4·85 in the East, $5·88 in the South, and $4·44 in the States west of the Mississippi.

The Colorado River Dam.

Fresh plans are now under examination for rebuilding the great dam across the Colorado River at Austin. They are submitted by a Pennsylvania syndicate, and the contract they ask for provides for the rebuilding of the dam and the operation of the municipal electric light and power plant. The syndicate agrees to construct the dam and hydroelectric plant and to have the works ready for operation within two years from the date of signing the contract. It is proposed that the city shall pay the syndicate the sum of $60,000 annually in two equal semi-annual instalments for a period of 30 years, or a total of $1,800,000. This money shall not only be in payment of the light and power furnished by the syndicate, but it will give the city the ownership of the dam and hydroelectric plant at the expiration of 30 years. The contract provides that a minimum of 1,000 h.p. shall be furnished the city during the life of the contract, and that the city shall receive without extra cost all over 1,000 h.p. produced by the dam and shall pledge the earnings of the present and future plant to cover the payment of $60,000 annually.

Diminishing Transformer Losses.

In a letter on this subject Mr. Herman Meyer, of Buffalo, points out that there is always a continuous loss in the primary coils and core of a transformer whether the secondary is carrying any load or not. This loss, although small in well-designed transformers, is continuous and amounts to considerable in the year. There have been numerous schemes and devices proposed and used for diminishing the loss, such as cutting out the transformer entirely when it is not in use, but in actual practice none of these is employed. One method of interest is to divide the primary and secondary of each into two equal parts and to couple them in multiple for full load and in series for small loads. The voltage transformation ratio, of course, remains the same; but the induction will be reduced to a half for the series connection, the loss due to hysteresis will be reduced more than half and that due to the heating of the coils, although increased considerably, is small in value, so that there is an appreciable gain in economy. A similar scheme, applicable to three-phase circuits only, consists in connecting the three coils first with the end of one to the beginning of the next, or connecting them in delta and then changing them to star connection. In the first case the voltage per coil will be 73% greater than in the second, so that the delta connection may be used for full loads and the star connection for light loads. The change must be made simultaneously in both the primary and secondary circuits so as to retain the same ratio of transformation.

Chicago's Engineering Needs.

Some large propositions concerned with the engineering of Chicago were put forward at the annual meeting in that city of the Wetsern Society of Engineers. The general conclusion of the speakers was that commercial Chicago is 30 years ahead of municipal Chicago, and that urgently needed improvements and developments stand little chance of accomplishment until the city provides itself with a Civic Board of Engineers, since Chicago is at present without any engineering organisation or facilities for carrying out great and necessary works. Numerous new electric subways are needed in addition to surface lines and many other big undertakings are called for. Mr. Fritch, chief engineer of the Chicago Great Western Railway, called attention to the fact that there are 2,200 miles of steam railroad tracks in the city, and urged that the sooner the railroad companies faced the electrification problem, and worked it out, the better it would be for them, as otherwise they would be forced to adopt electrification under duress, and so be unable to give the subject the careful consideration which its importance demands.

The Gyrostat in Practice.

Professor Franklin, has been lecturing before the New York Electrical Society on the practical applications of the

gyrostat. Explaining the force exerted by the gyroscope when any attempt is made to alter its plane of rotation, he said the tendency was for the device to resist the motion by a slow precession in a direction such that the gyroscope would finally rotate in the direction of the imparted motion. An effective method for causing a gyroscope to resist a force in a certain direction is to hasten the precession caused by the motion producing the precession. Upon this method is based the stabilizing action of the gyroscopes used for preventing the rolling of ships and the overturning of monorail cars. In the Brennan car the gyroscopes are so mounted that the precession action is hastened by the friction between an extended shaft of each gyroscope and a surface against which it rubs when displaced from the normal position. In the Scherl car the hastening of the precession is accomplished by means of a piston moving in a cylinder containing oil, the pressure of which is varied, by an electric motor, according to the force of displacement to which the gyroscope is subjected. A small working model of the Brennan car was shown in operation upon a rope suspension track, and Mr. H. H. Barnes read a description of this type of car as proposed for actual passenger service. A discussion of the characteristic features of the Scherl car by the inventor was also read. Mr. E. A. Sperry showed some illustrations of the Schlick device for preventing the rolling of ships. In one test the rolling of the ship was reduced from 16° to about 1° when the gyroscope which had been clamped in position—although revolving at full speed—was allowed to operate under its automatically hastened precession. Professor William Hallock explained the advantages of utilizing the gyroscopic principle in stabilising an aeroplane in flight against all wind disturbances.

New Polyphase Induction Motor.

Among the many interesting exhibits at the recent Electrical Show at Chicago was an entirely new polyphase induction motor, designed by the Kimball Electric Company of Chicago, in co-operation with Professor John Nies, of the Lewis Institute. The polar area of the motor is much larger than is usual, and permits the use of a much lower value of the no-load current; thus contributing to the power-factor at all loads as well as to enhanced efficiency through reduction of the copper loss. The pitch of the stator winding is chosen to give a magnetic field of maximum smoothness, the field being almost sinusoidal, so that little damping action is required of the rotor, and the losses due to stray currents in the rotor amount to practically nothing. The use of the selected winding pitch results in short coil ends, leading to a reduction of the magnetic leakage and also to a reduction of the stator copper losses. Though designed for low slip, these motors are nevertheless possessed of a starting torque ample for most purposes, and higher than is usually obtained in motors of the same efficiency and slip. The results secured are due to the smoothness of the motor field, which causes any back torque due to the rotor's damping action to be eliminated. The efficiency is high and sustained through a wide range; the power-factor is exceptionally good, and the slip small. The tendency of the design is toward shorter length and larger diameter, thus permitting the use of short, stiff shafts running in bearings of good size and set close together, so that no trouble is likely to occur on account of sprung shafts or contacts between stator and rotor iron. The outer surface of the rotor is made smooth, which, together with the smoothness of the field, makes the motor practically noiseless.

Electric Pumping.

A report which has just been issued on the test of the motor-driven pumping plant which supplies Lockport, in this State, with water, gives some very interesting results. The plant consists of three independent units with a combined capacity for delivering 15,000,000 gal. in 24 hours, against a pressure of 125 lb. per sq. in. Each unit comprises a 500 h.p., 400 volt, three-phase Westinghouse induction motor, operating at 750 r.p.m., direct-connected to a single-suction, enclosed, impeller centrifugal pump. Electrical energy generated at Niagara Falls is transmitted to North Tonawanda at 22,000 volts, being stepped down to 440 volts at the pumping station by three 500 kw., oil-insulated, water-cooled transformers. From the pumping station the water is forced through 69,000 ft. of 30 in. main to a standpipe, 25 ft. in diameter and 120 ft. high, at Lockport, 13 miles away. During the tests, each unit was run continuously for 15 hours, during which time readings of the electrical input were taken every 5 min. and readings of the Venturi water meter and the pressure gauge every 10 min. Each pump showed an average delivery of about 237,000 gal. per hour, against a head of 320 ft. The motor input was approximately 343 kw. for each machine, indicating an equivalent pumpage of 1,450 gal. per kw. hour, and an over-all pumping efficiency of 70%. The combined delivery shown by the three pumps was 17,096,000 gal. per 24 hours.

Telephoning from Moving Trains.

Writing in the *Telephone Engineer*, Mr. W. J. O'Neill gives an interesting account of the new telephone system which has been installed on the Newark branch of the Erie Railway, by means of which passengers may communicate with New York or Chicago or any other point while the train is proceeding at full speed, and officials on the train can link up with any station on the road. The invention, says Mr. O'Neill, is not merely a telephone, but also an automatic electric signal system, which will wholly supersede the block system, as it warns the engineer of the approach of another train within the same section, and when danger is near automatically stops both trains and enables the engineers to communicate with each other and with headquarters. Stretched along the right-hand track on small supports is a stout steel tape carrying 10 volts. At intervals wires run out from this tape to the telephone and telegraph lines at the edge of the right-of-way. Below the engine cab is a set of wire brushes which rub along the tape and keep in constant contact with it. To telephone, the engineer merely plugs in, and his telephone apparatus is thereby connected with an operator at division headquarters, who gives him the station he wants, or any other train along the line, or any private telephone he wants to reach that can be connected with the line. The automatic train-stopping apparatus is much more complicated. It consists of an arrangement whereby, if two trains get upon the same "section" of tape, say within 2 miles of each other, a certain circuit is broken in the cabs, a lever is released, and the air rushes into the brakes at all the wheels. At the same time a little green incandescent light, which burns at all times when the track is clear, goes out like a switchboard pilot lamp. The system is the invention of Mr. F. Lacroix, electrical engineer for the Electrical Automatic Railroad Safety Signal Company, who is barely four-and-twenty years old.

Current Items.

For the purpose of assisting teams of horses in hauling heavy loads up a grade varying from 15% to 20% for 2,000 ft. in Seattle, Wash., a team cableway, driven by electric motors, has been placed in service. Use is made of a ¾ in. steel cable which is capable of hauling simultaneously six 3-ton loads with the wagons.

B. L. T., of the Chicago *Daily Tribune*, announces the discovery of a new creation, "alternating-current pie"—first a currant, then a fly.

Announcement has been made of the completion of a merger combining six electric railways, 20 electric lighting plants and five gas plants in Berwick, Bloomsburg, Danville, Sunbury, Shamokin, Mount Carmel, Centralia, Ashland, Girardsville, Shenandoah, Mahanoy City and McAdoo, Pennsylvania, by E. R. Spensler, president of the Columbia Power, Light and Railways Company. The electric railways comprise 142 miles of trackage and extensions of 65 miles are planned, which will give a connection of electric railways from Wilkes-Barre to St. Claire, where the system will connect with electric railways of the J. G. White Company into Pottsville. The merger involves about $7,000,000.

An official report shows that 26% of the 312 cotton mills of North Carolina are now using electricity solely as motive power. This revolution in the matter of motive power has been achieved practically within the last 10 years, especially among the new mills, and probably 60% of the existing mills have been completed during the 10-year period referred to. It is found by comparison of figures that 35% of the cotton manufacturing plants use electricity either entirely or in part. The indications are that this percentage will gradually increase, until practically every up-to-date mill in the South will be electrically driven, unless it is so

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situated that inaccessibility to electric supply will prevent the change.

The change from the steam to the electric drive in several of the larger mills in Greenville, S.C., has been carried to the furthest limit by the Monaghan cotton mills, which has not only supplied the mill village with electric street lights, but has installed the incandescent light in the homes of all of the several hundred operatives, at a nominal monthly rate.

POST OFFICE ENGINEERS.

The seventh annual dinner was held at the *Hotel Cecil*, Strand, on February 15, Major O'Meara, C.M.G., Engineer-in-Chief, presiding.

The guests of the evening included the Right Hon. Sydney Buxton, M.P., Postmaster-General; Sir Robert Hunter, C.B.; Dr. Gisbert Kapp, President of the Institution of Electrical Engineers; Sir John Gavey, C.B., late Engineer-in-Chief; Dr. Walmsley, Professor Wilson, Mr. A. M. Ogilvie, Col. A. Bain, Mr. G. Morgan, Mr. F. Gill, Mr. S. J. Goddard, Mr. A. F. King, C.B., Mr. E. A. Eames, etc., etc.

After the royal toasts had been duly honoured, the Postmaster-General said this was the fifth time that he had had the honour of being asked to propose the toast of "The Engineering Department," and was likely to be the last time as Postmaster-General. When he addressed them last year, he referred to the revision in the Engineering Department—the long overdue revision; since then that revision had taken place. He found that in the course of last year the number of first-class engineers increased by 37%, and that first-class engineers in charge of sections are now all on terms of equality. There had also been an increase of 35% in second-class engineers, and they hoped to obtain additional clerical appointments in other parts of the department. He desired, on behalf of the department, to recognise to the full the zeal and energy with which gentlemen of the engineering department had performed under exceptional strain and circumstances an exceptional amount of work; and that he desired to say very honestly and very sincerely. They had had in the past year, from the engineering point of view, apart from internal interests, one or two questions which had come up, and which were either disposed of, or are under discussion, at the present moment. In the first place, as regards the Telegraph Construction Act, which he was able to get through the House of Commons two sessions ago, this Act had been of very considerable advantage to them, and they were now able to deal with recalcitrant owners and others in a manner which had assisted them enormously in carrying out lines of telegraph and telephone poles in the direction that they desired; and while it was the department's desire to treat owners with the utmost consideration, they were now able to meet them and owners were able to meet them on terms of equality. Then a further matter to which he referred last year, and which was of considerable interest, was the fact that the State had acquired what they might call the internal wireless system of this country. They were able to acquire it at a very reasonable price, which he was afraid their friends of the National Telephone Co.—whom he was glad to see there that night—would not accept for their system as a whole, namely, £15,000. They had been able to acquire those various stations and licences for a reasonable sum, and were now in the position of having this system in their own hands, and of being able to develop it on the right lines in the general interest of the community. Of course, wireless telegraphy was at present in its infancy, but he thought they might feel that it had before it a great future in various ways, especially for the purposes of mercantile marine. Hitherto he had been rather against compulsory wireless telegraphy for the mercantile marine, but now that he was going to the Board of Trade he was inclined to think in order to assist the G.P.O. that he would have to introduce a Bill for a compulsory wireless system. One matter of importance to the engineering department is the Conference in Paris in regard to various technical matters connected with telephone and telegraph work. This Conference would be of very great value from the international point of view, and matters of very considerable moment to the telegraph and telephone interests will be discussed. There was one other matter to which he should refer, they were within a few days of the 40th anniversary of the taking over of the telegraph system by the State from the Telegraph Co.'s. In 1869, the year before the companies were taken over, the actual number of telegrams dealt with was 6¾ millions; in 1909 there were not less than 85 millions. The mileage of land wires at the time of taking over was 60,000, and they had now over a million miles. That, he thought, showed the extraordinary development which had taken place. As regards the engineering department, they had no figures going right back to the beginning, but they had those for three years later. The total engineering establishment in 1873 was 630, and last year the figures had risen to nearly 2,900, which showed the enormous development which had taken place. These were remarkable figures; what was most satisfactory about them was that while they showed enormous development in regard to the matter of telegraphs and telephones, they all knew that not only had the staff increased and the work increased, but that the efficiency and the speed and the general advantage to the public had increased even in greater ratio. Therefore, he was proud as Postmaster-General, for the time being representing that great department, to ask them to drink the health of the engineering department, coupled with the name of Major O'Meara, Engineer-in-Chief.

Major O'Meara, in responding, said he was expressing their views when he told the Postmaster-General that they very much appreciated his presence there. It was a pleasure to them to have at their table Dr. Kapp, President of the Institution of Electrical Engineers, with which their branch of the Post Office had been long associated. The Postmaster-General referred to the Paris Conference. At Budapest there were only three of them. He omitted to tell them that he had nominated eight officers of the engineering department to attend this Conference, so that they would be very strongly represented at Paris. The Hungarian Administration had taken the lesson of the first conference to heart, and the Conference Committee had wisely decided to limit the number of subjects which would be discussed at the coming meeting. This would give everybody an opportunity of posting themselves up on the selected subjects beforehand. He had been warned that they would expect to hear something about his visit to America. It would be difficult to cover the ground satisfactorily, but he must on that occasion acknowledge publicly the exceedingly courteous manner in which he was received by all the officials connected with the telephone and telegraph services of that great continent. The Americans were a go-ahead people, but, after all, they were almost as conservative as we were in this country. In engineering matters we gave them credit for doing big things—and they did big things—but they moved cautiously, and it was only when they had "tested out" and "proved in" any new idea, that they adopted it. He might say that their own pre-conceived ideas that they had come to a state of rest in the development of the telephone art were rather shaken on his visit to America. The telephone art was still in a state of flux. He would not be at all surprised if developments took place within a short time which in their nature might prove to be even more radical than the change from the magnet to the C.B. system.

Dr. Gisbert Kapp, in replying for "The Visitors," declared that it was the first time that he had had the honour of attending the annual dinner of the engineering department of the Post Office. He appreciated it, especially as it was his privilege to represent the Institution of Electrical Engineers, of which his hosts might be considered the godfathers, it having been founded as the Society of Telegraph Engineers and Electricians. They were, however, liberal-minded enough to admit other branches of the electrical profession as these developed in succeeding years. Thus the activity of the Institution, having first embraced telegraphy, was gradually extended to electric lighting, then to transmission and distribution of power, then to railway working and other applications in which heavy electrical currents were required. The founders of the Society of Telegraph Engineers, recognising the importance of all these new developments, welcomed the

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influx of new members representing them, and agreed to the title the society now bears as more appropriate to the widened scope of its work. A close connection between telegraphic and the heavier branch of electrical engineering has, however, always existed, and this has certainly been the cause of a great deal of improvement in all directions. Those of them who were engaged in the heavier side of the profession must recognise the services which had been rendered to the profession by the early work of telegraph engineers and also by their present work. If they went into an electrical factory they would find an instrument for measuring resistance in general use. This is the "Post Office" bridge. Telegraph engineers, when bothered by faults on their lines, invented the "loop test," and have thus shown the way to central station engineers to test their electric light cables. Sir Henry Mance invented a method for measuring the internal resistance of batteries. This also has been used by the makers of secondary batteries. Recently one of the G.P.O. engineers had invented a new type of condenser, which was an enormous improvement on the old one. They could now buy microfarads for shillings where they had to spend pounds before. On the other hand, the telegraph engineer also adopted the electrical engineers' methods. In telegraph work he had replaced the primary batteries by storage cells or dynamos, and even in telephone work he had succeeded in using dynamos as a source of current, the dynamo having a very finely sub-divided commutator. So the two branches were helping each other. In fact, in their department they were not entirely confined to telegraphic and telephonic engineering. They had considerable power requirements for lighting, blowing engines, lifts and conveyors. When one considered that the P.O. engineers had to provide generally for the technical requirements of that vast department, one began to realise what an enormous importance engineering had in that branch of the national service. It was not only a question of dealing annually with something like five million telegrams and 40 million trunk line conversation, but also with incidental engineering requirements for light and power in that service. All such work came strictly into the province of the Institution of Electrical Engineers, and he was glad to say that many of his hosts were members of the Institution. Quite recently 28 members had been enrolled, and these, together with those who were already members, formed quite a respectable contingent; but he need hardly say that they would welcome further accessions, and since, as Mr. Buxton had told them the staff numbered 2,900, he hoped that a part of them would join. It would be to their mutual advantage. The Institution of Post Office Electrical Engineers, too, was known to him through its publications, which he found very interesting. Should the time come that the Northampton Polytechnic could no longer accommodate them, he hoped that institution would be able to do so. Arrangements had been made in their new building for the meetings of their Students' Section in a room which would hold about 150; and there was also the large lecture hall. If the Institution of Post Office Electrical Engineers required it, he felt confident the Council would be pleased to give them hospitality.

Mr. H. C. Gunton, rising to propose the toast of "The Chairman," said he was fortunate, on the occasion of his first speech in the Post Office, to have so congenial a task as to propose the toast of the Chairman. Major O'Meara's military career would ensure him their respect, his position as the head of that department entitled him to their loyalty. His past engineering work brought him in contact with the staffs of railway companies, municipalities and large contracting firms, and he had no hesitation in saying that the work which Post Office engineers were called upon to perform was greater in volume, that it was dealt with quite as efficiently, having regard to the greater volume, and that he did not think it met with nearly as much recognition, as compared with outside concerns. If a railway company electrified one of its lines, considerable attention was drawn to the fact. If a Borough Council or Corporation laid down an electric scheme, everybody heard of it. While he was sure none of them desired any fuss, a certain amount of recognition of the work they were doing was more or less encouraging, and he thought a time was coming when the work of the power engineers in the Post Office must necessarily, from force of circumstances, come more to the surface. At the present time the Post Office electric power and lighting circuit were absorbing 5,400,000 units a year from outside sources, and they were actually generating another 5,000,000 units a year. He did not think that it was realised that the plant already laid down for driving pneumatics, generating electricity, etc., amounted to 7,000 h.p. This plant was very largely hid away in basements, and he did not think its existence was realised. Very shortly the new power scheme would be brought into operation, and King Edward Building would be fully equipped with a large installation of lifts and conveyors, to say nothing of the lighting. That would bring the power engineer to the surface, and make his work very much more recognised than it had been in the past. He wished to be quite sincere, and not suggest that he thought everything was splendid and perfect. It was hard to obtain perfect punctuality combined with sufficient attention to detail if you were being absolutely swamped with work, and he did think that the Post Office engineers were called upon to do very much more than engineers in concerns outside. As an example of the rapid extension of the power work, he might say that they had at present for electric lifts motors of a total capacity of about 750 h.p. installed, and they have either ordered or are about to order a further 550 h.p., or an increase of about 70%. He thought this increase of the work of the power engineer, combined with the increase in the other sections, must necessarily tend to raise the status of the engineer in the Post Office, and make their work more recognised. Now, with all this strenuous work ahead, he thought they should look forward to the future with some anxiety if they did not know that they had a chief who not only realised the developments in engineering which were going on, but who sympathised fully with their difficulties and responsibilities. It was because they could feel that he was fully alive to all these considerations that he asked them to honour, and he asked the Major to accept, this toast as a sign of their respect, loyalty and enthusiastic support.

Major O'Meara, responding to the toast of "The Chairman," thanked Mr. Gunton for the very kind way in which he had proposed "The Chairman" and the reception which they gave to his toast. They had, perhaps, all noticed the sentry marching up and down in front of some royal palace or treasure house. He goes on with unfaltering step, and one wondered at the confidence with which he had taken on such a charge. It was simply due to the fact that he had close by some loyal comrades and the knowledge that the cry of "Guard, turn out" would bring immediate assistance in time of need. He felt himself in the position of the sentinel. It was because he knew that there was also a guard only too eager to turn out in time of need that he could march on with confidence. He thanked them for the many occasions on which they had responded to the cry, "Guard, turn out!"

DIARY.

FRIDAY, FEBRUARY 25.

INSTITUTION OF ELECTRICAL ENGINEERS (Manchester Section).—Annual Dinner at the Banqueting Hall, *Midland Hotel*, Manchester, at 6.45 p.m.

NORTHAMPTON INSTITUTE ENGINEERING SOCIETY.—Visit to the Western Electric Co.

TUESDAY, MARCH 1.

INSTITUTION OF ELECTRICAL ENGINEERS (Manchester Students' Section).—At the Municipal School of Technology, at 7.30 p.m., "The Commercial Side of the Electrical Industry," by J. J. Low Brooks.

WEDNESDAY, MARCH 2.

INSTITUTION OF ELECTRICAL ENGINEERS (Students' Section).—Meeting at 7.45 p.m. at 92, Victoria-street, S.W. Paper by T. J. Sack, "Insulating Materials."

FRIDAY, MARCH 4.

NORTHAMPTON INSTITUTE ENGINEERING SOCIETY.—At the Northampton Institute, "D.C. Liquid Starters," by Mr. J. K. Hwoo.

TUESDAY, MARCH 8.

NATIONAL ELECTRICAL MANUFACTURERS' ASSOCIATION (Incorporated).—Committee meeting at Balfour House, Finsbury Pavement, at 2.30 p.m.

WEDNESDAY, MARCH 9.

ASSOCIATION OF ENGINEERS-IN-CHARGE.—At the St. Bride's Institute, at 7.30 p.m., "The Application of Recording Instruments to Steam Generation," by Mr. J. Abady, M.I.Mech.E.

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Business Notes and News.

LIGHTING AND GENERAL—Home.

BRUMBY AND FRODINGHAM.—The Urban District Council are considering the question of lighting by electricity. It has been decided in any case not to promote a Parliamentary Bill, but to apply for a Provisional Order. The cost of providing these 75 lamps and laying down mains, to be also available for house supply, is estimated at £25,000.

BISHOP'S STORTFORD.—The Urban District Council have decided to oppose the Bishop's Stortford, Harboro' and Epping Gas and Electricity Bill, which is being promoted by various local companies. The Council have also decided to adopt the electricity scheme formulated for them by Messrs. May & Hawes, particulars of which were given in THE ELECTRICAL ENGINEER, Vol. XLIV., page 889.

CITY OF LONDON.—The Common Council have agreed to the City of London Electric Lighting Co. carrying on a further series of experiments in street lighting, at a cost of £525 per annum.

CHICHESTER.—The Chichester Electric Light Co. have offered to tender for the street lighting of the city by electricity, and in the event of the contract being placed with them, (1) to take over the whole of the lighting of the city at the end of the year (2) to undertake the same at a lower total rate per annum than the Corporation is now paying; and (3) to guarantee an improvement in the light at present obtained.

DOWLAIS.—With regard to the proposal to provide electric light by means of overhead wires, the Merthyr Corporation have given an undertaking to the Board of Trade that the regulations of the department shall be carried out.

DUBLIN.—The Electro-Vibration and Light Cure Institute 15, Kildare-street, which was opened in 1902, has undergone complete overhauling. It is equipped with a static electric machine, electric massage machine, and electric light baths. Mr. Charles M'Keone is the superintendent.

DUBLIN.—The annual report of the Port and Docks Board contains the following passage concerning the electrical equipment: Within the year the sum of £558 was expended on the electric generating station, making a total of £40,855 9s. 1d. to end of December last. On electrical equipment, £1,564 17s. 2d., making £3,324 13s. 10d. to same date; and on electric portal wharf cranes £4,518 6s., making £15,945 12s. 5d. The maintenance and repairs of the generating station for the year was £2,332 5s. 8d.

DUNFERMLINE.—At the Fife Electric Power Co.'s station at Townhill, a new engine, the introduction of which has been necessitated principally by the increase of current required for the West Fife tramways. The engine is a vertical British Thomson-Houston impulse turbine, and is the first of its kind to be built in Scotland. It is capable of developing 2,000 h.p. The voltage current generated by the dynamo is 6,600 alternating. Above the condenser, which forms what might be called the base of the engine, is the cylinder, which includes the turbines, and above this is placed the dynamo. This dynamo travels at a rate of 1,500 r.p.m., and it weighs, with its accessories, 9 tons. A man can turn the weight by his own strength. Water for use in the turbine is obtained from the town loch into the engine by a 21 in. pipe. After passing through the condenser it is returned to the loch at an increased temperature.

DUNDEE.—Messrs. The Ladywell Calender Works Co., Ltd., are adopting electric drive, and part is already installed; while the Ogilvie Street Engineering Works (Thomas C. Keay) have this week installed a complete installation of electric power and lighting. In both these cases the city supply is being drawn upon.

GOSPORT AND ALVERSTOKE.—The Urban District Council have decided to accept the Electric Lighting Co.'s tender for lighting several streets, in most cases replacing gas. The price agreed upon for 120 c.p. lamps was £3 7s. 6d., and for 300 c.p. lamps £8 per annum. According to a special clause the company are to provide columns and lamps and keep lighted and maintain the lights from sunset until midnight six nights per week and from sunset to 11.30 Sundays in 10 positions along the Fareham-road for the sum of £18 10s.

GREYSTONES (Ireland).—The parish is about to be lighted by the Greystones Electric Light Co., Ltd., at a cost not to exceed a rate of 3d. in the £. The local Carnegie Library is also to be lighted by electricity.

HEMEL HEMPSTEAD.—The Rural District Council have finally decided to "grant to the Chesham Electric Light & Power Co., Ltd., of a Provisional Order in respect of an extension of their existing area of supply to include the Borough of Hemel Hempstead and the parishes of Bovingdon and Kings Langley."

KEIGHLEY.—Mr. J. M. Smyth, borough electrical engineer, is carrying out considerable extensions to cope with the increasing demand for power in textile factories, both spinning and weaving. It has been decided not to extend the direct current supply, but to instal an alternating current supply at 6,000 volts. There will be laid down two turbo-alternators of the horizontal Curtis type, each of 1,000 kw. capacity running at 3,000 r.p.m., separate condensers being fitted to each turbine. A motor-generator of 300 kw. capacity and a high-tension switchboard will also be added. Steam will be generated by two water-tube boilers, each having an evaporative capacity of 20,000 lb. of steam hourly. The current will be transmitted by three-core mains, paper-insulated and lead-covered, and will be transformed as required on the consumer's premises. The area of supply is approximately 3 miles long by 2 miles wide. It is considered that there are good prospects of a demand for power. One new textile mill is being erected in the town, and several existing mill owners are contemplating a complete or partial change to electric driving. About £15,400 will be spent on the generating plant, £1,000 on transformers, £200 on servers, and £4,340 on mains. The Local Government Board's sanction for this expenditure has been secured.

LLANTWIT.—The Rural District Council are in treaty with the Electrical Power Co. for the electric lighting of the village.

LONDON.—The London County Council have acceded to the application of the St. Marylebone Borough Council to borrow £20,900 for extension of electric light mains, the sum to be repaid within 25 years. To the application of the Woolwich Borough Council to borrow £3,600 for electric lighting, as to £2,100 for purchase of premises by equal payments as to £1,990 within 30 years, and as to £110 by equal payments within 18 years, and as to £1,500 for alterations to structure and fitting up showroom by equal payments within 10 years, in each case from the date of the borrowing. To the application of the Southwark Borough Council to borrow £3,330 for electric lighting, as to £1,200 for erection of battery room within 50 years, as to £1,000 for mains within 30 years, as to £80 for switchboard panels within 20 years, as to £600 for house services within 12 years, and as to £450 for meters within 10 years, in each case from the date of the borrowing.

LONDON, STEPNEY.—The Borough Council are applying to take up the loan of £7,100 granted by the London County Council last year for extensions at the Limehouse Electricity Station; and to apply for a further loan of £13,000.

LUTON.—The Corporation electricity is doing well. At the last meeting of the committee it was reported that there were applications for 970 additional lamps and 20 h.p. in motors.

MANCHESTER.—The Corporation are installing electricity throughout their Women's Lodging House in Ashley-lane.

MANSFIELD.—It has been decided to extend the municipal electricity plant, and to procure the most powerful additional equipment that the available space will admit of. A full report is to be drawn up, when specifications will be prepared.

NEWPORT (Mon.).—It is proposed by the Corporation to raise a loan of £34,000 for electricity department extensions, including much new plant at the Corporation-road power station, and new cable over Newport Bridge. Meanwhile, the price of electricity has been raised one halfpenny per unit, but a discount of 5% is to be allowed on all accounts promptly paid.

PLYMOUTH.—A cable is to be laid in Cambridge-street at a cost of £60.

PONTYPRIDD.—The Urban District Council invite tenders for (1) electric lamps and stores, (2) paper and rubber insulated wires and cables, for twelve months ending March 31, 1911. Particulars from Mr. J. E. Teasdell, Electrical Engineer, Pontypridd.

PORT GLASGOW.—Terms have been discussed between the Electricity Committee and Greenock Corporation as to the lighting of the burgh. Port Glasgow will relinquish its Provisional Order to Greenock for a term of years, and will receive electricity (not in bulk) at prices not above those prevailing in Greenock.

RUGBY.—At a Local Government Board enquiry into an application by the Urban District Council to borrow £5,500 for purposes of electric lighting, the Clerk explained that in the contract with the British Thomson-Houston Co., who supplied the light, the Council agreed, in the event of the load exceeding 200 kw., to supply additional plant and apparatus, and carry out the necessary works. That amount was exceeded, and it was now necessary that the Council should carry out their part of the contract. The Inspector suggested that the Council should withdraw their application to borrow for meters and instruments, and pay this sum out of revenue account. This suggestion was adopted, so that it reduced the amount asked for to £5,180. The Inspector said the undertaking had made steady progress in Rugby, and he noticed there was no bolstering up of the revenue by large fictitious contributions in respect of the lighting of public offices and so on.

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SCARBOROUGH.—The Scarborough Electric Supply Co., Ltd., following the example of so many boroughs all over the country, have been organising public demonstrations of the application of electricity to cooking and other domestic purposes outside of lighting. The demonstrations have been very successful, and will probably mean a considerable accession of business.

SHREWSBURY.—A Local Government Board enquiry has been held into the Corporation's application to borrow £6,328 for their electric light undertaking. The Inspector objected to sums being included for the purchase of meters and for street lamp connections, which ought to be defrayed out of revenue, and so the amount put down for the first item was withdrawn and the second reduced.

WORCESTER.—A Local Government Board enquiry has been held into the application of the Corporation for powers to borrow, on a seven years' loan, £656, to defray the cost of a coal handling plant at the Hylton-road electricity station. The City Electricity Engineer estimated that the plant would enable them to effect an economy of £100 a year.

LIGHTING AND GENERAL—Overseas.

CHRISTIANIA.—The Storthing has voted money for the laying down of a cable between Christiania and Newcastle.

TRACTION—Home.

ABERDEEN.—With regard to the difficulty over the question of charges by the Corporation for power to the Suburban Tramway Co., it has been decided to offer the company at 1·75d. per unit, for a minimum supply of 140,000 units, on a contract for a period of five years from June 23, 1909.

HALIFAX.—A club-house has been opened in connection with the Corporation Tramways and Electricity Employees' Social, Athletic and Benevolent Society.

LEEK.—The Board of Trade have confirmed the undermentioned Order made by the Light Railway Commissioners:—Leek, Caldon Low and Hartington Light Railways (Borrowing Powers) Order, 1910, amending the Leek, Caldon Low and Hartington Light Railways Orders, 1898 to 1906.

LONDON, ISLINGTON.—The Borough Council propose to oppose the L.C.C. Bill for the re-construction and electrification of the tramway along Ball's Pond-road, on the ground that it provides for a double track the whole distance, which would involve doubling the cost as at first agreed to.

LLANDUDNO.—The question of the purchase of the tramways by the Corporation is under consideration.

PLYMOUTH.—Owing to the increasing expense of upkeep, £4,000 being spent this year on permanent way repairs, the Tramway Committee have applied to the Electricity Committee for a reduction in the charges for power. The new terms are to be 1¾d. per unit for current up to 750,000 units per annum, current in excess of that quantity to be charged for at 1½d. per unit, and that the charge to private consumers in respect of current supplied for motors be 1¾d. per unit up to 100 units per quarter, current in excess of that quantity be charged for at 1½d. per unit.

SOYLAND.—The Urban District Council have applied to the Halifax Corporation to run trackless tramcars from the present terminus at the Triangle to Rushworth. The Halifax Tramways Committee have no power to do this, but if, as is probable, an omnibus Bill is promoted in Parliament, powers to do this will be included.

TRACTION—Overseas.

CALCUTTA.—Messrs. W. T. Glover & Co., Ltd., had, we hear, a large order in hand for the supply of electric cables, etc., to the Bengal-Nagpur Railway and the Electric Construction Co., Ltd., for the supply of electric motors.

VANCOUVER, BRITISH COLUMBIA.—Large contracts have been awarded to the Canadian General Electric Co., of Toronto, for electrical machinery for the Jordan River plant of the British Columbia Electric Railway Co., and also for the plant of the Western Canada Power Co. on Stave River. In the first instance, the approximate value of the contract will be $30,000, while in the latter it will reach $150,000. For the Jordan River plant the machinery will include step-up and step-down transformers, switchboards, lightning arresters, etc., including two-thirds of the electrical portion of the machinery. On Stave River the company will instal two generators of 16,000 kw. normal capacity, and a 36,000 kw. transformer, and under full operation 30,000 h.p. will be produced. The Escher-Wyss Co., of Switzerland, will supply the water wheels for the Stave River plant, and the high tension insulators by the Thomas Insulator Co. The contracts for the switchboards and the steel towers and poles have not yet been awarded.

WESTLAND, HOLLAND.—The Dutch Ministerie van Waterstaat has entered into a contract with the Westlandsche Stoomtramwegmaatschappij, domiciled at Loosduinen, for the construction and working of various lines of electric light railway in Westland. The concessionary company will receive advances from the State and from various provinces.

CONTRACTS OPEN.

HOME.

BATTERSEA.—Borough Council.—Electricity Department.—Annual supplies. (Part., Electrical Engineer, Lombard-street Works.)

BELFAST.—Borough Council.—Annual supplies for Electricity Committee. (Part., 2s. 6d., Chief Engineer, Napier-street.) March 7.

BOLTON.—Borough Council Tramways.—Annual supplies (Part., General Manager.) March 5.

BOLTON.—Borough Council.—Annual supplies. (Part., General Manager, Tramways Department.) March 5.

BOOTLE.—Corporation.—Electric light installation at school. (Part., Borough Electrical Engineer.) March 1.

CARLISLE.—Corporation.—Two reciprocating steam engine-driven dynamo sets. (Spec., £1., Engineer at works.) March 1.

CARLISLE.—Corporation Electricity Works.—Two reciprocating steam engine-driven dynamo sets, ejector condenser. March 1.

DUBLIN.—Corporation Lighting Committee.—Extra high pressure and low pressure cables. (Spec., £1 1s., City Electrical Engineer, Fleet-street.) March 2.

FULHAM.—Borough Council.—Electrical stores (annual supply). (Part., Town Clerk.) March 2.

GRAVESEND.—Borough Council.—Annual supplies of electrical stores. (Part., Electrical Engineer, at works.) February 28.

HESTON AND ISLEWORTH.—Urban District Council.—Annual supplies of cables, meters, etc. (Part., Clerk, Hounslow, W.) March 1.

LEEDS.—City Tramways.—8,050 solid copper bonds, 6,000 sets mild steel drop forged anchor clips; also reconstruction of tramway track. (Part., General Manager.) February 28.

MANCHESTER.—Exhibition Buildings.—Wiring, incandescent lamps and fittings. (Spec., £1.) (L.), W. Davenport, Ridler-place, Holland-street, Blackfriars, S.E.) February 28.

MANCHESTER.—Corporation Electricity Committee invite tenders for the supply of high and low tension cable. Specifications from Mr. F. E. Hughes, Electricity Department, Town Hall, Manchester, February 25.

MANCHESTER.—Great Central Railway.—The directors are prepared to receive tenders for (14) electric light materials, (45) signal materials, (55) telegraph materials, and (59) wire. Samples and patterns to be seen, from February 25 to March 7, at the Public Hall, Conservative Club, Gorton-lane, Gorton Manchester. Sealed tenders by March 8.

SALFORD.—Borough Council.—Electricity Department.—Annual supplies. 32 schedules. (Part., No. 1, cables; No. 4, cable conduits, etc. No. 7, house service cut outs; No. 8, meters; No. 10, gravity type ammeters; No. 11, circuit breakers; No. 9, *maximum* demand indicators; No. 14, carbon filament lamps; No. 16, electric motors; No. 17, motor starters, 10s. each, Borough Electrical Engineer, Frederick-road Works, Pendleton.) February 28.

WATFORD.—Urban District Council.—Cables. March 1.

OVERSEAS.

HOBART, TASMANIA.—Tenders will be received at the office of the Deputy Postmaster-General, Hobart, up to noon on March 28, for the supply of 17 cordless switchboards, in accordance with Specification No. 314. Tenders must be sent in on the proper forms, accompanied by a deposit, and endorsed "Tender for Switchboards." Specifications, for both the foregoing contracts, may be obtained, and preliminary deposits paid, at the Commonwealth Offices in London, 72, Victoria-street, S.W. Copies of the specifications may be seen by British firms interested on application at the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, London, E.C.

VICTORIA.—H.M. Trade Commissioner for Australia reports that tenders are invited by the Victorian Railways Commissioners for the supply of (1) 20 tons of galvanised telegraph wire, and (2) 2,000 cast steel wheel centres. Tenders, marked "Tender for Telegraph Wire," or "Tender for Wheel Centres," will be received at the Secretary's Office, Victorian Railways, Spencer-street, Melbourne. No date to which tenders will be received is mentioned. Copies of the conditions of tender and drawings may be seen by British makers at the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, London, E.C.

TENDERS ACCEPTED—Home.

DEVONPORT DOCKYARD.—The Admiralty have accepted a tender for two 1,200 kw. direct-current turbo-dynamos and condensing plant from Messrs. Willans & Robinson, Ltd., Rugby.

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LONDON.—London County Council Educational Authority: installation of electric lighting at Cow-lane School, Rotherhithe. Johnson & Phillips, Ltd., Charlton (accepted), £236 10s.; G. Weston & Sons, Ltd., 153, Fenchurch-street, £271; W. J. Fryer & Co., Beavington Works, Paddington, £304 10s.; Edmundsun's Electricity Corporation, Ltd., Broad Sanctuary-chambers, £317; Stegman & Co., Clapham Junction, £330 10s.; F. A. Glover & Co., Ltd., Vine-street, Clerkenwell-road, £340; Simmonds Bros., Ltd., Newton-street, High Holborn, £372; the British Westinghouse Electric & Manufacturing Co., Ltd., 27, Chancery-lane, £401; Checkogram (1908), Ltd., 151, Oxford-street, £590.

LONDON.—London County Council Tramways: Supply of track rails and fastenings required for the construction or reconstruction of tramway works. Bolckow, Vaughan & Co., Ltd., Middlesbrough (accepted), £21,065; Walter Scott, Ltd., Leeds, £21,118 15s.; P. & W. Maclellan, Ltd., Glasgow, £21,981 5s.; Barrow Hæmatite Steel Co., Ltd., Barrow-in-Furness, £22,007 10s.; The Lorain Steel Co., U.S.A., £31,010.

TENDERS ACCEPTED—Overseas.

MELBOURNE.—The tender of the General Electric Co. of London, for whom Messrs. Lawrence & Hansen, of Queen-street, Melbourne, are the local agents, has been accepted by the Postal Department for the complete new equipment of the Hawthorn (Melbourne) Telephone Exchange. The price, which is subject to slight variation, is £14,317.

SYDNEY, AUSTRALIA.—The New South Wales Government Railways, Sydney, have provisionally accepted a tender for a 6,000 kw. turbo-alternator and condensing plant from Messrs. Willans & Robinson, Ltd., Rugby.

COMPANIES' MEETINGS AND REPORTS.

W. T. HENLEY'S TELEGRAPH WORKS CO., LTD.

Subject to audit, the directors of this company have decided to recommend a dividend on the ordinary shares at the rate of 15%, free of income tax, including the interim dividend of 5% paid September 1 last.

LONDON ELECTRIC WIRE CO. AND SMITHS.

The directors of the London Electric Wire Co. and Smiths recommend a dividend of 7½% (7s. 6d. per share), less income tax, on the Ordinary shares for the half-year, making 10% for the year, placing £5,000 to reserve and carrying £2,088 forward.

ASCOT GAS AND ELECTRICITY.

The report states that the profit on gas account is £4,722 and on electricity account £374. After providing for every charge against the year's working and interest on Mortgage Debenture stock and loan and the payment of an interim dividend at the rate of 5% per annum for the half-year to June 30, and setting aside £225 for reserve for renewal of plant, there remains £2,284, out of which the directors recommend a dividend at the rate of 6% per annum for the half-year to December 31, making 5½% for the year, and that the balance, £101, be carried forward.

ELECTRICAL DISTRIBUTION OF YORKSHIRE.

The report to be submitted to the shareholders at the sixth ordinary general meeting, to be held at the Hotel Metropole, Leeds, on March 1, states that after payment of interest charges the profit and loss account shows a net profit on the year of £183 13s. 3d., against a net profit of £13 2s. 9d, for the year 1908. This net profit, with £13 2s. 9d. brought forward from last year, makes a total disposable balance of £196 16s., which would be sufficient for a small dividend, but the directors recommend that this balance should be carried forward. During the year the Company has acquired the Electric Lighting Provisional Order promoted by the Sowerby Bridge Urban District Council.

GENERAL HYDRAULIC POWER.

The gross receipts of the London and Liverpool Undertakings during the year 1909 have been £130,224, as against £131,169 in 1908. After providing for interest on Debentures etc., £8,550 for depreciation and renewals, and placing £10,000 to general reserve, the balance, including £12,973 brought forward, is £52,053. The board recommend a final dividend of 2½%, making 5% for the year, a balance of £5,936 being carried forward. In order to provide for capital requirements the directors have arranged a Debenture loan for £100,000 at 4½% per annum, of which £60,000 has been issued. The company's business, both in London and Liverpool, showed expansion, while a further sum of £30,000 was received from the London County Council on account of the Millbank Station.

BRITISH ELECTRIC TRANSFORMER CO.

The report states that the accounts show that after paying all manufacturing costs and the expenses of administration there remains a net profit of £11,774 18s. 10d.; which, with the amount brought forward from last year, viz., £1,119 14s. 11d., makes a total available balance of £12,894 13s. 9d. The board recommend that this balance be allocated as follows:—(1) To depreciation reserve, £1,000; (2) to reserve account, £4,000; (3) to preliminary expenses written off, £1,266 13s. 8d.; (4) to payment of Preference dividend of 6% for the year ended December 31, 1909, £1,904 8s.; (5) to payment of a dividend of 5% on the Ordinary shares, £3,469 19s.; (6) to carry forward a balance of £1,253 13s. 1d.

HUELVA GAS AND ELECTRICITY.

The report of the directors of the Huelva Gas and Electricity Co., Ltd., for the year ended December 31 last, submitted at the meeting in Glasgow, states that the net profit for the year amounts to £3,441, to which has been added the balance brought forward, £548, making £3,989. They recommend that a dividend of 4% be declared, free of income tax, which will absorb £1,000, that there be written off for depreciation of property and assets £2,000, leaving a balance of £989 to be carried forward. The works, plant and machinery are in good order. The capital outlay during the year has been as follows:—Electric plant, £2,976; electric meters, £478; gas meters, £319; making a total of £3,773. Full benefit has not yet been obtained from the new electric plant.

NORTHAMPTON ELECTRIC LIGHT AND POWER.

The report of the Northampton Electric Light and Power Co., Ltd., for 1909, to be presented at the meeting on 24th inst., states that the depreciation account has been increased by £3,000 (out of which £500 has been written off accumulators), £500 has been added to reserve, and £300 has been written off motors. The sum of £626 will be required for the half-year's dividend on the 5% Preference shares, and the directors propose that 6½% per annum should be paid on the Ordinary shares for the half-year (making 5½% for the year). This will amount to £1,480, and there will be £1,053 to be carried forward. On January 1 next the 4% Debentures will be redeemable, and it is proposed that "4% Debenture stock" shall then be created and that all Debenture holders shall have the opportunity of taking stock in exchange for their Debentures. Notice of these proposals will be sent out in due course.

YORKSHIRE ELECTRIC POWER.

At the half-yearly meeting of the Yorkshire Electric Power Co., Ltd., at Leeds, the Chairman said that the revenue accounts showed a balance of £6,087, as compared with £2,819 in 1908. The net profit of £2,664 remained after paying interest on the mortgage capital of over £78,000, a good deal of which has been expended during this year on mains and equipment, which will bring in an increased revenue in the coming year. As a consequence of demands from power users in the eastern portion of the area of the Company, the directors decided to erect an overhead main, in duplicate, of about 12½ route miles, from Soothill Nether to Allerton Bywater, and revenue will begin to accrue from this within the next week or two. The first consumer will be a large colliery who are equipped to take a considerable supply for haulage, pumping, ventilating, lighting, and other purposes. A supply will also be given to the Distribution Co. who recently took out a Provisional Order for Castleford. This demand has compelled the directors to increase the generating plant at Thornhill Power Station.

There is a steady increase in the number of motors connected to the mains, not only by new consumers, but also by those who were connected before the beginning of the year. This is the most satisfactory evidence of appreciation of the Company's supply, and gives the directors great confidence in the future of the Company.

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NEWCASTLE ELECTRIC LIGHTING CO.

The report of the directors of the Newcastle and District Electric Lighting Co., Ltd., to be submitted at the annual meeting in Newcastle, is as follows :—The number of units sold during the year ended December 31, 1909, was 10,875,205, as against 9,182,095 sold in 1908, being an increase of 18·43% for the year. The result of the year's working is as follows :—Gross profit at Newcastle works, as per profit and loss account, £21,479 8s. ; gross profit at Lemington and Newburn works as per profit and loss account, £1,757 10s. 9d. ; transfer fees, £5 17s. 6d. ; total, £23,242 16s. 3d. ; add, balance from last year, £1,104 4s. 6d.; a total of £24,347 0s. 9d. Deduct, interest on Debenture stock, temporary loans, etc., £11,749 13s. 1d., and directors' trustees', and auditors' fees, income tax, leasehold redemption fund, etc., £1,277 17s. ; and there is an available balance of £11,319 10s. 8d. left. The directors recommend a dividend of 3% for the year ended December 31 last (less Income Tax) absorbing £8,381 12s. 6d., and carrying forward a balance of £2,937 18s. 2d. The capital expenditure for the year is larger than was anticipated at the time the last report was sent out, but owing to increased demands from different works for the supply of electrical energy for power and other pruposes, it was found necessary to lay an extra large main cable, and also to erect an additional boiler. This expenditure has already proved remunerative. The new sub-station erected at Newburn is now in full operation, and has shown excellent results. As in previous years the whole of the plant and machinery has been maintained in a complete state of efficiency.

DUBLIN AND LUCAN ELECTRIC RAILWAY CO.

At the half-yearly meeting, held in the offices at the Phœnix Park terminus of the line, Dublin, Mr. William Mooney, J.P., chairman, who presided, said the gross receipts from all sources had been £3,676 0s. 4d., which was £33 3s. 4d. in excess of those of the corresponding period of 1908—itself a "record"—whilst the expenses have been £50 10s. 3d. less. The sum available for distribution, after payment of Debenture interest, was £1,240 11s. 6d., which they proposed should be appropriated as follows :—viz., £475 in payment of the half-year's dividend on the 5% Preference shares, £350 in full discharge of the principal and interest remaining due on foot of the electrical equipment debt, and that the balance of £415 11s. 6d. should be carried forward to next half-year. By the terms of the contract with the electrical equipment contractors, Messrs. Dick Kerr & Co., they were entitled to pay them £2,920, with interest, on account of their contract by deferred annual instalments out of current revenue, and it was a very great relief indeed to the directors to know that, when they had paid the above £350, they would have completely got rid of that large debt. The entire amount, including this £350, paid out of a revenue on account of capital, since the opening of the electric line just ten years ago, was £4,793, the only set off being the temporary advance due to the bankers and ordinary trade engagements. This large outlay of revenue on account of capital had necessarily prevented the payment so far of a dividend on the Ordinary Shares, but it had nevertheless enormously strengthened the financial position of the company, and made the prospects of the Ordinary shareholders much brighter.

On the motion of the chairman, seconded by Mr. Edgar Anderson, a dividend at the rate of 5% was declared on the Preference Shares.

Captain Charles Colthurst Vesey was re-elected a director.

SOUTH METROPOLITAN ELECTRIC LIGHT AND POWER CO.

The report states that the revenue account shows a credit balance of £25,382 4s. 7d., which, with £6,492 16s. 8d., the balance brought forward from the last account, makes a total of £31,875 1s. 3d. After deducting £10,963 6s. 8d. for interest on debenture stock paid and accrued, and for other interest, £5,003 17s. 7d. for interim dividend paid on the 7% cumulative first preference shares, and £484 18s. 7d. for interim dividend paid on the 6% cumulative second preference shares, there remains a balance of £15,422 18s. 5d., which the directors recommend be dealt with as follows :—To payment of final dividend to December 31, 1909, upon the 7% cumulative first preference shares, £5,003 17s. 7d. ; to payment of final dividend to December 31, 1909 upon the 6% cumulative second preference shares, £1,312 10s. ; to credit of depreciation account, £6,500 ; to credit of preliminary expenses, £1,500 ; and that the balance of £1,106 10s. 10d. be carried forward to the next account, making a total of £15,422 18s. 5d. The increase in the number of new orders has been maintained, but the revenue is less owing to the great saving to consumers of lectricity by the increasing use of metal filament lamps. Energetic steps have been taken to bring the advantages of the electric light before occupiers of smaller properties in the thickly populated districts, and also to develop the more general use of electricity. Model houses have been opened at Hither Green and Catford, which have excited public interest and have formed the subject of numerous articles in the press. A large number of local residents and others have visited these houses, and the directors are pleased to report that new orders are now being obtained more rapidly than hitherto. In order to meet the requirements for supply in an adjoining district, the West Kent Electric Co., Ltd., was registered, and has taken over certain of the powers of the Kent Electric Power Co., Ltd., for an area between Northfleet, Sevenoaks, and London. An agreement has been entered into to give a bulk supply, and arrangements have been made for the company to work the undertaking and to subscribe £10,000 share capital of the West Kent Electric Co., Ltd., one half of which will be called up and will be used for repayment of disbursements made by the company and for laying mains for the supply of electricity for lighting and power in part of the Bromley Rural district, where a number of orders have already been obtained.

NOTTING HILL ELECTRIC LIGHTING CO., LTD.

The 20th annual report for the year ending December 31 last states that the expenditure on capital account at the date of the last balance sheet stood at £237,742 13s. 3d., and has been increased during the past year by £3,709 3s. 2d., thus it now stands at £241,451 16s. 5d. The expenditure on capital account exceeds the receipts by £33,451 16s. 5d. The cost of the joint station to date has amounted to £221,197 10s. 1d., and joint debenture stock amounting to £222,000 has been issued. This stock is subject to a cumulative sinking fund, which now amounts to £34,765 15s. 3d. invested in trustee securities. In 1891, with an equivalent of 8 c.p. lamps 6,056, in use there was a loss of £554 18s. 6d.; while last year, with an equivalent of 180,903 lamps, there was a profit of £20,858 19s. 3d. The number of consumers is now 3,021, and, with the exception of 36, are supplied at 200 volts. The gross revenue for the year was £39,878 6s. 2d., showing an increase of £976, and the total net profit was £20,858 19s. 3d. From the net profit of £20,858 19s. 3d. have to be deducted the following sums :—Depreciation, renewal and reserve fund, £3,000 ; debenture and other interest, £2,440 3s. 11d. ; Kensington and Notting Hill joint debenture stock : Interest, £2,400 17s. 3d. ; Sinking Fund, £1,408 18s. 4d., or a total of £9,249 19s. 6d., leaving a balance available for dividend of £11,608 19s. 9d. The directors recommend that this be appropriated as follows :—In payment of the usual dividend of 6% (less income tax) on both the Preference and Ordinary shares and that the balance be divided in accordance with the Articles of Association, one-half being credited to the Founders' shares and the other half to the Ordinary and Preference shares. This will enable a further 1½% to be paid on both Ordinary and Preference, with a distribution of £3 10s. per share on the Founders' shares. An interim dividend of 3% was paid to the holders of the Ordinary shares on July 1, and the balance of 4½% will be paid forthwith, together with the distribution on the Founders' shares. The Preference shares having received their full 6%, the 1½% bonus will be added to the interim dividend on these shares, to be paid on July 1 next. The amount paid in rates to the local authorities was nearly £3,500, equal to 2½% on the share capital. The quinquennial assessment is about to be made, and the directors are taking measures to safeguard the interests of the company, but until there is some alteration in the law under which machinery is liable to assessment, and limited companies have no votes, shareholders must expect to find a large portion of their profits handed over to bodies, in the election of which they have no voice. The London Electric

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Supply Bill was introduced during the year by the Board of Trade, to transfer the rights of purchasing the company's undertaking from the Kensington Borough Council to the London County Council. The Bill did not pass owing to pressure of Parliamentary business. It is being introduced again this Session, and the directors see no reason for opposing it. The directors have under consideration arrangements for utilising for the benefit of the company, the powers conferred by the Act, passed in 1908, containing facilities for combination.

WASTE HEAT AND GAS ELECTRICAL GENERATING STATIONS, LTD.

The report states that the profits earned by the company during the year, after deducting administration and other expenses, and an amount of £255 18s. 11d. for interest on calls on shares paid in advance, amount to £16,475 6s. 7d. Out of this sum the directors have transferred to reserve for depreciation and other purposes, £4,000; and have also written off the brokerage paid on the issue of capital in February last year, £865 2s. 6d., making £4,865 2s. 6d., leaving a balance of £11,610 4s. 1d. To this balance there must be added the amount brought forward from the previous year, £912 12s. 3d.; making a total of £12,523 1s. 4d. The directors propose to declare a dividend at the rate of 7% for the year, to be paid on the share capital from the dates on which it was called and paid up to January 31, 1910, which will absorb £8,919 16s. 9d. (Out of this an interim dividend was paid in August, 1909, amounting to £2,749 12s. 11d.), leaving a balance to be carried forward of £3,603 4s. 7d. It is proposed to pay the balance of the dividend on March 1, 1910, less income tax. The Weardale and Newport generating stations have been running satisfactorily and to their full capacity throughout the year. The Tees Bridge generating station, although completed in the early part of the year, has not yet been running regularly, but it is hoped that the company will derive full benefit from this station also in the coming year. The expenditure on capital account during the year has amounted to £13,940 12s. 4d., and other available cash in hand has been deposited at interest with contractors on account of the contracts not yet entirely completed. The company also applied for, and were allotted, 19,996 shares of £1 each in the Bankfoot Power Co., Ltd., in accordance with the agreement referred to in the last report, and this investment, which was taken up in March, 1909, has already yielded a satisfactory return. As a result of the prospectus which was issued by the directors in February, 1909, inviting subscriptions for £65,000, the whole of which was taken up, the issued and subscribed capital of the company is now £150,000 shares of £1 each. Under the company's agreement with the Weardale Steel, Coal and Coke Co., Ltd., that company are now entitled to apply and pay for in cash at par 10,000 £1 shares in this company. This application having been received, and in order that the shares may be forthwith allotted, the directors propose to increase the authorised capital of the company by a further £100,000, £10,000 of which will be issued to the Weardale Steel, Coal and Coke Co., Ltd. The balance will only be issued when required for the further development of the company's business. The shareholders will be asked to pass a resolution to authorise this increase of capital at the general meeting. A contract has been entered into for the extension of the Newport generating station, which will provide a further 1,600 kw. of plant capacity.

LONDON ELECTRIC SUPPLY CORPORATION.

The report states that the profit on the working for the year is £50,686 0s. 11d., against £53,209 last year. To this has to be added the amount brought forward, viz., £3,408 0s. 4d., less interest on temporary loan, viz., £2,569 2s. 9d., making a total of £51,524 18s. 6d. Out of this the interest on Debenture stock to December 31, viz., £15,494 4s., has been paid, leaving a balance of £36,030 14s. 6d. to be appropriated. The Board propose to deal with this amount as follows:—Payment of a dividend of 6% on the Preference shares (of which an interim dividend of 3% was paid on September 1, 1909), viz., £20,952; payment of a dividend of 2% on the Ordinary shares, £6,660; to reserve account (making a total of £67,500), £5,000; and to carry forward, £3,418 14s. 6d. The supply has been efficiently maintained during the year. The number of units sold amounted to 10,308,537, as against 13,160,130 last year. The contract with the London County Council for the supply of power for their tramways expired in June last. The number of units supplied to them for this purpose during the year was 994,500, as against 5,401,500 last year—a decrease of 4,407,000 units, amounting in gross receipts to £16,158. Considering this large decrease, the Board think the result of the year's working, which only shows a decrease in revenue of £2,523 as compared with last year, is satisfactory. This is largely owing to the greater efficiency and economy in working. The London, Brighton and South Coast Railway opened their new electric service to the public on December 1 last. From that date until now the power supply has been maintained without a failure or mishap of any kind. The following is an extract from the Earl of Bessborough's speech at the general meeting of the railway held on 2nd inst.:—"He believed he was right in saying that this was the first recorded instance where electrical traction, established on an ordinary steam railway had worked from the commencement so smoothly and uninterruptedly, and in this connection it was only fair to acknowledge the ready co-operation and help of the London Electric Supply Corporation, the contractors for the supply of current, and the efficiency and regularity with which their part of the task had been performed." The safety, economy and efficiency of the single-phase system having been so satisfactory, the railway company are considering the electrification of other portions of their system, and negotiations are now proceeding with them for a further contract for supply of power for such extensions. The plant and machinery have been maintained out of revenue, and are in an efficient condition.

COMPANIES REGISTERED.

British Electro-Metallurgical Products Co.—£100,000 (£1) (60,000 7% non-cumulative preferred Ordinary). As title. The signatories are: W. L. Madgen, Falcon Works, Loughborough, electrical engineer; J. J. Stuntze, Falcon Works, Loughborough, electrical engineer; C. J. Head, F.I.C., 25, Victoria-street, Westminster; W. D. Rock, 62, Leadenhall-street, E.C., engineer; J. R. Easton, C.E., 25, Victoria-street, S.W.; R. O. Ahliss, A.M.I.C.E., A.M.I.M.M., Holly Bank, Godalming; W. G. Jarrett, Holmleigh, Holden-road, Woodside-park, N., retired bank accountant (one share each). Minimum cash subscription, £1,000. The directors are to number not less than three nor more than seven. C. J. Head is one of the first. £250, £300 each per annum (chairman £400) and 2½% of the surplus profits available for dividend after 7% has been paid on the Ordinary shares, divisible. 25, Victoria-street, Westminster.

TRADE NOTES.

The British Thomson-Houston Co., Ltd., electrical engineers and manufacturers, Rugby, have opened a Branch Office at Royal Chambers, Cardiff, to care for their business interests in the South Wales district.

BRISTOL MISHAPS.

In connection with the interruption in the single phase supply on Friday, February 18, Mr. H. Faraday Proctor, the city electrical engineer, issued the following report to his committee:—"The switchboard is divided into two different sections so that any machine may be coupled to either section. This is arranged so that, should any accident occur on one section, the machine can run on another section. On the switchboard, to enable a machine to be run on the two sections alternatively, there must be a piece of apparatus common to both sections. This is what we may term a selector switch. That is to say, a switch by which you can select which section a machine is to be run upon. Unfortunately, it was this very switch which broke down and the two sections were joined together by the broken portion, which also made a contact with the common mass of earth, and it was not until this was localised and all connections to this switch were severed, that the whole of the supply was put on again. No damage was done at the works apart from the one switch and the whole of the trouble consisted in the inconvenience and the annoyance caused to our consumers."

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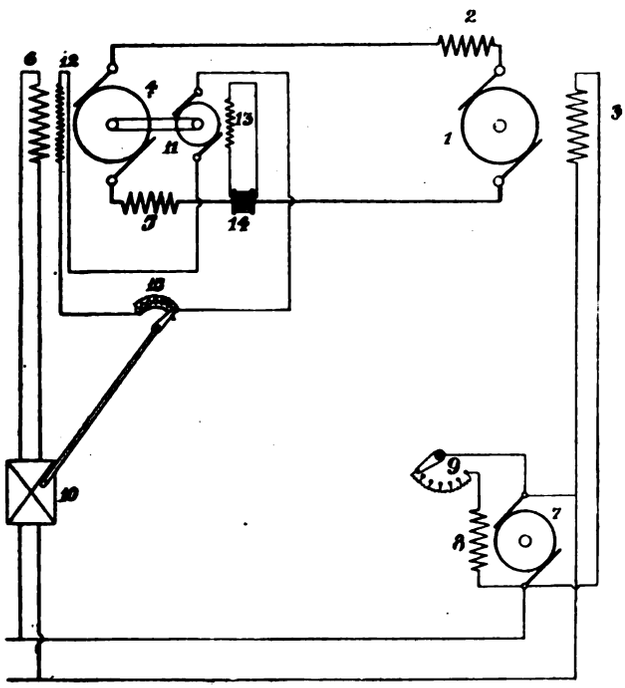
PATENTS.

Electric Systems for Power Transmission.

11339.—1909. ALLGEMEINE ELEKTRICITATS-GESELLSCHAFT, Berlin. In the known control system in which the speed of the motor is regulated by varying the exciting field of a starting generator, the speed of the motor is not always the same for various positions of the controller, with the disadvantage that the regularity and reliability of the plant are undesirably affected. This is specially noticeable in systems such as winding engines having automatic starting and retarding devices and load equalisation by means of fly wheels. The cause of the various disturbances on the one hand resides in the fact that the working motor supplied with constant potential suffers a certain drop in speed with increase of load in consequence of the internal losses and armature reaction. While on the other hand the potential supply to the motor from the starting machine falls with increased current owing to the armature reaction and internal losses of the starting generator, and also in this case in consequence of the dropping in speed of the latter. The result of these defects is that at heavy loads the control lever must be moved over excessively before the cage is put in motion. Moreover, with a drop in speed of the starting machine during the time when the control lever is full on, the winding or working speed does not remain constant but gradually falls. Again, with retardation or braking the cage or other apparatus does not come to rest exactly at the desired point, but with heavy loads will stop short, while at light loads will overrun, so that the operation of the brake is accompanied by a shock. By this improved system it is not only possible to make the potential of the starting generator independent of the current strength, but to so raise it that the speed of the working motor is made as nearly as possible dependent upon the position of the control lever. In the diagram, 1

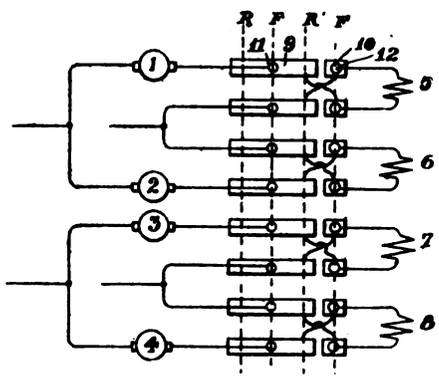


indicates the winding or other working motor of a power transmission system, 2 the compensating or auxiliary pole winding in series with the armature of the motor, and 3 the separately excited field winding. The starting generator 4 is also provided with a compensating winding 5 and a separately excited winding 6. The exciter 7 supplies both the motor winding 3 and the generator winding 6 and its field 8 is regulated by means of resistance 9. The control switch 10 in the circuit of winding 6 is for controlling the starting generator 4 and by means of this switch the speed and direction of rotation of the working motor 1 are determined. The starting generator is provided with an additional separately excited field winding 12, fed from an auxiliary machine 11, the field winding 13 of which is shunted across resistance 14 in the main circuit. As the current of the latter circuit increases the excitation of the auxiliary machine 11 is increased, whereby the excitation of the generator due to winding 12 is also increased, and if the parts are suitably proportioned the result is obtained that the potential of the starting machine increases to such a degree that the rotation speed of the winding motor remains constant independently of its load. If the starting machine were not saturated this result could be obtained at all speeds, but in consequence of the saturation of the starting machine the additional excitation is more effective at low speeds than at high speeds. In order to overcome this defect a regulating resistance 15 is inserted in series with a winding 12 and arranged so that this resistance is regulated by the controller 10. A resistance 15 is shown in the drawing in the armature circuit of the auxiliary machine 11, but in the alternative said resistance may be arranged in the circuit of the exciting winding 13. The first mentioned connection is, however, preferable, because the influence of the residual magnetism of the auxiliary machine at low speeds is less effective. The system operates in the manner described when the starting machine acts as a generator to supply the winding motor. If, however, the latter machine operates as a generator, as, for instance, during retardation, then the potential generated by the auxiliary machine reverses and the field winding 12 excites the starting generator in the right direction, that is to say, not so as to strengthen the field of the machine 4 but to weaken it. When the starting generator is reversed by the controller the current also reverses in the field winding 12, and is again energised in the proper direction with respect to field winding 6. The auxiliary machine 11 is shown arranged upon the generator shaft. In each case in which the starting machine suffers only a small or no speed variation, the device described practically operates to make the winding speed at all speeds independent of the current strength and in identical dependence upon the position of the control lever. On the other hand, when large variations in speed take place, other means of regulation must be employed.

Control of Electric Motors.

20246.—1909. BRITISH THOMSON-HOUSTON CO., LTD., London. In electrically driven railway cars or locomotives in which four driving motors are employed, the motors are often normally operated in two pairs, the motors of each pair being always connected in parallel with one another. With such an equipment the pairs of motors are first connected in series and then in parallel, thereby giving what is called "a series parallel" and "full parallel" operation. In these systems it has been the custom to reverse the motors by reversing the armatures with reference to the fields of the motors, this being accomplished by opening the armature circuit and closing it again in reverse connection with reference to its field. It has also been the custom under emergency conditions for the operator to throw his reverser to the reverse position, thereby connecting each pair of motors in a closed circuit and allowing one to act as a generator to pump current through the other motor acting as a motor. This action will take place owing to the residual magnetism in the fields of the motors and to the fact that as the fields are never exactly the same the voltage of one motor will be higher than the voltage of the other, and current will commence to flow from one to the other through the closed circuit established by the reversing switch. It has been found that when a control system of this kind is operated in this manner, if the operator throws his reverser back again to its original position before the car has come to rest, the interruption of the current flowing in the closed circuit through each pair of motors will cause serious arcing at the contacts of the reverser owing to the fact that the closed circuit is interrupted during the process of reversal.

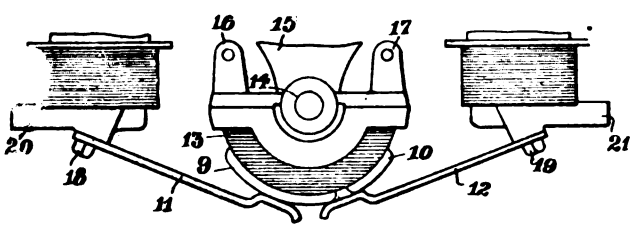
Fig. 1



This invention consists in providing an improved method of reversing two or four motors while operating in parallel and acting as a brake so that the burning of the contacts during reversing will be effectively prevented. Fig. 1 shows four motors and a reversing switch for controlling the motor connections, and Fig. 2 is an end elevation of a portion of the reversing switch showing the relation of the segments and fingers. In Fig. 1 the armatures of the motors are shown at 1, 2, 3 and 4 and their series fields at 5, 6, 7 and 8. The drum of the reverser, which is shown developed in the usual manner, is provided with eight pairs of segments 9 and 10 arranged, as shown, in four groups in which the segments are cross-connected, as clearly indicated. With these segments, co-operate fingers 11 and 12 connected, as shown to the circuits leading to the armatures and fields. In the forward position, the fingers engage with the segments on

the lines F F, as shown, while in the reverse position the fingers and segments engage on the lines R R. The middle lines F and R may coincide if it is desired to keep the angular movement of the switch small. The space between the segments 9 and 10 is made small enough so that the fingers 12 will, for an instant while the drum is moved from its forward to its reverse position or *vice versa*, bridge the space and connect the segments 9 and 10 so that the reverse connections are made while the original connections still exist and the latter ultimately interrupted. In Fig. 2 the drum of the reverser is shown at 13 pivoted on a shaft 14 mounted in a frame 15, the operating mechanism, which is not shown, being attached to the lugs 16 and 17. The drum 13, which may be of insulating material, carries the segments 9 and 10. The fingers 11 and 12, which co-operate with the segments 9 and 10, are secured by bolts 18 and 19 on the

Fig. 2



side frames 20 and 21. As shown in Fig. 2, the reverser drum is in its mid-position and finger 12 is bridging the gap between the segments 9 and 10. From an inspection of the diagram of Fig. 1 it will be clear that in the forward position of the reverser the motors of each pair will be connected in parallel with one another with their fields and armatures in a certain relation, while in the reverse position of the reverser the motors will be connected in parallel with their fields reversed in relation to their armature. It will also be clear that in throwing from one position to the other the fingers 12 by bridging the gaps between the segments 9 and 10 will for an instant short circuit the fields, thereby obtaining the results explained above.

Wireless Telegraphy.

11544.—1909. MARCONI'S WIRELESS TELEGRAPH CO., London. The object is to provide means for readily ascertaining with great precision the bearings of a station from which signals are emanating. For this purpose two directional aerials are employed at the signalling station. These aerials are set at an angle to one another. A switch is provided for connecting the receiving apparatus to each of the two aerials. With such an apparatus the signals received in the two positions of the switch will be of unequal strength unless the transmitting station lies in a certain direction, and this direction, if the two aerials are similar will bisect the angle between them. Provided this angle is sufficiently large the direction of equality may be determined with great precision since the strength of the signals will then change rapidly with the angle.

Current Collectors for Electric Traction Systems.

11947.—1909. E. M. MUNRO, London. The trolley head is mounted upon a bridge piece carried by the upper extremities of two trolley arms. The lower ends of these arms are secured in sockets formed on two levers pivoted to the trolley base, the distance between the pivots being equal to that between the points where the upper ends of the arms are pivoted to the bridge piece of the trolley head. The arrangement thus forms a parallelogram and the bridge piece carrying the trolley head remains approximately parallel to the trolley base whatever the angle of inclination of the two trolley arms may be.

Telephone Exchanges.

13749.—1909. SIEMENS BROS. & Co., Westminster. In telephone exchanges in which, for the purpose of listening-in, branch leads from the plug cards are connected with the exchange clerk's telephone by means of switches, the switches have one member adapted to be removed. The clerk has only one removable member for all the switches at his operating position so that multiple listening-in is prevented.

Magneto Electric Machines.

14153.—1909. E. TRICKE, Sandusky, U.S.A. The armature of bipolar magneto-electric machines has a disc which serves as the current collecting ring at one end. At the other end of the armature there is a current collecting ring supported on an insulating disc and held in position by a second insulating disc.

Electrolytic Cells.

6872.—1909. BRITISH THOMSON-HOUSTON CO., London. In electrolytic cells of the aluminium type the electrolyte consists of a solution of a mixture of borates and tartrates to which a certain amount of glycerine may be added.

Maintaining a Constant Voltage in Electric Lighting Systems.

442.—1909. A. CRAVEN, Sheffield. The system is principally designed for use in connection with electrical lighting of railway carriages. An ordinary shunt wound dynamo is employed in combination with an improved form of reversing switch. In order to compensate for the varying speed of the train and to operate a cell charging switch a solenoid has been introduced which at any predetermined voltage not only puts the cells on charge but also continues to regulate the output of the dynamo by inserting a proportionate amount of resistance in the shunt circuit. The solenoid also cuts a resistance into the lighting circuit at the same time as the cells are put on charge and the lamps coupled with the generator mains of the system. By the increase of electrical efficiency obtained with this invention the power previously absorbed in the friction due to the slipping of the belt is now utilised for the purposes of ventilation and heating in addition to lighting. Moreover, fewer accumulators are required in the system, whereby a reduction in first cost and maintenance is effected.

Dynamo Electric Machine.

693.—1909. M. WALKER, Hale. The machine has a star wound armature with the outer ends of its coils connected to the bars of a commutator. Each individual coil has a pitch greater or less than the pole pitch so that the flux from a pole of the machine excited by the current from a particular group of coils produces a proper commutating electromotive force in those coils.

Gun Sighting Control.

984.—1909. A. T. DAWSON, Westminster. The electrical transmitting apparatus is provided with calibrating gear for controling the sighting of guns. The calibrating lever is provided with two slidably mounted setting members capable of adjustment relatively to each other and also to the lever, and may also be secured together at any predetermined distance apart. Either of the members may be connected to the mechanism for imparting the additional movement of the transmitter pointer.

Axle Boxes of Electrical Cars.

1031.—1909. C. J. CONATY, Birmingham. Each of the top radial guides of the axle box has two or more inclined surfaces at both sides of its centre line made to slope upwardly and downwardly to the centre line at about 1 in 40. The top of the inner axle box is correspondingly formed with inclines so that when the inner axle box moves either to one side or to the other on its radial centre line, its inclined upper surfaces will have a full bearing on the top radial guide at both sides of the axle.

Metallic Conduits for Electric Wiring.

4560.—1909. F. W. BAYLISS, Edgbaston. The bend or other fitting for the metallic conduit is formed from a pair of sheet metal sections, one of which is joined around its edges with upturned flanges and the other with narrower plain flanges capable of being placed between the upturned portion of the flanges of the first mentioned section. The two portions are united by closing the flanges of one part over those of the other.

Apparatus for Producing Electric Power.

6317.—1909. P. C. DAY, West Drayton. The apparatus comprises a gas producer with gas engines, steam boilers, thermal storage vessels and steam engines arranged in such a manner that the steady portion of the demand for power is supplied by the gas engines working from the producers direct, whilst the fluctuating portion of the demand is provided for by means of steam engines supplied with steam from thermal storage vessels heated by live steam from gas fired boilers consuming gas from the producers.

Electric Prepayment Meter with Alarm Switch.

7005.—1909. J. H. BOWDEN, Poplar. The mechanism for giving an audible warning consists of an escapement operated by a train of wheels which are set in motion by a spring, a trip lever and catch connected with the switch arm, a pin on the trip lever and a fixed surface. The escapement is released by a trip wheel connected with the differential gear of the meter.

Armoured Conductors.

7706.—1909. W. SCHMAHL, Teddington. The armoured conductor for portable electrical purposes comprises an insulated conductor and an outer cover in combination made of cotton cords covered with rubber. The cords are plaited together and the whole body is then vulcanised.

Electric Junction Box.

9971.—1909. W. SCHMAHL, Teddington. The box has an exterior and interior grooved packing rim filled with a permanently plastic packing to such an extent as to protrude well above the top face of the rim so that when the cover is screwed down the packing is squeezed out and forms a waterproof packing joint between the packing rim and the cover.

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An Illustrated Record and Review of Electrical Progress.
WITH WHICH IS INCORPORATED "ELECTRIC LIGHT."

Old Series, Vol. LI.
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NOTES.

MINE DANGERS.

Lecturing on "The Electrical Ignition of Coal Dust," before the South Staffordshire and Warwickshire Institute of Mining Engineers, Professor J. Cadman, D.Sc., of the Birmingham University, said that from his own experiments he felt sure that every dust had its critical degree of fineness for minimum ignition. He was inclined to place the danger of direct ignition of coal dust by electrical means much higher than many mining engineers, but he agreed with Mr. Garforth when he pointed out to the British Coal Dust Committee that stone dust has a most valuable property as a dampener of coal dust. He thought that there was little doubt that the careful spreading of stone dust on all roads where electric cables passed would be a simple and efficacious way of preventing ignition of dust by accidental sparks from the underground cables.

BOILERS.

Mr. W. H. Patchell, M.I.E.E., speaking before the Ipswich Engineering Society, declared that it was his opinion that there was a general tendency to put down too small boilers in electricity generating stations. He was convinced that better economy in equipment of works could be secured by putting in boilers of a large size. He had adopted this principle in equipping the Charing Cross Electricity Co.'s Bow Station with excellent results; that was a case where he had used reciprocating engines, and had seen the output grow from 300 kw. to 4,000 kw. Questions as to the choice of boilers must, of course, depend to some extent on individual equipments, and on local conditions. In large towns, subject to visitations from black fogs, where electricity is chiefly required for lighting purposes, and where space is limited, compact boilers, able to raise steam quickly from cold water if necessary, are desirable; but in other places where demand is more uniform, and space is not such a big consideration, the Lancashire type of boiler possesses special advantages that are very attractive to the practical engineer. Certainly such boilers have long lives, are economical in firing, and easy to work, inspect and clean. The latter are great points where economy as regards staff has been strictly observed. The boiler must, in other words, be considered in connection with the class of station and its probable stress of work, rather than one type being specified in all cases. Apart from this, Mr. Patchell's warning as to under-estimating of boiler capacity for a station should not be overlooked.

ELECTRICITY ON BOARD SHIPS.

Electricity is being pretty freely used on the two huge White Star liners, the *Olympic* and *Titanic*, now fast approaching completion in Harland & Wolff's shipyard, Belfast. Lord Pirrie has taken a very keen and active part in the building of these two vessels, which will each have a gross tonnage of about 45,000, or an advance of some 12,000 tons upon any other Atlantic monster. The vessels are divided into 33 steel compartments, which are separated by heavy bulkheads. These doors can be closed by one operation from the bridge by means of an automatic device, and by the aid of coloured electric lights the officer on the bridge will be able to tell at a glance whether or not the doors are closed. Similar elaborate arrangements will be made for the prevention of fire and the extinguishing of the flames should an outbreak unfortunately take place.

A NEW ATLANTIC CABLE.

"Wireless" telegraphy, progressing apace though it be, has not really cut into the business of the cable companies. This is shown by the returning prosperity to cable manufacturing companies as revealed by the improved financial position of W. T. Henley's Telegraph Works Co. and the Telegraph Construction and Maintenance Co.; but more particularly by the laying down of a new cable between England and America by the Commercial Cable Co., making the sixteenth so laid, and the sixth owned by this Company. Mr. George Ward, the vice-president and general manager of the Commercial Co., explains that, in spite of the many improvements tending to accelerate transmission, they are at times unable to cope with the rush of business.

CABLE AND "WIRELESS" CO-OPERATION.

It looks as though there is plenty of room for both systems, and while the "wireless" can render services quite beyond the scope of cables, yet there are occasions when the former is benefited by the co-operation of the latter. A most striking illustration of this is told by Dr. F. H. Bowman. He was communicating with a ship in mid-Atlantic by radio-telegraphy, but presently the ocean greyhound raced too far away, and the "wireless" was powerless. As the question was important, however, the message was cabled across to America, and thence re-transmitted to the liner by "wireless," to the satisfaction of everybody.

VISIT OF AMERICAN ENGINEERS.

The ready respondance of members of the American Society of Mechanical Engineers to the invitation of our Institution of Mechanical Engineers to come over and take part in the meeting to be held at Birmingham in July, will give much pleasure. Among those who are coming over are Mr. George Westinghouse and Mr. William B. Potter, chief engineer of the railway and traction department of the American General Electric Co. These two will be responsible for a paper on "The Electrification of Railways," which will be sure to attract widespread attention. It would appear that the electrical side of engineering will exercise quite as much interest on the part of the visitors as will purely mechanical subjects.

ROLLING MILL AND ELECTRIC DRIVE.

Writing about the merits of the electric motor for driving rolling mills—pointing out its economy, precision, and safety as compared with steam driving—our contemporary the Chicago *Electrical Review* says: "It is a significant fact that not only are most of the new mills being equipped with electric drive, but many of the older mills are scrapping their old steam-driven plant and substituting, therefore, the electric drive." This is a move that should be noted for imitation over here. As our friends point out, the electric drive permits of far greater accuracy and control of every motion, although certain problems still remain to be solved. One of these problems, we learn, was adroitly solved by Mr. B. R. Shover during the electrical equipment of the Gary Rolling Mills. The question was to design the flywheel effect necessary to overcome the excessive loads on the immense 2,000 and 6,000 h.p. motors. He got over the difficulty by attaching heavy cast steel rims to the rotor spiders, these rims being replaceable by others of different weights. Good results were obtained and smooth running achieved.

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THE BENEVOLENT FUNDS.

Everyone will rejoice that the Electrical Trades' Benevolent Institution's dinner should have turned out such a success. Dr. Gisbert Kapp had very influential support, in spite of the unavoidable absence of many leading men connected with different branches of the industry. The Benevolent Institution, so ably managed by Mr. Davenport and his committee, is on a sound basis and doing excellent work. It is quite natural that they should be anxious to extend its usefulness by introducing the granting of pensions, but this is a big undertaking, and should not be attempted until every aspect of the question has been carefully thought out and adequate support assured. One way of obtaining greater security has been suggested: the amalgamation of the benevolent fund of I.E.E. with the other. Mr. Mordey favoured this suggestion, but Dr. Kapp and the majority of the I.E.E. Council are against the proposition. After all, their aims are somewhat different, and there is room and need for both. The I.E.E. fund is restricted to members, and is meant chiefly for those of the professional class; the E.T.B.I. is more open, but in effect leans more towards those who are connected with the manufacturing and commercial sides of the industry. Considering the uncertainty of all mundane affairs, as we said there is room and need for both organisations.

IMPROVED ELECTRO-PLATING.

Mr. W. Lascelles-Scott, of the Chemical and Physical Laboratories, Little Ilford, has written a letter dealing with Mr. Rosenberg's "Galvanit" process of powder electroplating. It appears that Mr. Lascelles-Scott had been experimenting along these lines for some time past, owing to his having noticed that an experimental form of dynamo, with hardened steel surfaces and flattened copper-wire brushes, had become "coppered." As a result of observation and direct experiment, he found that this was the result of the presence of a number of zinc castings in the damp atmosphere of the laboratory, the dynamo being found to be covered with a fine dust of metallic zinc. The chief aim of the correspondence, however, is to point out that the depositing of metal is materially improved by the passing of a weak voltaic current (from a single Leclanché or ordinary "dry" cell) to the object treated during the rubbing process. Under these conditions, the correspondent thinks, "Galvanit" might well become of commercial importance, especially in the treatment of all objects with undercut parts. In such cases, Mr. Lascelles-Scott uses not "rubbers," but a modification of the "sand-blast" process for projecting the powders, kept dry, on to a moist surface connected with the cell.

RUBBER SHARE BOOM.

The remarkable outcrop of rubber plantation company promotions, and the readiness with which the public are subscribing, would look rather hopeful for the future of the electrical industry. However, many of the companies recently floated are foredoomed to failure, for various reasons, among others, that in some cases, owing to the cost or other difficulties connected with labour, they will not be able to stand any serious fall in prices. It is interesting to find experts estimating the output of plantation rubber by the year 1920 as anything between 34,000 to 100,000 tons. Mr. Robert Bethune, chairman of the Rubber Growers' Association, has just declared that a fall in prices is almost sure to come, though he qualifies this boon by pointing out the wonderful increase in the outlet for rubber—for motors, electrification of railways, flooring, and even aeronautics. However, he says that growers must be prepared for a much lower level of prices and for a time of strenuous competition with the wild product. The trouble is, from the industrial standpoint, that rubber cannot well be stored for any length of time, and that the levelling down element of wild rubber is a slow process, being mainly controlled from New York and London, by the sending out of expeditions, especially up the Amazon. When prices rule low these expeditions are generally countermanded, with the result, as in 1908–9, following on the Yankee panic of 1907, that eighteen months to two years later there is a shortage. The hope is for a steady growth of the trade, a laying down of large areas of plantation, coinciding with a spread of the use of rubber. Then planters, given good localities, would find it worth while to produce in large, steady quantities, at moderate prices. For some time to come, however, the rubber market is bound to be at the mercy of wild fluctuations, but with a tendency to high prices.

ELECTRICITY ON RAILWAYS.

RUSSIAN GOVERNMENT'S PROJECT.

As already announced in our columns in August of this, year will be held at St. Petersburg an international exhibition of "Electricity as applied to railway service." The main sections will comprise:—

1. The application of electrical energy to the uses of steam-power railways.
2. The use of electricity as the hauling force on (a) main railway lines, (b) local narrow gauge lines, and (c) tramway lines.
3. The application of water power to provide electrical energy.

These three main sections will be again sub-divided. The president of the organising committee is General Sitenko (St. Petersburg, Sadovaja 24), to whom inquiries, in English, may be addressed by intending exhibitors. He is a high official in the Ministry of Ways of Communication, and his rank of general is the usual civil rank of a distinguished engineer. It may be mentioned that Russia is contemplating the application of electricity on as extended a scale as possible to the use of all her railways, but will begin, of course, with the short distance local lines with a large number of trains at frequent intervals. In connection with the exhibition will be arranged a special trial ground at which all exhibits of electro-railway motors will be tested on the level and with varying grades and loads. Exhibitors will be permitted to sell any exhibit during the progress or at the conclusion of the exhibition, with the necessary consent in the first case of the committee, who will require any engine sold to be replaced.

In this exhibition, says the correspondent of *The Standard*, the Russian Government is practically inviting the world to compete for the electrification of Russian railways in their entirety. The main idea appears to be to produce electrical energy (as being more conveniently dealt with than other forms), from waterfalls, where possible, failing that, by auxiliary steam or gas engines working a dynamo on a train in motion; and, third by means of accumulators, in the development of which great things are expected in the near future. The longest run of a locomotive on a Russian railway is 200 miles, but the average run from depôt to depôt is about 80 miles. In the production of electrical energy on a train in motion, by means of steam or gas engines, it is intended to increase the use of liquid as against other forms of fuel, thus making Russia entirely self-sufficing in this important matter.

While the above is the main object of the forthcoming exhibition, which has been duly sanctioned by Government, there will be a number of exhibits of all forms of electrical energy, of high or low voltage, to the uses of railways, as, for example, electrical signalling, manipulation of points, etc.

CANADIAN HYDRO-ELECTRIC PROJECT.

The St. Lawrence Power Co. is seeking permission to dam the St. Lawrence river opposite Cornwall, Ontario. This, says the *Standard of Empire* local correspondent, is in order to develop electrical energy for manufacturing purposes on both sides of the river. The project involves the construction of a dam 4,500 ft. long and 45 ft. high across the Long Sault Rapids. The rapids at this point are on the United States side, and the proposed dam would cause the waters on the Canadian side to be deflected to the other shore. The scheme as detailed would develop 200,000 h.p. at the outset, and later would reach a total development of 700,000 h.p. It would cost $20,000,000. Mr. F. H. McGuigan has worked out the plans. The National Commission of Conservation opposes the project, on the ground that it would endanger Canada's control of navigation on the St. Lawrence.

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ELECTRICITY AND PRINTING.

By A LONDON PRINTER.

The editor of THE ELECTRICAL ENGINEER has handed to me a well-produced and admirably illustrated publication, entitled "Electric Control of Printing Machinery," with a courteous request that I should review it from the standpoint of the practical printer. I have much pleasure in doing so, for a careful perusal of the work persuades me that it is one which should be in the hands of every printing works manager, whether his machinery is driven by electricity, steam, or gas. If he is already using electric power there is much in this booklet which it will be immensely to his advantage to know. If he is still running his machinery with the aid of gas or steam plant, it is all the more desirable that he should learn not only what can be achieved by means of electricity, but the best means of achieving it. The book is published by the Adams' Manufacturing Co., Ltd., of Bedford and London, and the price is one shilling.

Perhaps I may be permitted to say at the outset that it has long seemed to me a somewhat remarkable fact that, while the managers of practically all the great London morning and evening newspapers, as well as of the principal provincial daily journals, have been keen to recognise the enormous advantage and economy of electricity as a motive power, both for the linotype composing machines and for the gigantic Hoe and Goss presses on which their issues are produced, the printing trade generally—especially in the provinces—has been much slower to recognise the peculiar adaptability of the electric drive to the constantly varying conditions of their output. They have been quite content to jog along in the old-fashioned way, and to lose in driving shafting, pulleys, and belts anything from half to three-quarters of the power generated by their gas or steam engines, in addition to putting up with many other disadvantages, apart altogether from the loss of efficiency. As no business man voluntarily wastes time and money in this fashion, it may fairly be assumed that the only explanation of this costly conservatism is a lack of knowledge of new conditions. That lack of knowledge this book should be instrumental in remedying.

While in a newspaper office the amount of power required is fairly constant, in an ordinary book or jobbing office it necessarily varies greatly from day to day, yet under the old conditions speed and power have to be maintained at the maximum, whatever may be the amount of work which has to be done. In the case of steam plant, there is not only the big loss in the transmission of power to be considered, but also the cost of engineer, fireman, coal, and labour; the large amount of boiler and engine space required, and half a dozen other factors all tending to enhance the cost of service, in addition to the inflexibility of the power itself. In the case of the gas engine, there is a similar inflexibility in the matter of speed, combined with the risk of stoppage on a comparatively slight overload, a similar loss of power through the shafting, the disadvantages of noise, smell, high initial cost, cost of lubrication, water, water-pipes, tanks, heat, space, danger, vibration, inefficiency at small loads, and risks of a breakdown which is liable to paralyse the whole work of the printing office.

There is not one of these disadvantages which is not either wholly eliminated or materially diminished by the use of the electric drive. Engineer and fireman, fuel and water, and complicated gearing are all eliminated. There is no loss of power, and no increase of insurance premium. The electric motor occupies the absolute minimum of space. There is no risk from an overload and no loss when the work required to be done is small. It is no longer a case of running the Scotch express for a single passenger. The output of power automatically adjusts itself to the amount of work to be done, and not a farthingsworth of energy runs to waste. This point is well put in the book under notice. "It is always possible," says the writer, "to run just the machines there may be work for, without driving an unnecessary lot of shafting and without having to run an engine large enough to drive the whole works, or to keep a man at work to attend to the engine. Thus in the case of an urgent job, one machine may be kept working all night if necessary. without using a single unit more power than is required to drive that one machine, and without keeping anybody at work except the operators of the one machine."

It will have been observed that up to this stage the reviewer has been taking the case of the printer who has not yet installed a motor in his works, and it is quite conceivable that it may occur to him that, admitting the advantages of electric drive, he would have to stop his works in order to make the change over. But as a matter of fact, no such stoppage is necessary. The conversion can be effected machine by machine, as in the recent case of Messrs. Cassell & Co., Ltd., where one of the largest printing houses in London was converted without the stoppage of a single machine for a single day.

Reference has already been made in a general way to the economies which are effected by the application of electricity to printing machinery, but there are many specific advantages which the practical printer will be quick to appreciate. Every printer knows that when he drives a number of machines off the same shafting he can only establish individual control of any particular machine by means of change gears and the shifting of belts or pulleys, and even then the control can only be partial and unsatisfactory. If he uses electricity, however, and each machine is driven by its own motor, complete flexibility is established and speed can be perfectly regulated at the will of the operator.

But at this point there comes in a consideration of no small importance—that of the particular controlling gear which is in use. On this subject I may quote from the author of "Electric Control of Printing Machinery" a paragraph with which my own experience is quite in accord. "It matters not how good the machinery is," says the writer, "or how well the motors have been selected, or how skilled and careful the employés may be, if the control is not perfect all sorts of troubles occur which make the work difficult, reduce the output, spoil the printing, break the paper, shorten the life of the machinery, waste the current, keep the engineer busy on repairs, and in a multitude of ways help to reduce the proprietor's profit and reputation." If this catalogue of possibilities sounds somewhat formidable the printer may take courage from the reflection that none of these misfortunes is likely to occur if he selects at the outset the type of controlling gear best suited to his requirements, and it is to afford him practical aid in that direction that the publication under notice has been written. In it he will find every branch of the subject tersely and succinctly dealt with—the essential features of good control gear, "inching" devices, motor starting switches, speed regulation, reversible control gear, stopping devices, overload preventers, and much else of great practical value, together with sections dealing with alternating current controllers and with controllers for rotary presses of all sizes up to the latest octuple newspaper machine.

ISLE OF WIGHT RAILWAY ELECTRIFICATION.

At the meetings of two Isle of Wight Railway Companies the question of electrification was referred to in a very half-hearted way by the chairman. Mr. Percy Mortimer, presiding at the Isle of Wight Central Railway Co., said that they were not prepared to run any risk, and he considered that the risk was considerable. It was an unknown quantity, for no railway in the kingdom carrying a mixed passenger, goods and mineral traffic had yet been electrified. However, if any definite scheme was put before them, or a responsible syndicate came forward, they would consider the matter. Mr. Horace F. Tahourdin, presiding at the meeting of the Isle of Wight Railway Co., said that they had been asked by the County Council to consider the desirability of electrifying the railway, but the directors did not see their way to take any steps in that direction at present. They would do nothing unless they had very reliable assurances. As regards the Ventnor Funicular Railway, there had been regrettable delays, but he still hoped that the scheme would be carried through successfully. It might be pointed out that electricity would enormously simplify the working of this Ventnor venture.

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CHARGES FOR TRAMWAY SUPPLY.

BIRMINGHAM DISCUSSION.

At the meeting of the Birmingham Local Section of the Institution of Electrical Engineers, held at the University on February 16, a discussion took place on Mr. H. E. Yerbury's paper. The President, Mr. R. C. Morcom, was in the chair.

Mr. R. A. Chattock, City Electrical Engineer, of Birmingham, in opening the discussion, said that Mr. Yerbury had evidently come to the conclusion that the engineers of combined municipal stations were one and all making charges for tramway supply that could not be justified when the charges made to power consumers were considered. Mr. Yerbury had also suggested that millions of units were being sold for power actually below cost price. It was not conceivable that the engineers of the 65 combined stations referred to by Mr. Yerbury would all be able to get their committees to make charges that were in favour of one class of consumer over another, especially when it was remembered that such charges in the case of tramway supply were criticised by another committee of equally hard-headed business men. Nor was it conceivable that such committees would for a moment agree to sell any current below cost price. It was admitted by Mr. Yerbury that the load factor of each class of supply had a great bearing on the price that should be charged, and it was assumed by him that the load factor of a tramway supply was better than that of other class of supply. But this was not so. The load factor figures in Birmingham for the present year were: lighting, 10.75%; power, 34%; trams, 27.5%. In addition to this, the low tension cables which were necessary to supply current at 550 volts to the tramway routes, and which could be used only for such supply, were immeasurably more costly than the high tension cables required for the supply to large power consumers at 5,000 volts. These two points would justify a lower price being charged to the power consumer. Figures could be made to prove many things, and the comparative figures submitted by Mr. Yerbury in his tables had apparently led him to the conclusion he had put before them. He must confess that Mr. Yerbury's figures were so meagre that he had been unable to follow him. For instance, Mr. Yerbury had not made it clear in his comparisons between Bradford and Sheffield whether he had included the interest and sinking fund charges on the feeder cables in the Sheffield figure of 0·241d. per unit. In Birmingham, these charges, as allocated to tramways, amounted to 0·378d. per unit, and he took it that in all large tramway under takingsthis item was approximately the same. Comparing these two figures, for interest and sinking fund charges, it would appear that Mr. Yerbury had only included the capital charges on his building, land, and plant, and had ignored cables altogether. If this was so, it was obviously unfair to the combined stations, and was nothing less than misleading in making a comparison which was the subject of the paper. In the tables submitted it would certainly appear that Mr. Yerbury wished them to compare the costs per unit generated in a separate tramway station, which did not include any charges on cables or depreciation, with the selling price per unit in a combined station, which had to include all charges, including profit, and he thought it was a matter for regret that Mr. Yerbury had not made this point clear in his paper.

Mr. A. M. Taylor said it would be found that Mr. Pearce's charges were substantially correct, and he was pleased to see that the latter made an attempt to break up the so-called "works costs" into "running" costs and "standing" costs. The rate per unit at which the consumer is charged should, as far as possible, include only that element of cost which is strictly proportional to the number of units. All other charges should be thrown into a charge which is proportional to kilowatts demanded. Strictly speaking, there should be a third class of charge, virtually independent both of units and of kilowatts, and of the nature of a constant charge: but for the sake of simplicity this might be thrown into the charge made per k.w per annum. This was less unfair to the purchaser than to throw it into the charge made per unit. The latter penalises a consumer who has an improving load factor. An example would make this plain. Let them assume, for the sake of argument, that the Tramways Department is charged on the basis of 0·17d. per unit + £9·45 per kw. per annum (see later). This meant, on 29½ million units and with 11,200 kw., a charge of £20,900 + £106,000 = £126,900. If now the load factor went up 50%, the total charge would be £137,350. But, if charged on a basis of (0·865 + 0·17 =) 1·04d. per unit, the Tramways Department would have had to pay £190,350, that is, they would have been penalised for an improving load factor to the extent of £53,000. The effect of reducing the "running" charge is, of course, to increase the total of the "fixed" charges. Mr. Yerbury's curves were intended to show that, in large stations, at least, the oil, wages, and repairs costs were in no sort of proportion to the units sold; and that they were not even in proportion to the kw. of maximum demand, but more nearly a constant quantity. The curves represent the Manchester expenses, as incurred over the last eight years, taken from the published figures. The thin straight line (A.B.) on each curve represents the rate at which the charges should grow, if they followed a law of growth in proportion to kws.; and the thin curved line (C.D.) represents that required to follow a law of growth in proportion to units. It would be seen at once how entirely wrong in principle it is to throw oil, wages, or repairs into a charge to be levied on every unit sold. Taking the "running" charge for coal at 0·17d. per unit (which allows approximately 4 lbs. of coal per unit sold), the fixed charges for 1907–8 came out as follows:—

Standby coal	£0·74	per kw.	per annum.
Oil	£0·18	,,	,,
Wages	£1·11	,,	,,
Repairs	£1·20	,,	,,
Rates	£1·02	,,	,,
Management	£0·46	,,	,,
Interest and S.F.	£5·12	,,	,,
Reserve and depreciation	£2·09	,,	,,
Total	£11·92	,,	,,

With the exception of the last two items, there was very little difference for the year 1908–9; and if the charges per kw. were plotted with kws. it would be seen that the annual diminbution was, on a station of that size, very small. If they took it that the Manchester tramway load had a load factor of 30%, giving a maximum demand of 11,200 kw. for 29½ million units, the fixed charges levied on the tramways at Manchester became:—

Coal (standby)	£0·47	per kw.
Oil, etc.	£0·04	,,
Wages	£0·75	,,
Repairs	£0·70	,,
Rates, etc.	£0·95	,,
Management, etc.	£0.39	,,
Interest, etc.	£4·82	,,
Reserves or depreciation	£1·32	,,
Total	£9·45	per kw. of maximum demand per annum.

He, therefore, thought that, considering that Mr. Pearce's fixed charges for the general supply were some £12 per annum per kw., he was justified in charging the tramways department £9·45 per annum per kw., this latter giving a difference of some £2½ per annum per kw. as a reduction on account of those expenses not incurred in connection with tramway supply.

Mr. Jackson said that the writer of the paper apparently thought that all charges for current made to the tramway department were to be based not upon the profit-earning power of the electricity department as a whole, but simply upon the most economical conditions upon which the electricity department could be run. Mr. Yerbury had put the legitimate profits at 3% on the running costs, while Mr. Chattock had suggested 5% on the total cost, but he did not see why they should not put on something higher. If there was any economical advantage due to the efficient running of any electricity department, the department should have some advantage from it. Mr. Yerbury might say that if the tramways manager were running the station himself he would be able to get rid of a number of the costs and earn a large profit for himself. But a municipal undertaking had to be run as a profit-earning concern, and was surely entitled to something more than 5% on its bare

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running costs. The profit should be calculated as a dividend on its total capital, and this would come to something higher than Mr. Yerbury suggested. The limitation of profit suggested did not allow for extraordinary expenses, such as accidents, and though such risks were minimised in a well-organised generating station, the tramway department was not entitled to the full benefit of this. Mr. Yerbury's contention, while very good from the tramway engineer's point of view, was not altogether fair to the Corporation and the other parties interested. Mr. Taylor's curves brought out very plainly the point that the standing charges should be dealt with for the benefit, not of the tramway undertaking, but of the electricity undertaking. He quite agreed with Mr. Taylor's method of allocating the charges.

Mr. Yerbury, in reply, said that Mr. Chattock appeared to shield himself behind his committee, but he (Mr. Yerbury) knew what committees were, and he ventured to say that they invariably followed out the advice of their expert. He would not like to suggest that there was a higher coefficient of moral elasticity in one class of engineer than in the other, but the fact remained that they did find a considerable difference in the prices charged to tramways in separate and in combined stations. He had been looking over the Birmingham supply account, and he found that Mr. Chattock's load factor to his total supply was for tramways from 20 to 30%, while he charged the tramway department 76% above his total works costs, including rent, rates, taxes and management. This appeared to him (Mr. Yerbury) to be rather a high price. With respect to power being sometimes sold below cost price, he was looking the other day at the accounts of a certain corporation, and found that the total works cost, ignoring interest and sinking fund, was ·66d. per unit. This particular corporation sold electrical energy to power consumers at 1d. per unit, with a discount of 40%, bringing to ·6d. per unit, how could they do that if their works cost, ignoring standing charges, was ·66 without loss. He would be pleased to give Mr. Chattock the name of that city afterwards if he would like to have it. Interest and sinking fund was, of course, a very vital point in connection with the tramways department. In Sheffield, the original loans were for 30 years, but those they had obtained within the last five years had been for 25 years, so that over the whole period the charge worked out at 3·163%. The ·205% Mr. Chattock mentioned for combined stations was no doubt very largely due to the very high sinking fund charges, which determined the high selling price to the tramway department, because they found a very great difference in cases of the general installation, especially where a high tension system had to be installed. At Manchester they pooled the whole of their total charges and debited a proportion to the tramways department. If they had anything like 3,000 to 4,000 consumers, the service charges worked out at from £30,000 to £40,000. Interest and sinking fund had to be charged on that £40,000, which was certainly not applicable to the tramways department. Mr. Chattock had criticised the percentage of profits suggested in the paper. It must be borne in mind in regard to municipal undertakings that in arriving at a percentage of profits, a certain sum had first been put aside for interest and sinking fund, which would be declared, in the case of a company, as dividend. Thus, if only 3% were charged by the supply department that would mean 6%, because they had already put aside 3% for their sinking fund. Both at Bradford and at Manchester they considered that 3% profit was an equitable and reasonable charge, and they made £1,200 profit from the tramways department in each of those cities on the basis of 3% on the work scost. In his paper, he had been a little more generous, having said that 3% to 5% might be charged. The question of fixed charges was one upon which Mr. Taylor seemed to be very keen. Of course, it must be admitted that certain quantity of coal was a fixed charge on the station, but he failed to see how, in considering the quantity of coal burned and the recovering of certain losses by radiation and so on, they could differentiate how much should be debited to the tramway department and how much to the power consumer. It seemed to him that if they calculated the whole of their coal, oil and other things in their total works cost and based their selling price on their total works cost, they were including all their charges. All tramway managers and engineers were now working to a standard form of accounts in which coal, oil, waste, water, and so on were all included as running charges. With respect to wages per unit, no one suggested that wages could be in proportion to units generally. That was in no way suggested in the paper. Some of them would be very pleased if wages were not such a fixed charge, but in Sheffield almost every month they got an agitation for increased wages. If wages were a fixed charge, they would, of course, be able to show an increasing profit. With regard to the figure of 1·04 mentioned by Mr. Taylor for Manchester, he believed that figure was the present price charged for the tramways department. He was unable to get last year's figures from Mr. McIlroy, and he had to use those for 1907-8, where the price charged was, he believed, 1·12d. Four pounds of coal per unit had been mentioned by Mr. Taylor, but that seemed to him to be an exceptionally high amount. In Sheffield they got it down to about 3·6d. With regard to the question of supply and demand referred to by Mr. Jackson, he, of course, in writing the paper bore in mind that it was a question of supply and demand, and the supply should be determined by the total kw. capacity required, say, by the tramways department, while 25% should be set aside for fares. That, in his opinion, was quite sufficient, although in the majority of lighting stations they had 33 to 34% spare plant. That was an altogether diverse factor in the two cases. Mr. Jackson had also criticised the figure of 3 to 5% proposed on the works cost, but it must be borne in mind that by the acquisition of a big power load such as the tramway load their total generating cost dropped as much as 50%, or even very much more. In that case, they were improving the position of the lighting department all the way round by the acquisition of the tramway load, and he thought 5% should be ample profit to be charged to the tramways. As to the amount to be put aside for accidents or contingencies, these items were generally included in the insurance policies, which were usually so drawn up that there was no very great loss to the municipality if an accident took place.

Mr. Kemp, in proposing a vote of thanks to the author, said that there was one point that Mr. Yerbury did not seem to have dealt with. It was commonly assumed that in generating stations combining traction, lighting and power, they got the benefit of a very high day factor owing to the tramway load. That was not necessarily the case, because the maximum loads for tramways, lighting and power might very often be coincident. In fact, if they were not more or less so it was the merest accident. For instance, in the days preceding Christmas it might be that they would have all three having their heaviest loads coincident. Therefore, in weighing out plant for combined stations it must not be assumed that they could do it with a less plant than they could do with otherwise.

Mr. Lindsay Foster seconded the vote of thanks, and pointed out that the depreciation of cables was not mentioned in Mr. Yerbury's reply.

D.C. LIQUID STARTERS.*

By JINSUN K. HWOO.

The use of liquids as resistances in D.C. motor starters is not a new idea; but recently some of the English manufacturers, such as those mentioned in the paper, have made improvements on such types of starters and manufactured them as proper engineering appliances.

The object of the paper is to give descriptions of some of the latest types of liquid starters, their advantages as compared with the ordinary wire starters, and a rough idea of their cost and weight. The descriptions are accompanied by sketches showing the details of construction, and connections to motor. Two tables are drawn up to show the comparison of costs.

The net weight of some liquid starters is shown in Table 3. Besides these, however, some other notes concerning liquid starters are also given, such as—

(1) The principles of motor starters.
(2) Liquid starters for series wound and shunt wound machines.
(3) Forms of liquid starters.

* Abstract of paper to be read before the Northampton Institute Engineering Society, March 4th.

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(4) Materials for liquid starters.
(5) Short circuit of liquid starters.
(6) Evaporation of liquid.
(7) Electrolytic effects.

But as to fulfil the object of the paper, the conclusion is made by summarising the advantages of liquid starters as follows:

(1) Cheapness.
(2) Absence of jumping effect.
(3) Absence of multiple sliding contacts.
(4) Freedom from sparking.
(5) Adaptability for all voltages.
(6) No danger of burning out.

ELECTRICAL TRADES BENEVOLENT INSTITUTION

FESTIVAL DINNER IN LONDON.

As briefly announced in our last issue, the second festival dinner of the Electrical Trades Benevolent Institution took place at Whitehall Rooms, *Hotel Metropole*, London, on the evening of February 23. In the chair was Dr. Gisbert Kapp, the esteemed President, supporting whom were Sir Irving Courtenay (vice-chairman), Mr. Justus Eck, Mr. Watson, Mr. J. S. Highfield, Mr. C. J. Kiralfy, Mr. H. W. Butler, Mr. L. G. Sloan, Mr. W. B. Esson, Mr. J. McCaffery, Mr. Hugo Hirst, Mr. J. A. Blackwood, Mr. E. J. Clark, Mr. L. G. Tate, Mr. Wm. Finlay, Mr. T. E. Gatehouse, Mr. F. H. Nalder, Mr. J. E. Kingsbury, Mr. F. B. O. Hawes, Mr. W. Davenport (the energetic secretary), etc.

Proposing the toast of the evening—"Prosperity to the Electrical Trades Benevolent Institution," Dr. Gisbert Kapp regretted that their official Chairman, Sir Wm. Preece, was unable to be among them on that occasion. Sir William wrote, regretting extremely that he was still under the doctor's orders and was strictly forbidden to go out to any evening entertainment. "I am deeply sorry," Sir William added, "that I cannot come and support the very excellent and necessary work that you have inaugurated. You shall have my continued support, and, though Nature is very unkind to my body, it has not affected my heart or my purse strings." That, observed Dr. Kapp, was a noble sentiment. He was glad to know that others who were more in bodily comfort than their friend had also loosened their purse strings. Up to half-past four that afternoon the Secretary had received promises amounting in all to £217, another £45 had since been subscribed, and he was hopeful that they had not yet reached the limit. Some people were under the impression that benevolent societies should especially be assisted in times of bad trade. Unfortunately, they had had bad trade and, in fact, were only now on the eve of an improvement. But he wished to point out that even in times of good trade there was always scope for their benevolence. Everyone of them was liable to reverses in fortune, and it was well that all should have the feeling that there were friends ready to lend a helping hand. That was the noble object of the Benevolent Institution. The Institution of Electrical Engineers also had a benevolent fund and were doing their best, but he almost thought that the Electrical Trades Benevolent Institution had outstripped them—perhaps not in the total amount distributed, but in mathematical language, in the differential of the increase of their fund. The Trades Benevolent Society increased their funds at a faster rate than did the Benevolent department of the Institution, and he certainly thought that the Committee of Management had worked exceedingly well. Started in 1905, they possessed, exclusive of the amount subscribed in connection with the festival dinner, £300 in cash, and £2,089 invested. It was a record of which they might well be proud. The subscriptions—the regular income—came to a little over £100, and the donations last year amounted to £578. There was an exceptional item of £364 handed over from the Manchester Exhibition. In dealing with necessitous cases they expended £63, very nearly the whole of the interest on the investment. He considered that the management did the right thing in not spending the whole of the assured income. The original intention was that the Benevolent Institution should, not only relieve necessitous cases, but also give pensions. Well, if they started too soon they would all spend their money and never accumulate a fund. The Committee acted wisely in restricting their benevolence to the most urgent cases, looking forward to a greater accumulation of funds before they began operations on the larger scale of, what they might call, not old age pensions, but industrial pensions to those members of the industrial army who fell on the way. The Committee dealt with the various cases in a liberal minded spirit, and in cases of urgency the Secretary showed the right spirit by giving immediate assistance. He was glad to see by the list that many of the donors were large trading or manufacturing firms who also had among their own working people benevolent funds. He wanted to convince the members of the electrical trades generally that they would do a good work if they subscribed to this society. He had heard that his good friend, Mr. Mordey, who was President of the Institution last year, broached the question as to the Benevolent Fund of the Institution of Electrical Engineers and that of the Electrical Trades pooling their interests and making one society. The proposition sounded very well, and there might be reasons in favour of it, but he had not so far discovered them. If they pooled their interests he did not think they would reduce the expenses—expenses were already zero because of the disinterested work which the Committee and Secretary were doing—or obtain receipts equal to the combined income of the two efforts. The benevolent fund of the Institution of Electrical Engineers was restricted to members of that body, whereas the electrical trades were more catholic in their benevolence. In most questions of policy he was heartily in accord with Mr. Mordey, but on this question he (Dr. Kapp) did not share his views. He thought it would be better for both of the societies if they preserved a sort of healthy rivalry. Let them see who could do the most good.

Sir Irving Courtenay maintained that it would be a great misfortune if there was any idea of pooling their interests or amalgamating with the other institution. He held that there was a distinct field for the operations of the Trades Benevolent Institution. On the general question of diminished subscriptions, he thought that, on the whole, there was more money given to charitable purposes than there had ever been in the history of the country.

Mr. Hugo Hirst also associated himself with the sentiments expressed by the Chairman. They did not always see things with the same eye, but in this noble cause there was no difference between them. It was, he went on to say, extraordinary how few men in the electrical industry, compared with other industries, had reached a position of safety, or, at least, of indifference to the fortunes of war in which they were engaged. In the benevolent work of this society he encouraged them to try to interest the greatest possible number. Let them endeavour to enlist every young man in the industry to support the fund with their shillings, and within ten years they would have very large sums available for doing something substantial to relieve the distress of many people who called themselves electrical engineers of one description or another. As an instance of what could be done with small amounts, he mentioned that in his firm they had a sick fund. Members of the staff each contributed about a halfpenny a week; they paid out some hundreds of pounds a year; and they had saved and possessed some £4,000 or £5,000. What could they do with shillings where thousands could work and subscribe. The large firms would gladly subscribe big sums if they felt that it benefited the greatest number.

Mr. Justus Eck, in eulogistic terms, proposed the health of the President. Speaking in behalf of the fund, he observed that as bad times had come in some places, they had been superseded by a vast expansion of the electrical industry. Still they had had very serious cases brought to their notice, and it had been a great pleasure to feel they had a little hand in helping. Possibly in the future they might have Electrical Trades Almhouses, situate on the river banks, where the old and deserving members of the industry would be able to pass their days in pleasant surroundings. To get anything like that at all they must have plenty of funds. From the figures mentioned he thought they had the genuine basis of a permanent institution already established. The Committee had commenced to secure subscriptions of small amounts by means of voluntary

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collectors in the various large and small electrical undertakings throughout the country. The Society had been very successful in their investments; the money yielded a good return; and the interest was expended in the best possible way. Regretting the absence of Sir William Preece, he said that if the Committee had not been supported by the wonderful enthusiasm exhibited in him, he (the speaker) thought they would not have made such advance in the work.

The President, in acknowledging the toast, assured the gathering that he attended as a labour of love. He was in great sympathy with the objects of the Society. He paid a tribute of praise to the Technical Press for their hearty support to the cause.

The health of the committee and officers was honoured on the call of Mr. Guy Burney. In eloquent terms, Mr. Burney spoke of the valuable service rendered, particularly by Mr. Justus Eck and Mr. Davenport, the popular secretary, in furthering the interests of the Society.

Mr. Davenport, in replying, said that the Committee had worked very hard, and had been of very great assistance in bringing about the result announced that evening. He concluded by proposing the toast of the "Technical Press."

The programme was interspersed with some much appreciated vocal selections, etc.

ELAN VALLEY WORKS: PROTECTION FROM LIGHTNING.*

By SIR OLIVER LODGE.

I have now visited the Waterworks at Elan Valley, under the guidance of the Engineer-in-Charge, Mr. F. W. Macaulay, in order to see what possible danger existed from lightning, and how best to ensure something like adequate protection without extravagance.

The chief danger to be apprehended, beyond the ordinary house risks, lies in the possibility that an exceptionally powerful flash might strike one of the dams, or some appendage connected with the dams, or some metal work entering their interior; and thus, by explosion or shock due to sudden expansion, might cause some initial crack or other disturbance in the structure, which would ultimately lead to weakening. If, at a time when the dam was dry, the dam itself were struck, or if at any time a road on the top of a dam were struck, the damage done would not be serious, even if a stone were chipped or dislodged, because it would be patent and visible. But if a flash were to be conducted by metal work into the interior of a dam, and there, by reason of inadequate means of escape, cause an explosion and perhaps a perforation, the damage, though less obtrusive, would be likely to be more serious. And even if such a penetrated flash did escape by metal to some point beneath the surface of the lake, unless the metallic surface by which it took to the water were fairly extensive, a violent explosion would be liable to be caused there—much more violent than anything that can be produced in air by the same cause—and the shock so generated would be as objectionable as that caused by the explosion of a small charge of dynamite in the same position; although neither would be likely to have any visible immediate effect.

The explosion of a flash entering water from a *small* surface can be demonstrated thus: If a small spark is taken from the exposed end of a sharply-cut off gutta-percha covered copper wire under water inside a thick glass tumbler, the tumbler is shattered, not by any electrical perforation, but by the mere mechanical shock or explosion always caused when a concentrated spark occurs inside a liquid.

Similarly, I have taken a small spark from a square millimetre of surface inside a copper vessel filled with water, and thereby strained the joints of the vessel till it leaked.

I have reason to think that an explosion of a copper reservoir, in which sugar was being boiled under pressure at a factory near Liverpool, was due to a flash of lightning entering the vessel by a pipe, past a leather washer, and then sparking across to the walls of the vessel from the free end of the pipe, near the bottom of the vessel, under the liquid. In all these cases, if the cavity had been full of air instead of liquid, no violence need have been expected, nor would any damage have occurred.

The safest and quietest way in which a spark can strike water is on the *surface;* it then spreads out in all directions along the surface, like a crow foot, and is harmlessly diffused away. If lightning, therefore, struck the water of the lake directly, even close to a dam, I should anticipate no danger; but if it were conducted down by some metallic means, and then conveyed to the water through a small or quite insufficient area below the surface—say, merely the end of a pipe—then there would be the explosion I speak of at the place where the flash took the water. And this could only be avoided by exposing to the water plenty of metallic surface at that place, so that the rush might be spread out and got rid of quietly without any spark at all. The amount of surface necessary would depend upon the violence of the discharge and upon the conductivity of the water; *e.g.*, a smaller area would serve in salt water than in fresh. For any ordinary experimental or artificial flash, one or two square feet of surface is sufficient.

Protection, therefore, involves one of two things:—

(*a*) Either keeping the lightning to the surface without letting it penetrate into any interior; or,

(*b*) Taking care that if it does so penetrate it shall have plenty of metallic surface by which to reach the water in a quiet and unexplosive manner.

And in achieving either or both of these ends it is natural and proper to take advantage of any metal work already existing for other purposes. Indeed, all such metal work must be taken into account, whether it constitutes a source of danger or a means of protection.

One other general statement may be made: this time with regard to exposure and relative altitude. It might be thought that waterworks such as these, being in a valley and surrounded by hills, would be fairly well protected by nature. But that is not the case. In a mountain district lightning has often been known to strike

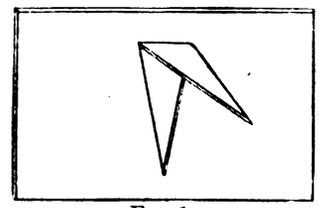

FIG. 1.

down ravines, and any part of a valley may be struck; though, of course, the likelihood is less in some places than in others. Moreover, it must be remembered that a flash, if a strong one, is often by no means a simple linear discharge, but that it may be, as it were, a "bush" or number of flashes, striking a number of points simultaneously or in rapid succession; the occurrence of one discharge weakening the air, and making another, for the moment, more easy. Whenever a violent flash occurs, it always means some danger, and if a flash can be avoided, by relieving the strain through a sufficiency of quiet point-discharges, that is the best plan. Such point prevention is always to be aimed at, and is often, though not always, achieved.

These being the principles, I now proceed to local details.

CRAIG GOCH.

The most exposed situation is the tower on the Craig Goch dam. This is thoroughly exposed on the north, and should be well protected. It is not in the middle of the dam, and, therefore, not in the most vulnerable position; but it contains metal work, namely, the hydraulic valves, which lead more or less into the dam, and are probably quite inadequately earthed. The best plan in this case is to keep the lightning *outside* as far as possible, so that only a smal residue, if any, need get into the metal work. The copper dome, with which the tower is surmounted, together with a metallic ventilator on top of the dome, terminating already in one vertical and a few other points, forms an admirable beginning; and all that is necessary is to connect this dome by metallic means outside the tower with the water of the lake, taking care that plenty of metallic surface is exposed to the water, and that as far as possible point discharge to its surface is encouraged.

* Report to the Corporation of Birmingham.

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If the level in the lake were fixed, or only slightly variable, I should recommend connection to be made by a kind of metallic floating *hand*, with fingers pointed out away from the dam, and hinged by a triangular girder frame to a horizontal line on the tower near high water level; but inasmuch as I am told that it may be necessary sometimes to lower the level of the lake many—even 40—feet, such a hinged floating-dock arrangement becomes too complicated. A moored floating buoy would serve, but any such arrangement might be troublesome in stormy weather, and on the whole, taking into account the rarity of danger, I must be satisfied with what I suppose to be a simpler recommendation.

I recommend, therefore, that the north face of the tower, from a foot above high-water level to as far down as can readily be managed, be covered with sheet copper, and that similar sheet copper—an extension of it, in fact—extend as a horizontal band one foot wide round the five most northerly of the octagonal faces of the tower, just above high-water mark. I also recommend that a copper ribbon or tape be run up each of these five northerly faces, and be thoroughly joined to the copper dome at top and to the copper band at bottom.

As to the copper sheeting which forms a downward continuation of the one-foot band, and is applied to the north face only (since this will probably be sufficient, though there is no reason against fixing it to two other faces also if preferred), I suggest that it terminate in a roll, which from time to time, as the water sinks, can be unrolled and fastened to the tower at greater and greater depths; and that in all cases its lower edge or roll is to be completely submerged in the water, as much beneath the surface as practicable.

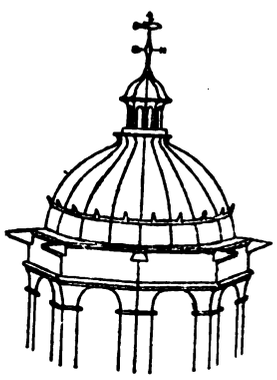

FIG. 2.

I specify copper solely because of its chemical durability. Iron or lead would be equally efficient, and iron would be even preferable electrically; but iron would rust away, and lead would be deleterious. Copper seems most likely to be efficient and durable under or near the water. The thickness of copper is electrically immaterial, and depends only on mechanical considerations of fixing and the like. It would probably not be thinner than $\frac{1}{16}$ in. nor thicker than $\frac{1}{8}$ in. The copper tapes or ribbon coming down the five northerly sides of the tower, and fixed in any convenient manner to the stonework, might be $1\frac{1}{4}$ in. × $\frac{1}{8}$ in. in section.

The object of this exceptionally great conducting power, and virtual "caging" of the tower, is to keep the lightning outside, and prevent any of it reaching the valves or metal work of the interior.

In order to give easy electrical access to the water when it is at what I assume to be its normal level, or just overflowing the dam, a number of copper spikes, say, about a foot long, and inclined downwards at about 30 degrees, could be arranged on the horizontal copper band, so that their points just touch or nearly touch the water; and a similar effect of points could be arranged on the north copper sheeting by cutting wedge-shaped or V-slits in the copper, each $1\frac{1}{2}$ in. at the base and 6 in. long, pointing downward, and then bending these flaps out at about 60°; one such discharge point being provided to about every square foot of the copper surface.

The only other protective feature that I can suggest is a ring or crown of points or sharpened rods, round the copper dome at any level consistent with good appearance—for instance, not far above its lower edge—each point protruding about a foot clear of obstruction, and being, say, 8 or 16 in number. These points might be fixed to sections of a metal ring, which could be taken to the tower in pieces and bolted together round the dome, without in any way interfering with the continuity of the dome itself.

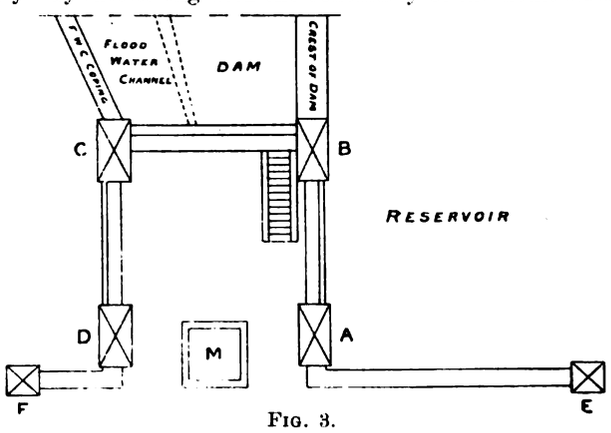

FIG. 3.

The object of these spikes is to supplement and assist the point at the top in relieving the tension during a violent storm in the immediate locality, thereby making the occurrence of disruptive discharge or lightning flash less likely.

Some of these recommendations are admittedly counsels of perfection, but in so far as they are reasonably feasible, I do not see why they should not be applied to work of this importance.

Any part of the *viaduct* over the dam might be struck by a flash; but the damage done would probably be limited to the road, and would be visible. Moreover, such discharge would probably be merely a subordinate part of the main flash: it would take the surface of the water quietly, and would do no damage to the dam itself.

FIG. 4.

PEN-Y-GAREG.

The next most exposed position is the tower on the Pen-y-gareg dam, which tower has many similar but a few different features. In the first place, being in the middle of the dam it is in a more serious position for inflicting damage on that structure.

Next, there is an electrical interval between the main dome and the upper minor dome with weathercock, for the ventilator between them is of wood—which is not the case on the Craig Goch tower. Consequently, it will be necessary to connect this minor upper dome with the main dome by copper tapes. These copper tapes might be pointed at the top, and protrude 6 in. above the rim of the upper small dome above the ventilator, sticking out at 45° all round, being stiffened if necessary to hold them in position. These tapes might then go down to the dome, and over it without break, and on down the faces of the tower. Three of them should be of great length, and be rolled up at the bottom, so that they can, when opportunity offers, be unrolled and fixed under water as the water sinks, always as deep as is practicable, the rolls being left under water. All the tapes should be connected by a horizontal copper band just above high water, as before, and every time the water sinks 6 ft. another copper band might be supplied, to unite them and to give more surface to the water. The number of strips down the tower should be five, into the water they should be three, and at the top there might be eight. But there they might be quite narrow, *e.g.*, $\frac{1}{2}$ in. × $\frac{1}{8}$ in.

I see some difficulty in taking strips down the east or "down" face of the tower. The three most westerly faces

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are the ones from which the lightning should be chiefly encouraged to enter the water, so that any shock delivered should be as far from the dam as possible. It would, indeed, be sufficient to carry on the submerged part of the work, that is, the work below high-water level, on these three faces only, being satisfied with the five strips, the dome, and the water-level copper band, as constituting a sufficient "encagement" to keep lightning out of the tower. A few points should be provided on the band to encourage surface discharge to the water, at the normal high level, as before.

The ribbons entering the water may be from 3 in. to 6 in. wide, and should go as deep as practicable, being united at 6 ft. intervals by a sheet copper band, a foot broad, with improvised points on it.

Foel Valve Tower.

Next comes the Foel Valve Tower, the protection of which seems singularly simple. It is not on a dam, and is not in a very exposed position. Moreover, it is already provided with rain-water pipes down each of its eight faces, constituting already a kind of cage which can be utilised. The following has to be done :—

Connect the upper minor dome, across the wooden ventilator, with the main dome by, say, four copper strips ($\frac{1}{2}$ in. × $\frac{1}{8}$ in. would be sufficient). Connect the tops of all the rain-water pipes with the lower edge of the main dome by any metal and in any convenient way.

Run a ribbon of any metal round near the floor of the tower, but outside, so as to join the water spouts together near their base. It is probably inconvenient to run this band across the doorway, but it can go round the other seven faces, and a copper strip, 1 in. × $\frac{1}{8}$ in. will serve. At two places, 120° from the doorway, a similar strip may be carried from this ribbon, through one of the water openings in the tower, into the interior, and there connected with the vertical girders which serve as guides for the drain-off cylinders, for I am informed that these descend a long way, and make thorough water connection. If, however, this interior water is at all isolated from the main body of the lake, or if the Engineer-in-Charge prefers to keep the flash wholly outside the tower, even in this case, then the base of this tower can be treated on the same lines as the other two, though as it is not on a dam I regard it as of less importance.

Caban Coch.

Now we come to the Caban Coch dam, which from some points of view is the most important of all, though it is manifestly the least exposed, and has no tower on it. In so far as the dam itself may be struck, or the surface of the water, I anticipate no particular trouble. The danger here is caused by the hydraulic pipes which ramify in its interior—having a multitude of joints and no specially contrived earth or water connection that I am aware of.

It is true that these pipes do not protrude above the ground, but if one of the turrets at either end of this dam were struck, the lightning would probably enter this system of pipes, and so be conducted into the interior of the structure. To avoid this somewhat remote, but not by any means impossible, contingency, I suggest providing an easier way of escape—encouraging the lightning to take the water at some little distance above the dam. Both ends of the dam would, of course, be treated alike : I will consider one end. The turret here has six buttresses or pillars, A B C D E F, each topped with great slabs of conglomerate stone, the pillars being arranged four in a square and two on either side, and between two of these, A D, is a manhole, M, giving access to the hydraulic pipes. This point seems to me the chief danger, in so far as there is any danger here.

To minimise it I suggest a point erection on at least one of the pillars, A, perhaps on four of them, A B C D, all such erections to be connected by a tape, the same tape being led away to the sixth pillar, E—the one on the up side—where it can be led into water down the sloping embankment or masonry beach. The band entering the water at this point should be at least 6 in. broad, and rolled up at the bottom so as from time to time to be fixed at lower levels. That would probably be sufficient under the circumstances, since an explosion here on taking the water, being a little removed from the dam, would not be serious.

For the sake of appearance, I suggest that the arrangement of points on the pillar A, or on the pillars A B C D, should take the form of a *metal aloe*, which can readily be purchased, and which would rather add to the appearance of the pillars than detract from it. This, however, is a mere matter of taste.

Turbine Station.

The turbine station, being below the Caban Coch dam, is very little exposed, but it might be given ordinary protection. This could be done by seeing that the roof-ventilators are connected with the iron of the roof, and by connecting the roof with the crane girders, and these at one or two points with the turbine pipe, which necessarily makes ample "earth" connection. Iron would be the natural metal to use for these connecting purposes, which are trivial and easy. A few spikes added to each ventilator, of which there are two, would be an improvement, but unnecessary.

The way I conceive that this turbine house might be struck is as follows :—

If lightning struck the dam when the reservoir was full of water and overflowing—with some of the spray blowing over the turbine house—the flash might make for the turbine pipes in order to get to earth, travelling down the face of the dam, through the surface water and spray-filled air, and finding the turbine house the best earth available. Under these circumstances, a man holding the chain hanging from the crane would be hurt ; but by the simple connections specified injury would be practically avoided.

Overhead Railway on the Filter Beds.

The girders of this railway are certainly exposed, and might be struck ; but it is a well-connected metallic structure standing on metal pillars, many of which have their feet in water. And though each one separately is very shallow and makes a very bad earth, yet the whole number of them, being so well connected, would diffuse the lightning to such an extent that no damage seems possible ; and I do not see any way of suggesting a better earth than the filters already provide.

Accordingly, I should consider that underneath this railway is as safe a place as anywhere in a thunderstorm, and do not recommend anything to be done.

Lime-feeding House.

The present lime-feeding house will, I understand, be dwarfed by a new house. This new house might have an ordinary protector of any commonplace kind, and if it is difficult to make a good earth the overhead railway itself might be utilised for the purpose.

Careg-Ddu.

Nothing needs doing to the viaduct over the submerged dam at Careg-Ddu.

I did not visit the Dol-y-mynach dam, presumably because it is as yet uncompleted.

For ordinary house and shed protection, and for protection when there is no question of corrosion by, or damage through, water, I recommend the lead-covered iron rope supplied by Mr. Hancock, plumber, of 99, Woodland-road, Clifton, Bristol. (Sample herewith.)

An Alternative "Earth" Plan.

Finally, if some kind of moored floating buoy can be arranged, especially if it happens to be considered as easy as fixing copper sheet below water level, then I should prefer it, as electrically better. The buoy would have a flat horizontal sharp-edged rim, and points all round, on a level with the water ; and a copper rope connection would come up to it under water.

One special advantage of a floating arrangement is that it would automatically make contact with the water without attention. Whereas, by the copper-sheeting plan, a rapid lowering of the lake at some future time might leave the conductor hanging free above the water, unless it were remmebered to send and unroll and fix its continuation as the water sank.

I have to thank the resident engineer, Mr. F. W. Macaulay, for much information and attention during my visit.

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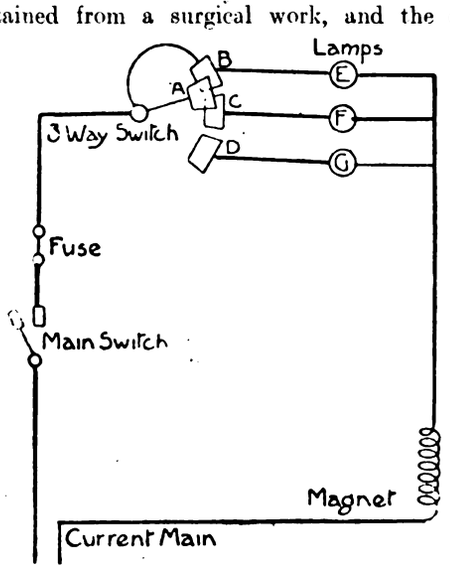
ELECTRO-MAGNET FOR REMOVING IRON PARTICLES FROM THE EYE.

USED ON THE GREAT FINGALL MINE (W.A.).

By G. C. KLUG.

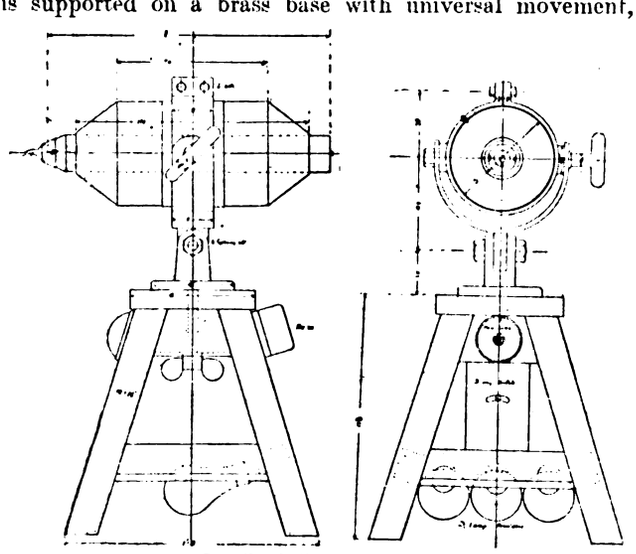
In connection with an accident to one of our mechanics, which occurred a few months ago, it was suggested by Dr. Blanchard, the surgeon attending the case, that a powerful magnet would be required to remove any iron particles that may be imbedded in the eye. The details of the magnet were obtained from a surgical work, and the doctor's



Wiring Connections on Magnet. Coil 12,000 Turns, 24 Gauge D.C.C. Wire.

suggestion was carried out. The accompanying drawings show the construction of the apparatus, together with the arrangement of the resistance and connections. This instrument has already been found very useful, and offers a safe and ready means for extracting iron matter from the eye. It was constructed by our electrician, Mr. G. S. Weymouth, to whom I am indebted for the following details :—

The magnet consists of a soft iron core 1¾ in. diameter by 13½ in. long, fitted at one end with a ball-and-socket joint carrying an extension 1½ in. long, tapered from ¼ in. to a fine point and curved to suitable shape. The core is insulated with fuller board and wound with 24-gauge double cotton-covered copper wire in 40 layers of an average number of 300 turns each. Each layer is bound in with a number of linen tapes running the whole length of the layer, making a solid winding without using end plates. The outer protection is a wrapping of fuller board, with an extra band of 1-16 in. red fibre in the centre where gripped by the brass mounting and a covering of varnished canvas over the tapered ends of the winding. The whole is supported on a brass base with universal movement,



Details of Electro Magnet.

mounted on a wooden stand 12 in. high. This stand also carries the cut-out regulating switch, and resistance. Connection is made to a lamp socket by means of an ordinary adaptor and flexible. As a protection from shock, should the insulation of the coil become damaged, another flexible connection leads from the end of the core to a plug fixed in the wall and permanently earthed. The coil has a resistance of 180 ohms, and is arranged to work on 220 volts (continuous current) with 3-step regulating resistance of 32 c.p. lamps, and takes 0·35, 0·55, and 0·65 amp. on the respective steps. If used on 110 volts (continuous current) it takes 0·6 amp. with all the resistance cut out and will stand this current for several hours without undue heating. At 0·6 amp. the magnet will sustain a 100 lb. bar of iron suspended from the end of the core, and at the working end the pull varies according to the length of the adjustable point and the size of the object. In the case of the 1½ in. point mentioned, the pull is 1½ oz. on the end of a sewing needle.

The small current used permits attachment to any lighting service, and an ordinary tumbler-switch breaks the circuit quite satisfactorily.

WESTMINSTER ELECTRIC SUPPLY.

At the annual meeting of shareholders of the Westminster Electric Supply Corporation, Ltd., held at Eccleston-place, S.W., Mr. W. Hayes Fisher, M.P., presiding, said that the chairman of the company, Lord Suffield, was unable to be present on account of his having been summoned to Buckingham Palace. It would be seen from the capital account that they had written off the whole of the expenditure connected with the old station in Millbank-street, which had been acquired by the London County Council. After an arbitration—and the arbitrator's award gave them less than they asked, though more than the Council offered—they took advantage of the occasion to acquire the freehold of the whole of the new site, which is situated in Horseferry-road, and had built a larger station and put into it more plant than at Millbank-street. It would be seen that there was some diminution in receipts, due to the increasing use of the metallic lamp. This drop occurred mainly in the last quarter of last year, and it would be felt also this year. They might, however, congratulate themselves that they had been able to meet what loss there had been by economies in working, and not only been able to maintain their 10% dividend, but to carry forward a larger sum. They were at present selling three times as much current for lighting as for other purposes. After consideration, the directors had started a deposit fund scheme, the main object of which was to encourage thrift, and thus enable the company's employees to make some provision for the future. It also gave them a direct interest in the success of the business by a form of profit-sharing, without involving them in any risk. All regular employees were allowed to deposit any number of shillings up to five each week. Interest was paid half-yearly at half the rate of dividend on the Ordinary shares, with a minimum of 4%. Being credited to the account, the interest became compound. At present 85% of the company's employees had taken advantage of the deposit fund, the average of the deposits being about 2s. each per week. There was at present a little over £900 in hand on account of this fund.

Mr. R. W. Wallace, K.C., seconded the motion, which, after a short discussion, was agreed to and the dividend confirmed.

GUERNSEY STATES TELEPHONES.

The annual report for 1909 of the Guernsey States Telephone Department, of which Mr. A. R. Bennett, M.I.E.E., Westminster, is consulting engineer, and Mr. R. McLean, manager and engineer, shows excellent progress. The mileage of overhead metallic circuit wire has been increased by 63, and of wires to subscribers' instruments by 1,515 yards. There are now 1,538 subscribers' lines, an increase of 79, and the total number of subscribers' and public calls during the year was 1,062,388, an increase of 71,801. It should be mentioned that the island tariff ranges from 30s. per year plus one penny per call, 45s. per annum plus a halfpenny per call, to 100s. with 3,200 free calls. The working expenses amounted to £1,592 (including £213 on reconstruction and £249 on line repairs), and the total revenue to £6,135, the net profit being £436.

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OVERHEAD TRANSMISSION OF POWER.

It is fairly obvious that if electricity is to be of any extensive service to British industry, overhead transmission for central stations where power can be most economically generated, must be the rule. This being so, it is worth while inquiring whether existing regulations seriously militate against overhead line construction. As we pointed out in our last week's "Notes," Mr. W. B. Woodhouse, Assoc. M.I.E.E., contends that they do. In his paper, a paper crowded with important information and hints, he declared that what was urgently needed to ensure expansion was the modification of the veto possessed by local authorities, the granting of power for compulsory acquisition of wayleaves, and less stringent Board of Trade regulations. Let us consider these points *seriatim*. No amending legislation has modified the restriction imposed by the Electric Lighting Act of 1882 upon undertakers, which compelled them to obtain the sanction of local authorities before erecting an overhead line. This regulation, therefore, belongs to a primitive state of affairs, when electric lighting was almost a novelty and the transmission of electric power over wires was unknown. Many argue that this affords an instance of legislators displaying unconscious wisdom, and, on the whole, it must be confessed, the restrictions have tended to greater safety existing in the United Kingdom as compared with the state of affairs existing in other countries. But safety could easily enough be provided for without unnecessarily penalising enterprise. Something, however, must be said on behalf of local authorities. As they are responsible for good government within their areas, have certain rights as regards the running of lighting and tramway departments, it is only just that they should have some voice in such a matter as the construction of an overhead wire system, involving not only the stretching of wires over thoroughfares and buildings, but the erection of poles and towers. A commercial undertaking cannot be expected to have the same

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solicitude for the general public as we naturally expect from local bodies elected by popular suffrage. Therefore, it would be useless for the electrician to expect, and unwise to demand, the total abolition of the local authorities' powers. The utmost that could be expected would be to secure the reduction of the absolute veto to a suspensory resolution. The undertakers should have power to appeal to the Board of Trade to secure an over-riding of local obstruction, providing that the local authorities shall be given a fair opportunity of arguing their point, bringing forward such objections as knowledge of local peculiarities would enable them to do. This, of course, would mean delay and expense, which are quite unavoidable where such a healthy jealousy of any infringement of local government exists. The complaint that the mills of government departments, while not always grinding exceedingly small, are almost invariably excessively slow, is only too well founded. Both the Board of Trade and the Local Government Board sin woefully in this matter of delay. This can only be remedied by a businesslike overhauling of the departments, which would have to include drastic modifications of the military incubus on the inspectorial staffs and of the lawyer influence leading to excessive red tapeism. Most people interested in electrical and, indeed, most other industries, will be at one with Mr. Woodhouse in his contention that compulsory wayleaves are necessary. An unreasonable landowner or tenant may retard an enterprise desired by a whole community, or cripple it by compelling most uncalled-for expenses. We have even seen a landowner, who had once held his Majesty's commission, refuse permission for the underground laying of telegraphic signal wires on the foreshore of a most dangerous coast, although this was most urgently required by the Coastguard service in the interests of humanity. When such scandals can happen in regard to public service, how much more are they likely to occur in connection with industrial enterprise? Certainly some machinery is required for the acquisition of compulsory wayleaves, some authority for fixing the nearest or most suitable line of route, and the amount to be paid for wayleaves. Such machinery exists in France, Italy, Switzerland and Norway, to the immense benefit of those countries. This is a case where the seeming cruelty of compulsion would be for the ultimate good of the recalcitrants. When we come to the question of modification of the Board of Trade regulations we are on more debatable ground. It must be confessed that the stringency of the regulations have produced good results as regards both comparative freedom from accidents and the high class nature of our engineering work. It may well be that with the recent advance of science many of the rules could be modified without danger, while giving greater facilities for expansion as the result of greater elasticity. It must always be remembered that in the United Kingdom, and more particularly in England, we are faced with a very different aspect of affairs than exists not only in America but in those European countries where high tension power is most developed. We have not the same great stretches of arid mountain ranges or lifeless plains. Our population is far more dense. This, naturally, imposes some restrictions. Allowing for this, however, it is probable that overhauling of the regulations, with a special desire to secure greater elasticity, is now due, if not overdue.

CORRESPONDENCE.

TO CORRESPONDENTS.

All communications intended for the Editor should be addressed "The Editor, 149, Fleet Street, London, E.C." Anonymous communications will not be noticed. Letters should reach the Editor not later than Tuesday afternoon to be included in that week's issue of the Journal.

The Editor is not responsible for, nor does he necessarily endorse opinions advanced by correspondents.

LIGHTNING CONDUCTORS.

Sir,—In your issue of February 18 was concluded a very interesting and racy article by Mr. Alfred Hands on "Lightning Conductors," and in the same number you inserted a few notes regarding a report by Sir Oliver Lodge on the same subject.

By those of your readers who are interested in this matter, the remarks of these experts are carefully read, and it is very tantalising, if I may say so, to find that you give us only scraps of Sir Oliver's report, when we are simply gasping for the whole thing. So far as I can gather, the battle is being fought by the two persons mentioned above—Mr. K. Hedges having apparently dropped out of it—and if you could see your way to publish Sir Oliver's report in full, together with an editorial summing up of the matter, it would undoubtedly assist our vision, for notwithstanding all that has been done towards clearing the atmosphere, the outlook is still very hazy, and we are sadly needing some really safe and sure conductors.

Yours, etc.,

February 25. W. H. B.

[Other readers having expressed a desire to see Sir Oliver Lodge's report, we comply with the request, and reprint it in this issue.—Ed.]

"GOTHIC WORKS" ANNUAL DINNER.

More than usual interest attached to the annual dinner of the employees of Messrs. Laurence, Scott & Co., Ltd., held in Norwich, this being the 21st annual gathering of the sort, and the first since the "coming of age" of the company last year, and in honour of the event, those attending the dinner found themselves the guests of the directors, who had taken upon themselves the responsibilities for the evening's entertainment.

Owing to the unavoidable absence of Mr. Laurence, the chair was taken by Mr. Cecil Wilson, who was supported by Messrs. W. H. Scott and W. B. Sibling.

The toast of "The King" was loyally honoured, and was followed by that of "Success to the Firm."

Mr. Wilson, in responding to the latter, traced the continued progress of the company since its registration in 1888. In spite of the general depression of trade, and in particular the decreased shipbuilding output of the past year, they had felt themselves justified in putting in hand another considerable extension to the works, which was now nearing completion, and would, he hoped, soon be full of work. To meet the keen and increasing competition experienced in the engineering trades, the company relied to a large extent on a continuance of the hearty co-operation between employers and men that had given such good results in the past. He referred to the success of the various athletic clubs and the social organisations got up among the employees at Gothic Works, and said that these had the hearty support of the directors. He concluded with a reference to the pensions fund and to the sick club and insurance schemes in connection with the works.

Mr. Scott, in proposing "The Staff," also spoke of the good feeling existing between all sections at the works, and said that this was a most important factor in the cheap production of high-class work.

The toast list was interspersed with a most enjoyable programme of song and sketch, and a pleasant evening was brought to a close with the singing of the National Anthem. The arrangements for the evening were in the hands of a committee of the workmen.

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NEW ELECTRICITY WORKS AT DUNDEE.

On Wednesday, February 23, there took place at Dundee the formal inauguration of a new municipal power station. A large and distinguished company was presided over by Ex-Bailie Don, convener of the Electricity Committee, who introduced Professor J. A. Ewing, of the Education Department of the Navy, in performing the opening ceremony, who set one of the turbines in motion. At the conclusion of the ceremony the company were entertained to luncheon, at which Lord Provost Urquhart, of Dundee, presided. In proposing the toast of the "Electricity Department," Dr. Ewing said that Dundee's capital cost of £39 per kw. of output was one of the lowest in this country. He understood the Corporation were ready to supply power at less than ½d. per unit. With such a figure as that they might hope to see a large number of factories adopt electric power and so abolish "these magnificent obelisks," which led Dundee to be described as not so much a landscape as a "lumscape."

The site of the new station is within the boundary of the harbour, 1½ miles to the east of the centre of the city. There is an ample supply of condensing water from the River Tay, and a convenient railway siding gives facilities for cheap transport of fuel.

As the ground is deposited material it was decided to support the buildings upon piles of reinforced concrete. Over 300 of these have been required, in groups according to the load to be carried. A reinforced raft 3½ in. to 4 in. thick is constructed over the piles.

The buildings are of red brick with a supporting steel framework for the roofs, travelling crane, and bunkers, the steel work being supplied by the Clyde Structural Iron Co.

The generating station consists of two complete units arranged about a centre line through the chimney. To keep the directly unproductive capital at a minimum the buildings are left just sufficient to accommodate the plant at present installed, although extension will be easy when it is found necessary, even should other types of plant be then decided upon.

The boiler house is 105 ft. long 40 ft. wide, and 52 ft. 9 in. from the basement level to the eaves. The bunker house is the same length, 20 ft. wide and 65 ft. from the basement level. The boiler house is particularly well lit. Coal is brought in by the siding and shunted by means of a small electric locomotive. The wagons, having been weighed and rushed into a revolving tippler, are emptied one at a time into a receiving hopper. Transferred by a tray conveyor to the main gravity bucket conveyor the coal is raised to the bunkers. The overhead bunkers have a capacity of about 700 tons. Coal is withdrawn for use through valves at the bottom, and after passing through measuring boxes falls down the shoots into the boiler hoppers. The ashes descend by gravity to the basement, and after cooling are elevated by the main conveyor into the ash bunker at the end of the coal bunkers.

There are four Babcock & Wilcox water tube boilers, each capable of evaporating 20,000 lbs. of water per hour at a pressure of 180 lbs. per sq. in. The boilers are fitted with superheaters to give 150° F. superheat. Each boiler is fitted with two motor-driven chain grate stokers with a total grate area of 120 sq. ft. The hot gases from the boilers are passed through two Green's economisers of 360 tubes each, thus raising the temperature of the feed water about 90° F. Special arrangements have been made for dealing with large quantities of dust in the flues so as to facilitate the use of the cheapest fuel.

The chimney is 9 ft. internal diameter, and 204 ft. high. Regulating damper levers CO_2 and draught recorders, which can be connected to any boiler or flue, the feed pump regulating valves, feed pressure gauges, all in a convenient position, are fixed at the base of the chimney.

The steam piping, which is by Messrs. Airton & Co., consists of an 8 in. header in the boiler house, and each boiler is connected to this header by 6 in. branches. There is an 8 in. branch to each turbine.

The engine room, 120 ft. long, 50 ft. 1 in. wide, and 49 ft. high from the floor level to the eaves, has an upper floor of reinforced concrete on the Columbrian system, 14 ft. 9 in. above the floor level. Two Willans-Parsons steam turbines are directly coupled to Dick Kerr alternators of 2,000 kw. each, but capable of giving 2,500 kw. for 2 hours, or 3,000 kw. for ½ hour. The generators are 3-phase, 6,000 to 6,600 volt machines, 50 cycles per sec., 1,500 r.p.m. The "Contra-flo" condensers situated immediately next to the turbines are capable of maintaining a vacuum of 28½ in. at full load.

Two "Weir" pumps, each with a capacity of 8,000 gal. per hour, are situated in the engine room between the two hot wells. Two 300 kw. motor generators transform the high tension current down to 200 and 400 volts for driving the auxiliary machinery, and for public supply in the adjacent area. The switchboards are designed in keeping with the most up-to-date practice, special precautions being taken to eliminate danger of shock. A battery of 102 Tudor cells of 840 ampere hour capacity have been installed in the uppermost floor of the switch house.

The pumping machinery for circulating cooling water through the condensers is situated in an underground pump room sunk at the edge of the Fish Dock. The pump room is of reinforced concrete 14 ft. in internal diameter and 27 ft. deep below ground level. It was constructed in cylindrical sections above ground level, and afterwards by excavating within and loading with weights, was sunk to the desired depth.

The two centrifugal pumps of 200,000 gal. capacity, each by Messrs. W. H. Allen, Son, & Co., are situated below the lowest water level, and are driven by vertical spindle variable speed motors of 63 h.p. each, fixed above ground level. These motors are started, regulated, and stopped from the main station.

The transmission cables are by the British Insulated & Helsby Cables, Ltd.

The whole works, which have taken three years to complete, have been carried out to the designs and under the supervision of Mr. H. Richardson, the City Electrical Engineer. The site leaves room for unlimited extension, and, in the words of Dr. Ewing, "the Corporation of Dundee are to be congratulated on having had the good sense to leave the work in the hands of Mr. Richardson instead of going to some outside expert."

REVIEWS.

"Telephonology": A description of Modern Telephone Appliances. A Common-Sense Treatise on the Erection, Equipment and Maintenance of Telephone Exchanges. Line, Instrument and Switchboard Troubles and their Remedies. Apparatus, Line and Cable Testing. By H. R. Van Deventer, B.S., E.E., and other experts. Size, 6¼ in. by 9¼ in., 590 pp., and 682 illustrations. (McGraw-Hill Book Co., New York, price 15s. net.)

The first thing that strikes one about this book are its main and sub-titles, and the second its vast number of illustrations. The four sub-titles, given above, have the merit of giving a very good idea of the contents of this portly volume. The work does not profess to be a history of telephony, and the whole of it is devoted to present types of telephone apparatus and present methods of installation, testing and maintenance, according to American practice. The majority of the illustrations are fine drawings, but many of these suffer from over-reduction, so much so, that details and lettering are often rather too fine for the average eye. The opening chapters deal with first principles and the constructive details and theory of the various signalling and speaking parts of telephone apparatus. Next follow sections on magneto instruments, circuits, and switchboards, selective and lock-out systems and batteries. Two chapters are devoted to testing and fault location, and one to measuring instruments and their uses. Common battery and party line systems are next dealt with, then line and cable construction, after that automatic and composite systems, and finally a chapter on wireless telephony.

The book undoubtedly contains a very great deal of practical information that will prove useful to the telephone engineer on this side of the Atlantic. The work is written in unmistakeable Americanese, but the style and the spelling may add a zest to its perusal. Here are a few examples: On page 17, we find—"The resistance due to self-inductance equals 6·2832 multiplied by the frequency of the current times the Henrys." It is explained in a footnote that resistance here really means reactance; but this does not excuse the construction of the latter

part of the sentence. There are a number of long extracts from the *American Telephone Journal*. This is a portion of one on page 160: "And last, but not least, send your trouble man around to one of these instruments, and when he unwittingly gets a screw driver or a pair of pliers across the right springs in the hook switch, he most assuredly will be possessed of the idea that the irascible and implacable brute—that incarnate thunderbolt—that monster of the upper deck—an 'old horny headed ram,' has struck him fair and hard, at which he will inform you in terms in no manner effeminate that you may have your choice of either changing your brand of instruments or forthwith put out the placard for another bug shooter!!"

The work is primarily written for American readers, but as our cousins have undoubtedly had a large hand in the development of practical telephony, there is much to be learnt from their work.

"Auto-Transformer Design," by A. H. Avery, A.Inst.E.E. (S. & F. N. Spon, 3s. 6d. net.)

This little book of 50 pages opens with an estimate to show the advantages of using metallic filament lamps with an auto-transformer, for an installation of 50 16 c.p. and 24 c.p. lamps assuming the current consumption to be equivalent to the whole of the lamps being in use for one hour per day throughout the year. The figures are :—

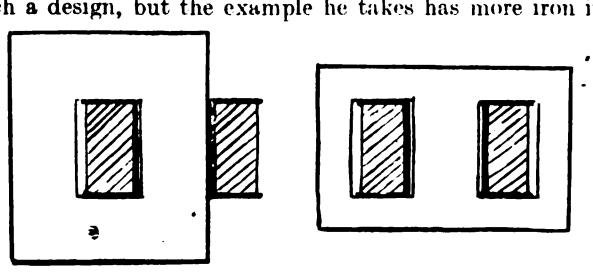
Metal Filament Lamps.

	£	s.	d.
Initial cost of 74 lamps at 3s.	11	2	0
1 k.w. auto-transformer	2	19	6
Annual cost of current at 4½d. ..	7	0	0
Iron losses	2	0	0
	23	1	6

Carbon Lamps.

	£	s.	d.
Initial cost of 74 lamps at 1s.	3	14	0
Annual cost of current at 4½d. ..	27	0	0
	30	14	0
	23	1	6
Saving effected at end of first year ..	7	12	6

The author skims over the theory of transformer design and gives fundamental formulæ etc. He points out that the energy loss in the iron is the most important matter in such a design, but the example he takes has more iron in



A B

it than is necessary. In the Fig. herewith A is the iron circuit calculated out by the author and B shows how it might have been made, to have much less iron; when working out the extra turns to allow for pressure drop the author figures on the secondary drop only. Although in calculating for copper loss he allows for both primary and secondary. As a first book on the subject it is not bad but the author should revise it considerably before issuing another edition.

CATALOGUES AND PRICE LISTS.

Pamphlet No. 6 of the Nederlandsche Instrumenten Fabriek, of Utrecht, deals with switchboards: type H. dead-beat moving coil ampere and voltmeters for continuous current, and type A. soft iron ampere and voltmeters for both continuous and alternating currents.

An illustrated leaflet of the Small Power Dynamo & Motor Co., Ltd., is devoted to semi-enclosed and ventilated enclosed small direct current dynamos and motors, a compact form of special charging dynamo, and motor starting rheostats.

A new little booklet from Messrs. Gibbons Bros., Ltd., gives pictures and details of a great variety of elevating and conveying plant as applied to all kinds of businesses.

A timely publication is that issued by Messrs. Ernest F. Moy, Ltd., dealing with cinematograph resistances. It describes a new form of appliance, possessing the special advantage of being able to be fixed at a distance from the lamp and projecting chamber without loss of efficiency.

Messrs. W. F. Dennis & Co. have brought out a revised price list of stocked "Fredennis" supplies.

Reprint No. 517c of Messrs. Siemens Bros. & Co., Ltd., gives a very interesting and instructive account of "The Lighting of Rossall School," in which the Stannos system of wiring was used.

Arc Lamps, Ltd., St. Albans, makers of the Davy "Sunræ," give particulars in an illustrated catalogue of various types of flame arcs for both direct current and alternating current; and also of their enclosed arc shuntless lamps, which do away with the trouble from burnt-out shunt coils. This system is applied to many types, including very useful patent photographic and photo printing arc lamps.

Messrs. G. A. Vandervelle & Co. send us three excellent examples of trade catalogues. The "C.A.V." catalogue is a large pamphlet of 52 pages, containing photographs, diagrams and particulars of accumulators, ignition coils, magnetos, electric driving lamps, and electrical specialities for the motor and allied trades. "Electricity *v.* Acetylene and Oil" introduces the "C.A.V." system of electric lighting for motor cars, motor boats, etc., by variable speed dynamos, manufactured under the Leitner patents. It is well compiled and gives some useful wiring diagrams. A leaflet gives "A Few Hints on the 'C.A.V.' Dual Ignition Magneto," with particulars of spare parts cases. It contains illustrated keys to the apparatus and parts.

The Yorkshire Boiler Co., Ltd., have compiled a pamphlet on their steam specialities, which comprises much information not easy to find elsewhere. Particulars are given as regards their boilers, "Leeds" feed-water circulators, gauges and indicators of various kinds, air-tight and automatic dampers, and torpedo smoke preventers.

Messrs. Richard Pope, Ltd., send us their "Fors" accumulators catalogue for 1910. The "Fors" accumulator is a handy type, embracing some novel features, among others the retention of a charge "indefinitely" when the battery is not in use. They are made up for various classes of work—motor cars, lighting and ignition, portable lighting for yachts, medical, scientific and X-ray work. The catalogue also includes particulars of the "Fors" hand lamps and the "Eley-Fors" patent electric safety miners' lamp.

Messrs. Pritchetts & Gold have brought out a handsome looking show card of their accumulators, suitable for window and shop display. The firm are prepared to send copies to dealers who may desire to have them.

The A. E. G. Electric Co.'s February abridged price list is a large octavo pamphlet of 121 pages. Besides being well illustrated, with very full information on each item, it contains a most useful "Explanation of Technical Terms," also illustrated.

The Vincit Co., Ltd., have brought out a handsome album giving particulars of their Carborundum and Electrite specialities. The pamphlet contains much information in a handy form that it is incumbent for contractors and dealers to know. The book is, therefore, well worth filing.

The Phœnix Dynamo Manufacturing Co.'s, Ltd., latest pamphlet describes their special machine called "Cine-Converter," designed particularly to meet the requirements of arc lamps for theatrical and cinematograph work. It is claimed that this machine is of much higher economy than an ordinary motor generator, and the Phœnix people have specialised three particular sizes for the work in question.

The considerable increase in the use of the metric system has induced Messrs. the Newall Engineering Co. to publish their standard "Tables of Limits" for diameters up to 150 mm. in metric sizes. These are printed on a card in an easy form to refer to. We may mention that copies of the card will be sent free to any applicant.

The Globe Electric Co., Ltd., have prepared for the trade a convincing leaflet on their "Multax" long burning flame lamps and "Bridgecore" carbons.

"Prepayment meters" is the subject of the latest of Messrs. Ferranti's publications. It is well illustrated and contains much explanatory letterpress.

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PUBLICITY.

In this Section of "The Electrical Engineer" we give Publicity to New Inventions and Specialities.

OSRAM LAMPS IN STREET LIGHTING.

Much has been written during the past two years regarding the economies that can be effected by the use of metallic filament lamps in the place of carbon and arc lamps for both interior and exterior lighting, and while the saving in the use of these lamps and their practicability for interior lighting have long ago been amply demonstrated, we are only just accumulating evidence of the value of such lamps for the lighting of streets and other open spaces. In the Grove, at Hammersmith, a wide, busy thoroughfare, 400 c.p. Osram lamps have been fitted in the arc lanterns, and at a recent meeting of the Hammersmith Borough Council, the Electricity and Lighting Committee reported that by converting the system as indicated, the cost of the electricity department for lighting the Grove has been

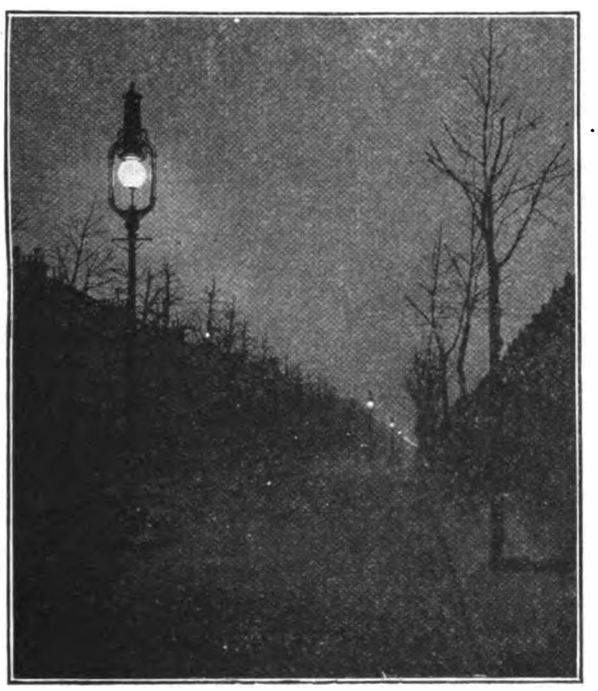
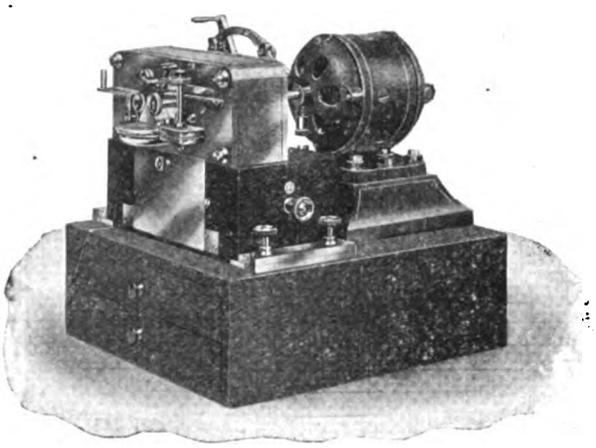


PHOTO TAKEN ON A RAINY AND FOGGY DECEMBER NIGHT.

reduced by no less than £40 per annum, equivalent to a saving of £2 16s. per lamp per annum. This testimony, coming as it does from absolutely independent and unprejudiced sources, confirms the optimistic predictions that were originally made for Osram lamps for street lighting, and there now seems no doubt whatever that its wide adoption for this purpose is assured. With regard to the life of "Osram" lamps for street lighting, records to hand show that they burn for an average of over 3,000 hours, which entirely disposes of the suggestion that has frequently been made, that these lamps would not withstand the vibration in busy thoroughfares due to heavy traffic. We hope to give from time to time the cost of using Osram lamps for street lighting on other London districts.

DIRECT DRIVE FOR TELEGRAPH APPARATUS.

Of the various systems to replace clock-work and weight attachments to Wheatstone and other automatic telegraphic apparatus by the direct motor drive, Mulligan's system gives the most satisfactory results. The Mulligan patents, which are controlled by Messrs. Siemens Bros. & Co., Ltd., have the advantage of being applicable to both the transmitting and receiving instruments, and to any form of machine with very little adaptation. Indeed, the main attention is the removing of the weights or clockwork and handles, and the affixing of the motors. The compactness of the attachment may be seen by the accompanying illustration of a Wheatstone receiver in use at the General Post Office, London. The motor requires from 24 to 30 volts to drive it, and consumes from 5 to 7·5 watts, according to the speed at which it is worked. These motors work wonderfully smoothly, and are found to do away with the stoppages and wrong signalling sometimes associated with weight or clockwork-driven machines when overwinding results in irregularity of speed. As we have said, the Mulligan system can be applied to any type of weight or



spring-driven apparatus, and, moreover, it can be worked from a section of the battery which usually supplies the circuit on which the automatic apparatus is installed. At the G.P.O. Central Telegraph Office the Mulligan motor attachment is chiefly used in connection with circuits where the received Morse slips are gummed on forms. At cable stations they are appreciated owing to their being automatic and reliable, running at a uniform rate as fixed by the governor, the only care required being to see that the voltage is constant. It is to be noted that the switch connecting up the transmitter also starts the motor, and the same mechanical speed governor is used for the direct motor drive as for the weight-driven apparatus. The system, in fact, is essentially one of simplification and the acquisition of greater accuracy and economy of working.

COMBINED A.C. AND D.C. TRANSFORMER.

The Crypto Electrical Co. are placing on the market a new type of combined alternating to continuous current transformer, which has been designed to work on any alternating current mains to transform to continuous current for such purposes as charging accumulators, lighting arc lamps, starting lifts, etc. This machine, as is the case with their smaller type, is arranged so that the alternating current and continuous current sides are self-contained in one frame, thus eliminating one pair of bearings and the cast iron base, which must be used if the old pattern motor generator is installed. This new machine will give an output of 100 watts on the secondary. They will send an illustrated circular to any reader on demand.

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Electrical Contractors' Section.

A Survey of New Things and Business Prospects.

NOTES ON NOVELTIES AND IMPROVEMENTS.

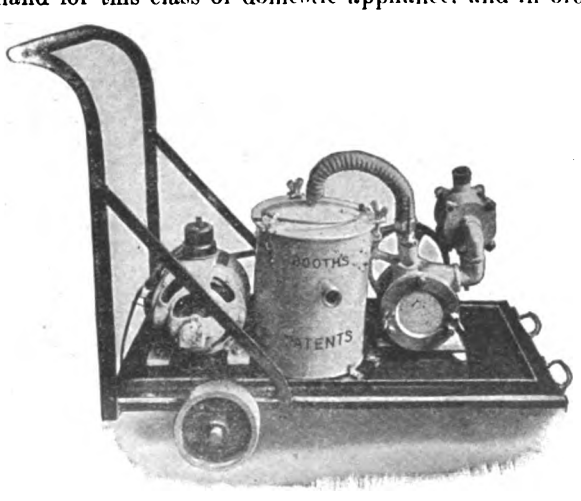
It is sometimes alleged against electrical contractors that there is lacking in their business methods that "push" which is necessary to make electrical novelties popular with the public. Whatever there may be in this belief, which, in our opinion, is exaggerated, there can be no question that this particular field offers immense scope for enterprise. Anyone acquainted with the Continent must have noticed that their domestic electrical novelties are much more extensively in use than they are in this country; in the laundry, the kitchen, the dining, drawing, and bedrooms, electrical appliances are much more in evidence than they are in the houses of the well-to-do in this country, and we cannot too strongly urge upon the electrical contractor to actively canvass this lucrative field for business, even if it is necessary to act in some kind of co-operation with the local supply undertaking. At all events, it cannot be said that there is lacking a supply of electrical appliances, suitable for domestic use, which should not command a ready sale.

BOOT POLISHER.

For instance, there is one novelty which has come to our notice, which, if not very cheap at first sight, is one for which a ready sale might be found in hotels, clubs and mansions. We refer to the "Domestic" electric boot polisher, which Messrs. Wright & Wood, Ltd., of the Century Works, Halifax, has just placed upon the market. This handy little plant consists of a motor and two circular brushes, and is intended for use in private houses, hotels, institutions, steamships, and other places where many boots require cleaning every day. Compared with the hand method, not only is the machine cleanly, but it does the work more rapidly, and we have no hesitation in accepting the statement of the makers that the initial cost is soon earned by the saving of time and labour effected. The motor can be run with alternating or continuous current. The machine is supplied with flexible cord and connector for attaching to a lampholder or plug. Messrs. Wright & Wood, we may add, by the way, have introduced improvements in their electric motors, which is calculated to afford the user a distinct assurance of high efficiency and service.

VACUUM CLEANER.

Another article to which we would invite the attention of the electrical trade is the small portable vacuum cleaner, which, to adopt a popular mode of expression, "has come to stay." The many portable electrically-driven cleaning outfits at present on the market furnish evidence of the demand for this class of domestic appliance, and in order



to demonstrate to users the advantages of this type over cleaners operated by other means, it is necessary to push it energetically. The electrically-driven machines introduced by the British Vacuum Cleaner Co., Ltd., of Parsons' Green-lane, London, S.W., deserve special mention. The smallest sizes act on the bellows principle, but in other outfits a rotary vacuum pump is used. One machine in particular operating on the latter principle, and driven by a half horse-power motor, deserves mention. It can be switched on from any lampholder, and is supplied complete with 15 yards of hose and an assortment of nozzles and brushes. The whole equipment is 3 ft. long by 18 in. wide, and 18 in. deep, fitted on a trolley which runs on three broad rubber wheels. The rotary pump is of very simple construction; it runs at 650 r.p.m., and produces a working vacuum of 15 to 18 in.

WINDOW DISPLAYS.

No apology is necessary for urging upon contractors to cultivate with might and main the market for domestic appliances of the types mentioned. Those who possess showrooms in commanding positions in streets should make a speciality of attractive window displays so as to interest the passer-by in the scope for electrical appliances. One thing it is necessary to bear in mind. Manufacturers who have gone to considerable expense in laying down plant for the production of these articles are not likely to neglect opportunities for selling them, and unless contractors can create a demand for them, the manufacturers will have to do it themselves, and the result will be—direct trading.

CONTRACTS WORTH WATCHING:—

Below we present a list of building contracts which have recently been placed. We have no means of ascertaining whether electricity will be used at all; but it is evident that in the majority of cases electricity will be used either for lighting or for power, or for both. Where names of firms are mentioned they are those of the builders or contractors who have the work in hand, and it will repay electricians to keep in touch with these jobs.

Altrincham.—H. Beswick, Esq., County Architect, Chester. Boys' Secondary School.

Blackpool.—Dryland & Preston, Blackpool. Art Gallery and Library.

Bristol.—Stephens, Barlow & Co., Ltd., Bristol. School.

Bromley.—F. P. Duthoit, Westmoreland-road, Bromley (Kent).

Chipping Barnet.—U. A. Smith, County Surveyor, Hatfield. New Manual Instruction and Cookery Centre.

Coventry.—A. J. Lord, Wolston, Coventry. School.

Darlington.—W. Bell, Architect to the North Eastern Railway, York. Offices for locomotive department at Stooperdale, Darlington.

Dewsbury.—Kirk, Sons & Ridgway, Architects, Dewsbury. Large six-storey fireproof warehouses and offices.

Eastbourne.—£3,000 to be spent on enlarging the Princess Alice Hospital.

Exeter.—Westcott, Austin & White, Summerland-crescent. Exeter. Church.

Ilford.—H. J. Carter, Grays, Essex. Hospital.

Lincoln.—T. Harper, Carlton, Notts. School.

Okehampton.—Blatchford & Dawe, Okehampton. Drill Hall, etc.

Pontefract.—S. R. & T. Kelsey, Goole. School.

Sale.—H. Beswick, County Architect, Chester. County High School for Girls.

Seaton Delavel.—Middlemiss Bros., Newcastle-on-Tyne. Hall.

Shrewsbury.—F. H. Shayler and J. A. Swan, Architects, 16, Pride-hill, Shrewsbury. Secondary School for 350 pupils.

Torquay.—Large hall to accommodate 1,500 people in the Pavilion, Princess Gardens.

Towcester.—Sturgess & Sons, Northampton, Engineering Works.

Tynemouth.—Fenwick, Stephen & Co., Newcastle-on-Tyne. Workhouse extensions.

Waterloo.—Henry Littler, County Architect, Preston. Secondary and Technical Schools at Seaforth.

Westcliffe-on-Sea.—F. E. Woodhams, Southend. Hall and Schools.

Yeovil.—S. Duckworth, Secretary of Co-operative Society, Ltd. New premises.

See also page 278.

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MAJOR'S INSULATING VARNISH.

THE VARNISH THAT RETAINS ITS EFFICIENCY
UNDER THE MOST SEVERE WORKING CONDITIONS.

MADE IN ENGLAND.

Samples and particulars from MAJOR & Co., Ltd., Sculcoates, HULL.

JOINT PUBLICITY.

With reference to our notice in last week's paper on the Electric Supply Publicity Committee of London and District, it should be stated that the scheme has received very considerable and very influential support. All the leading London companies and municipalities have joined, and, in addition to these, a very large number of provincial companies, even up to the present time; and a number of others are communicating with Mr. Renwick after their various committees have been consulted. A list of the provincial people who have so far come in is as follows: Loughborough, Harrogate, Nuneaton, Lowestoft, Midland Co. (Leamington), Aberdeen, Blackpool, Gosport, Leatherhead, Newmarket, Weymouth, Wolverhampton, Dundee, Derby, Devonport, National (Preston), Mansfield, Grimsby, Tunbridge Wells, Ipswich, Northampton, Southampton, Hanley, Ross, Bournemouth, Coatbridge.

We understand that the support which has been given to the poster by the provincial companies is most gratifying. The fact that it has been so designed as to be applicable for anywhere, and the heading made interchangeable for any town, has been widely appreciated. It may be stated that the sub-committee appointed to deal with the details are: H. B. Renwick (chairman), (County of London Co.), E. Cunliffe Owen (Metropolitan Co.), A. C. Cramb (Croydon Borough Council), E. Sayer (Hampstead Borough Council), with Mr. F. J. Walker acting as hon. secretary.

PERSONAL.

Mr. W. G. Hunter has resigned his post as Publicity Manager to the Union Electric Co., in order to embark on his own account as an advertising specialist, under the title of the Adcraft Studio, at Thanet House, 231, Strand, W.C.

Mr. R. W. Weekes, M.I.E.E., whose editorial connection with this paper ceased in July last, is now devoting his whole attention to consulting practise, carried on at Maxwell House, Arundel-street, Strand.

Mr. R. B. Leach, M.I.E.E., who during his five years' connection with the Farnworth Urban District Council as their resident electrical engineer and manager, carried out all the extensions and re-designing of old works, bulk supply scheme from the Lancashire Electric Power Co., the equipment of the destructor works and so on, has resigned his post to take up consulting and private work. His headquarters are at Manchester. He has, however, been appointed consulting electrical engineer to Farnworth, where he has been succeeded by his chief assistant, Mr. A. J. Hutchinson.

Mr. G. W. Humphreys, of Cardiff, has been appointed Secretary of the Institution of Mining Electrical Engineers, Welsh branch.

Mr. A. J. Beckett, electrical engineer to Bridlington Town Council, has definitely been appointed consulting engineer as well, with the intention that he should supervise various extension works.

Mr. Charles Bright, F.R.S.E., has been appointed consulting electrical engineer to the Government of the Commonwealth of Australia.

Mr. Archibald Robertson, manager of Rothesay Tramways Co., has been appointed general manager of the tramway undertakings controlled by the British Electrical Federation in Scotland—the Greenock and Port Glasgow, the Airdrie and Coatbridge, and the Rothesay Co.'s.—with headquarters at Greenock. Mr. H. H. Hill will be responsible for the working of the Rothesay Co.

Mr. A. R. Foskett, late assistant tramway engineer and car-shed superintendent to the Corporation of Chesterfield, has been appointed assistant manager of the Sunderland District Tramways Co. Before leaving Chesterfield Mr. Foskett was the recipient of presentations from the engineering staff and tramway employees and the boiler-house staff.

NOTICE.

Contract and Miscellaneous Advertisements should reach this Office by Mid-day on Wednesday. For rates apply to the Manager, 149. Fleet Street, London, E.C.

CONTRACTS.

COUNTY BOROUGH OF WIGAN.

WIGAN CORPORATION TRAMWAYS DEPARTMENT.

The Tramways Committee of the Wigan Corporation are prepared to receive Tenders for the supply of Timber, Glass, Varnish, Overhead Line Materials, Paint and Tramway Accessories and Ironmongery.

Specifications and Forms of Tender may be obtained on application to Mr. J. FLEVIN, Tramways Engineer and Manager, Bradford Place, Wigan.

Tenders, endorsed with the name of the article tendered for, to be addressed to the Town Clerk King Street West, Wigan, and must be received not later than Monday, the 21st inst.

The Committee do not bind themselves to accept the lowest or any tender

HAROLD JEVONS,
Town Clerk's Office,
2nd March, 1910. Wigan.

COUNTY BOROUGH OF WIGAN.

WIGAN CORPORATION ELECTRIC LIGHT DEPARTMENT.

The Electric Light Committee of the Wigan Corporation are prepared to receive Tenders for the supply of Cables, Carbon, Electric Accessories, Ironmongery, Engine Room Stores.

Specifications and forms of tender may be obtained on application to Mr. J. FLEVIN, Electrical Engineer, Bradford Place, Wigan.

Tenders, endorsed with the name of the article tendered for, are to be addressed to the Town Clerk, King Street West, Wigan, and must be received not later than Monday, the 21st inst.

The Committee do not bind themselves to accept the lowest or any tender.

HAROLD JEVONS,
Town Clerk's Office,
2nd March, 1910. Wigan.

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CONTRACTS—continued.

POWER HOUSE.

TENDERS are invited for the ERECTION of an ELECTRIC POWER HOUSE at Gwaun-Cae-Gurwen Colliery, near Brynamman.

Plans and full particulars can be seen on application at the Colliery.

Sealed tenders to be in by March 4, 1910, addressed to—

J. HARGREAVES, Esq.

Gwaun-Cae-Gurwen Colliery,

Gwaun-Cae-Gurwen.

URBAN DISTRICT OF CLECKHEATON.

ELECTRICITY WORKS.

The Council of the above District invites TENDERS for the Supply and Erection of a LANCASHIRE DYNAMO TYPE OF AUTOMATIC REVERSIBLE BOOSTER for Traction Purposes, complete, with Switchboard and all other accessories.

Specifications may be obtained from me at my Office, upon payment of the sum of £2 2s., which sum will be refunded on return of the Specification with a *bona-fide* tender.

The Council do not bind themselves to accept the lowest or any Tender, but no Tender will be considered from any firm who has not already carried out an installation of this character, and which is working with satisfactory results.

The successful Tenderer will be required to enter into the usual Contract and Bond.

Tenders marked "Booster" must be delivered at my office not later than 4 o'clock on Wednesday, the 9th March, 1910.

JOHN H. LINFIELD,
Clerk to the Council.

Town Hall, Cleckheaton,
February 25, 1910.

BARROW-IN-FURNESS.

ELECTRICITY DEPARTMENT.

The Corporation are prepared to receive TENDERS for the supply of:—

(1) STEAM COAL.

(2) OILS, ENGINE ROOM STORES, TOOLS, IRONMONGERY, &c.

(3) ELECTRICAL STORES.

Required at the Electricity Works during the year ending March 31, 1911.

Forms of Tender may be obtained and samples of materials, &c., may be seen on application to the Borough Electrical Engineer, at the Electricity Works.

Sealed Tenders, on the forms provided, addressed to "The Chairman, Electricity Committee," and endorsed "Messrs..... .....Tender for Coal, Oil, &c.," must be delivered at my office not later than 12 noon on Monday, March 7, 1910.

The lowest or any tender will not necessarily be accepted.

By Order,
L. HEWLETT,
Town Clerk.

Town Hall, Barrow-in-Furness.

PATENTS.

S. SOKAL, Chartered Patent Agent,
AND
Certified Austrian Patent Attorney (Patentanwalt),
55, CHANCERY LANE, LONDON, W.C.

THE PROPRIETOR of the PATENT No. 5301 of 1907 for "Electric Furnace" is desirous of entering into arrangements, by way of license and otherwise, on reasonable terms, for the purpose of exploiting the same, and ensuring its full development and practical working in this country. All communications should be addressed, in the first instance, to HASELTINE, LAKE & CO., Chartered Patent Agents and Consulting Engineers, 7 and 8, Southampton-buildings, Chancery-lane, London, W.C.

THE PROPRIETOR of LETTERS PATENT No. 5332, of 1907, relating to "Wireless Telegraph or Signalling Systems," desires to dispose of the Patent, or to grant Licences to interested parties on reasonable terms, with a view to the adequate working of the Patent in this country.—Enquiries to be addressed to Cruikshank & Fairweather, Ltd., International Patent Agency, 65-66, Chancery-lane, London, W.C.

PLANT FOR SALE.

Advertisements under this heading: Twenty-four words, 1s. per insertion; three insertions for 2s. 6d.; or each additional line of eight words, 4d.

STEAM ENGINE.
30 B.H.P. vertical, simple double acting, non-condensing.

TWO DYNAMOS.
One Easton 16 K.W. shunt wound dynamo, 100/105 volts or 140, 900 r.p.m., and one 5 K.W. compound wound dynamo, 105 volts, 890 r.p.m.

BELTS. **ENGINE ROOM SWITCHBOARD.**

BATTERY.
E.P.S. 56 cells, type P. 17, complete.

MOTOR.
8 B.H.P. shunt wound, by Crompton, semi-enclosed 110 volts, 750 r.p.m.

Apply to Mr. D. SPERO, 31, Duke Street, Aldgate, E.C.

HORIZONTAL HIGH PRESS CONDENSING ENGINE for sale by Woodhouse & Mitchell, capable of developing 20 to 30 h.p., first rate order. Selling as more power is wanted. —For particulars apply Box O, c/o THE ELECTRICAL ENGINEER, 149, Fleet Street, E.C.

FOR SALE, ELECTRIC LIGHTING PLANT, consisting of shunt-wound Dynamo, belt-driven, and National Gas Engine; also Switchboards, &c.; output 30 amps. at 100 volts. —Address, W. H., c/o THE ELECTRICAL ENGINEER, 149, Fleet-street.

DYNAMO, 220 to 240 volts, 110 amps., spare armature, in good order.—Address, C. R., c/o THE ELECTRICAL ENGINEER, 149, Fleet-street.

CROMPTON SHUNT DYNAMO, 65 volt, 54 amp., in first-class condition.—W. S., c/o THE ELECTRICAL ENGINEER, 149, Fleet-street.

ELECTRIC POWER DYNAMOS, MOTORS, CRANES, and HOISTS; several FOR SALE.—Address, S. H. P., c/o THE ELECTRICAL ENGINEER, 149, Fleet-street.

PLANT WANTED.

PLATINUM UTENSILS, SCRAP, LAMP TOPS.—Best prices given by DERBY AND CO., LTD., 44, Clerkenwell Road, London, E.C. N.B.—Platinum Sold.

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TO ENGINEERS, ARCHITECTS, AND OTHERS.

WESTMINSTER.

Exceptionally light and spacious OFFICES, near Victoria-street, Houses of Parliament, and District Railway station, consisting of 16 rooms on two floors, with private staircases, and having a total floor space of about 6,300 ft. super. Rent very moderate.—Particulars, plan, and order to view of Messrs. Trollope, 5, Victoria-street, Westminster.

Telegrams: "Cuivre, London."
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COPPER EXPANSION PIECE.
EXHAUSTING TURBINE ENGINES.
HIGH-CONDUCTIVITY CASTINGS & COPPER FORGINGS
JOHN DORE & CO.
Coppersmiths and Brass Founders,
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APPOINTMENTS.

CORPORATION OF DUBLIN.

ELECTRICIAN WANTED.

The Improvements Committee of the Corporation of Dublin REQUIRE the services of an ELECTRICIAN in connection with the running of the Main Drainage Pumping Station, Clontarf, which is electrically driven.

Age not to exceed 30 years.

Application must be accompanied by proof of age and copies of testimonials, and should be received by me not later than 10 o'clock on Tuesday, the 8th proximo.

The person appointed will be paid the Standard Rate of Wages of his Trade Society. He will be subject to medical examination as to physical fitness for the discharge of his duties, and shall be required to prove that he has been residing in Dublin during the past two years, at least.

By Order,
PATRICK TOBIN,
Secretary.

City Hall, Dublin.
February 25, 1910.

CANVASSER AND SHOW ROOM MANAGER required by the Willesden District Council, with twelve months' engagement to a suitable man. Must be conversant with the cost of installations for lighting, heating, power, and cooking, and with costs of working the same. Salary £2 2s. per week, with commission.—Applications, stating age and enclosing copies of testimonials, to be addressed to the Chief Electrical Engineer, Electricity Offices, Salusbury Road, Kilburn, N.W., and sent not later than Thursday, March 10, 1910.

SITUATIONS VACANT.

Advertisements under this heading: Twenty-four words, 1s. per insertion; three insertions 2s. 6d.

SWITCHBOARD ATTENDANT wanted immediately to assist on evening shift. Wages 20/- per week. Applications, stating age, experience, and enclosing copies of not more than three testimonials, to be sent, not later than the 10th instant, to ENGINEER, Electricity Works, Canterbury.

WANTED, ELECTRICAL ENGINEER, thoroughly competent to take charge of a 500 h.p Installation on Public Works. Apply No. 352, ROBERTSON & SCOTT, 25, Hanover-street, Edinburgh.

WANTED.—Junior Assistant in the Meter and Outdoor Departments. Wages 20/- week. Knowledge of Meter Testing essential. Applications, stating age, experience, and enclosing copies of not more than three testimonials, to be sent, not later than the 21st inst., to ENGINEER, Electricity Works, Canterbury.

SITUATIONS WANTED.

DRAUGHTSMAN, 28, Bavarian, speaking French, some English, experienced with switchboards, low and high tension, installation, electrical apparatus, general engineering, requires situation in England. Highest references.—KOLB, 24, Avenue Carnot, Paris.

WIREMAN, wants situation or job. Power, Lighting, Telephone Bells.—E.C., 65, St. John's Hill, Clapham, Junction, S.W.

THE ELECTRICAL ENGINEER REPRINTS.

New Series No. 1.

JUST PUBLISHED.

"LIGHTNING CONDUCTORS,"

By ALFRED HAHDS, F.R.Met.S.

Author of "Scientific Protection," "A Guide to the proper Application of Lightning Conductors," "Lightning and the Churches," etc.

PRICE THREEPENCE.

Post free, Threepence Half-penny.

THE ELECTRICAL ENGINEER, LTD.,

149, Fleet Street, London, E.C.

NEWPORT ELECTRICITY LOSS.

While the Newport (Mon.) Tramways are run at a goodly profit, the Electricity Department shows a substantial loss, and has entailed recourse to contributions from the rates amounting to £9,000 since the works were started. Mr. Charles P. Sparks was called in to report upon the whole subject. While he disapproves of the Committee's policy, adopted in 1902, to go in for general power supply, he says that considering the present position, the 1909 results compare favourably with other undertakings of similar size and load factor, and reflect credit on the borough electrical engineer. Mr. Sparks says he cannot indicate any economies in the use of existing equipment. The losses in the alternating system of distribution are high owing to the large number of small transformers in use, and the only remedy would be their gradual replacement by larger transformers placed in sub-stations supplying groups of consumers.

On the question of scale of charges for electrical energy, Mr. Sparks makes some drastic recommendations which are likely to meet with a good deal of opposition by consumers in the town. Briefly, they mean an all-round increase. On the other hand, there are those who urge that the committee will be justified in adopting the increased charge policy, and argue that it is manifestly unfair that all the ratepayers, only a proportion of whom use electrical power, should be taxed to maintain an undertaking which benefits only a proportion of the ratepayers.

The present scale of charges, says Mr. Sparks, is not adequate, and to balance accounts and provide a reserve fund to meet that renewal of plant which requires replacing before the expiry of loan periods, the present charges should be increased or modified to produce additional revenue on the basis of sales made to March, 1909, namely:

Power and Heating.—Increase of 15%, except to large consumers under long term contracts or guaranteed load factor. Heating —increase from 1d. to 1¼d.	£403	0	0
Discounts—reduced to 2½%	£235	0	0
Lighting.—General increase of ½d. per unit, with increase of ¼d. per unit to large power consumers—			
Short term contracts	£1,280	0	0
Long term contracts	£582	0	0
Minimum charge of 12s. per winter quarter, and 8s. per summer quarter	£180	0	0
Public Lighting.—Charge for side street lighting to be increased to £3 7s. 6d. per watt metallic filament lamp burning 4,000 hours	£225	0	0
Total	£2,905	0	0

As regards the question of keeping two generating stations, one at Corporation-road (east) and the other at Llanarth-street (west), Mr. Sparks says that having regard to the area of supply and economical working of the undertaking, the borough must ultimately be supplied from one generating station.

Although he recommends the concentration of the works at the East Power Station, he urges that the two 300 kw. 87 cycle sets at Llanarth-street should be kept in reserve.

On the question of offices and stores he says that new ones should be erected at Corporation-road, and the whole of the staff concentrated at this point.

Mr. Sparks holds that electric mains should be laid for public lighting, before there is any demand from private consumers, in all streets where the class of future residence is likely to give rise to a demand.

The committee have considered the report, but so far have only come to a decision as far as the scale of charges to consumers is concerned. On this point they have not adopted Mr. Sparks' recommendation that discounts be reduced to 2½%, but have agreed that all accounts should be subject to a discount of 5%, if paid within one month of date of delivery. They have resolved that the other recommendations with respect to the scale of charges should come into force on April 1 next.

The other recommendations will be further discussed, and copies of the report will be submitted to all the members of the Corporation.

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HIGH CLASS STEEL FROM ELECTRIC FURNACES.*

By JOH. HARDEN.

The use of electricity as a means of obtaining high temperature dates as far back as the beginning of the last century, when Sir Humphrey Davy was experimenting with his large primary battery composed of copper and zinc in an acid solution; this large battery was a gift from the nation to the celebrated scientist, or the Institution he represented.

Although several patents have been recorded bearing upon the use of electric power for metallurgical purposes, and dated as early as 1840 to 1850, no practical result was, or could be, obtained before the development of the dynamo electric machine by Gramme, in 1873. About the year 1879 Sir William Siemens, a brother of the eminent electrician, Werner von Siemens, tried to utilise electric power for steel melting. His furnace, which, of course, was only an experiment on a small scale, may be regarded as a forerunner of both the Stassano and the Girod types, which will be referred to later on, and which were brought into prominence many years later.

In Siemens' first experiment he placed two lateral and inclined electrodes of carbon in the upper part of a crucible in which some steel scrap was placed; a cover was then placed on the crucible. An electric arc was formed between the electrodes and the heat, partly radiated directly from the arc and partly reflected from the cover, brought the steel into a state of fusion. This must be considered the prototype of the Stassano indirect heating furnace. Siemens also modified his furnace in such a way that a water-cooled electrode was placed in the bottom of the crucible passing through the same, and brought into contact with the charge in the crucible. A vertical carbon rod, regulated by a kind of differential gear, formed the other electrode, and an arc was struck between the charge and the carbon rod. This is evidently the embryo of the Girod furnace, which will be described later. The experiment, however, did not at the time lead to any further development in the art, because large dynamos were not yet constructed, and electric power was, therefore, too costly for commercial metallurgical purposes.

There are on record a few further experiments since those days; Mr. Z. de Ferranti, well known to every English electrical engineer for the wide scope of his numerous inventions, patented in the year 1886 an induction furnace. This was actually built; but, as Mr. Ferranti himself stated to the author, this furnace was never operated because the proper form of electric energy could not be obtained.

About the same time, E. Colby, of U.S.A., also patented an induction furnace, primarily intended for melting platinum. As far as is known, little or nothing was done with this furnace, probably for the same reason that prevented the use of Ferranti's furnace.

Shortly after this period, Henry Moissan, in France, commenced his classical researches on the subject of electric furnaces, though more from a chemical point of view. The published results of the experiments made by Moissan are most highly interesting, bearing as they do on the scientific side of electro-chemistry; it may be said that his work forms the nucleus of the present day great and rapid development of the art of electro-metallurgy. His researches as to the carbides were rapidly followed on a practical scale by Bullier and Willson, who initiated the calcium carbide industry in the U.S.A., and also by E. Acheson in his development of the carborundum industry at Niagara Falls.

In the meantime, electrical engineering had made great strides forward, and created the means of obtaining electric power in quantity and at a price which enabled the skilled metallurgist to make use of the electric furnace for the commercial production of the highest grades of steel. The rapid development of carbide furnaces has no doubt assisted to bring the question of electric steel melting within the sphere of interest of metallurgists generally.

One of the first who seriously attacked the problem of electric steel making on a commercial basis was Major Ernest Stassano, of Turin, Italy. This inventor has worked steadily for some 15 years towards the solution of this problem, and has achieved some very good results. About 12 months ago the author had the opportunity of visiting his works at Turin, and it must be admitted that the results that have been obtained by the inventor are worthy of the greatest credit.

The Stassano furnace is of the arc furnace type, with indirect heating of the charge. The arcs also act directly on the surface of the bath, but this is purely accidental. The furnace consists of a cylindrical vessel of steel, lined with magnesite bricks. Three-phase current of about 50 periods per sec. and 150 volts is employed. Three electrodes, equally spaced about the circumference and inclined from the vertical, enter the sides of the furnace, and from these three arcs of considerable length, *i.e.*, from 8 in. to 14 in., play between the electrodes, and also on the surface of the charge. The roof of the furnace is dome-shaped, and the heat, which is radiated upwards from the arcs, is reflected back on to the surface of the charge. There is a considerable resemblance between this furnace and the one designed by Siemens, which has been previously mentioned. The furnace is closed as tightly as possible, so as to prevent the ingress of air. It is made to revolve on a vertically-inclined axis, to ensure the perfect mixing of the charge. It is rotated completely about three times during the working of the charge. Furnaces of this type seem to work very satisfactorily if not of too large a capacity, and they are especially useful for producing fine steel castings. One of the drawbacks appears to be the somewhat complicated design, but this is probably not very serious in the case of a small furnace. Judging from the shape of the roof, it is obvious that the lining must be somewhat expensive, particularly in large furnaces. It is also stated that the power consumption, when treating cold materials, is somewhat high, viz., from 1,000 to 1,200 kw. hours per ton of steel produced.

Dr. Paul Heroult, who is well-known for his work on the electro-metallurgy of aluminium and ferro-alloys, has given his name to another type of arc furnace. At La Praz, in Savoie, France, a steel furnace of about 2½ tons capacity has been in continuous operation for about eight years, in order to demonstrate his process, and several other furnaces of the same type have been erected in various parts of the world.

The largest furnace of this description, of a capacity of 15 tons, has been erected at one of the works of the United States Steel Corporation, and another is in course of erection. The Heroult furnace has two electrodes passing through the roof (in the case of polyphase current, three or more electrodes are used). The electrodes are connected in series, and form two arcs between the surface of the charge and the electrodes. It is generally stated that the arcs are formed between the slag and the electrodes, and that the heat thus generated is passed through the slag to the metal below. In actual practice, however, it is found that there is nothing to substantiate this statement, for, as soon as the slag becomes sufficiently liquid, it appears to be forced away from underneath the electrode by the action of the super-heated gases surrounding the end of the electrode. The charge is consequently directly operated upon by the arc which is playing under the electrode.

One of the weaknesses of the Heroult furnace is the rapid deterioration of the roof. This is a flat arch, and cannot be placed far above the surface of the bath, or the ends of the electrodes would occasion excessive waste. The highly super-heated gases around the electrodes appear to be actually the cause of the rapid destruction of the roof. As all the heat is developed on the surface of the charge at two or more points, there is an unavoidable over-heating of the charge at these points, and it is very questionable whether sufficiently rapid circulation of the metal is effected.

P. Girod, who has devoted a great deal of time to electric furnace design, has devised a furnace which very closely resembles, in general arrangement, the furnace originated by Siemens. The current enters the furnace through a large central carbon electrode, and an arc is formed between it and the charge; it then passes through the charge and leaves the furnace through an electrode which is formed by a number of steel rods, which pass through the hearth of the furnace and terminate in a water-cooled chamber. The design of this furnace is comparatively simple, but the lower electrode, which consists of rods, as mentioned above, and which terminate in the water bosh, are no doubt a

* Paper read before the Rugby Engineering Society, Thursday, Feb. 17, 1910.

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source of danger should the steel break through the hearth. However, it is not on record that any such accident has taken place. Another objection seems to be the difficulty of replacing magnesite on the floor of the hearth in such a manner as to avoid obstructing the path of current to the bottom electrode.

Keller's furnace is designed on similar lines. Originally he made use of electrodes in series on the lines of the Heroult furnace, but he has lately altered his design so as to use an electrode in the bottom of the hearth, placed in the same position as that of Girod's, but of somewhat different construction.

These four types represent the only arc furnaces which have gained any serious recognition. In these the heating takes place chiefly from above by means of arc playing either between the electrodes or between them and the charge.

Quite a different principle is made use of in the induction furnaces and their allied types. Here the heat is produced mainly within the charge by means of induction, *i.e.*, the furnace is, broadly speaking, a simple transformer in which the charge forms the secondary winding.

Apart from the Ferranti and Colby furnaces, which, as has been stated, have not been used to any large extent, various designs have been patented and even partly tried. But the only one which has been brought into extensive use is that designed by Dr. Adolf Kjellin, of Stockholm, Sweden. This was patented in England in 1900, and several furnaces of this type, of various sizes, are now in operation. The furnace proper consists of a closed magnet core with two or three limbs, one of which passes through the centre of the annular hearth. On this member, and co-axial to the bath, is placed the energising coil. The position of this coil is, of course, quite important, and is the subject of several patents. Other inventors have tried to place the coil differently; in the Ferranti design, it is placed above and beneath the hearth; Colby places it outside and around the hearth, etc. But all furnaces of the Kjellin type have their coil in the centre, as near the secondary as the heat of the furnace will permit. It is obvious that this must be the best position, as otherwise the power factor will be far too low. Owing to the great distance between the primary and the secondary, *i.e.*, the metal in the hearth, because of the heat developed in the latter, the magnetic leakage is considerable. Therefore, the more distant the coil from the bath, the lower is the power factor.

This furnace is especially suitable for melting down such materials as those used in crucible steel manufacture. A high degree of purity can be attained in the steel produced, owing to there being absolutely no contamination of any kind; further, it is possible to make a single cast of up to 4 tons, and assure a perfect uniformity of the steel. This uniformity is assisted by the strong movement of the molten charge, which is due to the action of the magnetic field. If cold scrap and pig iron is used for charging, about one-third of the metal is retained in the hearth in order to start up the next charge. The first charge is usually started by placing steel or iron rings in the furnace; these are melted down by the induced current, and form a bath into which the rest of the cold materials are charged.

For non-ferrous metals, such as bronze, brass, etc., this is not necessary. A specially composed crucible with conducting walls is then used, and the crucible heated by the induced current to the temperature necessary for melting the metal charged; the current being eventually induced in the molten metal. The use of this special crucible tends to nullify the difficulty of the "Pinch effect," which has been described by various scientists, the first of whom was Dr. Carl Hering, in the Electro-chemical and Metallurgical Industry for 1908. This phenomenon manifests itself always when a heavy current is passed through a molten conductor carrying a high density; it is especially prominent in case of copper and brass, etc. It is due to the magnetic attraction of the paths of current passing through the conductor, causing a hollow, which may rapidly interrupt the continuity of the bath, and cause serious fluctuations of the load factor, and eventually allow the metal to solidify. Owing to this, copper is exceedingly difficult to melt, but with the above-mentioned crucible, in which the conducting walls bridge over the rupture, the operation is comparatively easy to carry out.

The induction furnace proper, as described here, is admirably adapted for melting pure raw material in charges up to 2–3 tons. But owing to its nature, it is not a refining furnace, or suitable for the purification of inferior grades of steel in large quantities. The essential of rapid and efficient refining demands that a large area of the charge shall come in contact with the slag used for refining. If the Kjellin furnace was specially constructed for refining, the power factor would be unduly low, and the handling of the slags most difficult. To overcome this defect, the firm of Hermann Roechlig & Co., of Volklingen, Germany, who had experimented with an 8-ton Kjellin furnace at their works, designed the modified induction furnace known as the Roechling-Rodenhauser furnace. This is, again, an induction furnace where two or three limbs of the core pass vertically through the hearth, the energising coils being placed on these limbs in a similar manner to those in the Kjellin furnace. In addition to this, a special secondary winding of heavy copper bars is also placed outside and around the primary coils. The combined power induced in these secondary windings is about 35% of the total power of the furnace; the remainder is directly transmitted by induction to the charge.

The current induced in the secondary copper winding is conveyed to a set of steel plates inserted in the walls of the lining; these plates are covered with a material forming a conductor of the second class. Consequently, when the molten charge of pig-iron is poured into the furnace, these portions of the lining will become conductive, and allow the current to pass through. They then act as a kind of Nernst glower on a large scale, which, after being heated by the current, in turn heats the steel. The effect of this arrangement is that a much larger hearth can be used, because the close proximity of the secondary coil to the primary tends to increase the power factor considerably, also a high degree of refining can be carried out in a most economical manner. It is ordinary practice to take hot basic Bessemer steel having an analysis of about C, 0·3%, S, 0·07 to 0·08%, P, 0·06 to 0·07% and refine to high grade steels of the analysis required with only traces of S and P. The consumption of electric energy will vary from 100 to 300 kw. hours per ton, depending on the degree of refining required.

A specimen charge is given herewith:

Basic Bessemer steel charged—S, 0·071; P, 0·077.

Finished steel.—C. 0·14, Si. 0·01, Mn. 0·41, S. 0·032 P trace

This steel is especially suitable for tubes for marine water tube boilers.

In order to give an idea of the cost of the operation, a list of materials used, and the kw. hours consumed, is given below, from which calculations can be readily made:

Weight of finished ingot. 7,000 kgs.

Materials and alloys used:			s.	d.
Lime	550 kgs.	@ 10/- per ton	5	6
Roll Mill Scale ..	30 ,,	@ 13/- ,, ,,	0	4
Ferro Silican (50%)	30 ,,	@ 200/- ,, ,,	6	0
Ferro Manganese (80%)	20 ,,	@ 180/- ,, ,,	3	6
			15	4
		per 1,000 kg.	2	2½
Power consumed, 1,381 kw. hours ÷ 7 = 197 kw. hours @ 0·25d. per kw. hour			4	2
Lining			0	10
Labour			2	0
		per 1,000 kg.	9	2½

Another combination of this type of electric furnace and open hearth furnace has been in operation for some time. In this case, hot basic pig iron analysing approximately C, 4·0%; P, 1·8%; S, 0·6% is charged into a 25 ton Wellman gas-heated rolling furnace. This furnace is used to preliminarily reduce the carbon and phosphorous by the addition of ore, etc., and at the same time takes the place of a mixer. Charges of about 3½ tons at a time are withdrawn, and charged into an electric furnace where the phosphorous is eliminated, and finished in a second electric furnace of the same size, where the sulphur is extracted and carbon and other corrections made. The P and S are easily

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reduced to traces. There are several electric furnaces at this plant, the steel made being used for foundry purposes. The whole of the electric power is generated by blast furnace gas engines at a very low cost per kw. hour, and consequently the costs of refining are exceedingly low.

A special feature of the furnaces built on the induction type, either of the Kjellin or Roechling-Rodenhauser system, is their very steady load factor. In this respect these furnaces compare very favourably with the true arc furnaces, where the whole of the power is transferred to the charge through one or more arcs. Owing to the unavoidable irregularities on the surface of the charge in arc furnaces, the resistance of the arcs varies constantly, and causes the current to fluctuate violently. Consequently, it is necessary to provide for a generator of considerably larger kilovolt amps capacity, and flywheel effects than would be required if the furnace had a steadier load factor.

It is true that the induction furnace has a lower power factor, and it may be worth while to say a few words with regard to this. As a comparison, take a furnace of each type of a capacity of 5 tons, to be operated in each case from a 25 cycle generator. A furnace of the Roechling-Rodenhauser type will have a power factor of 0·65 to 0·70, while a plain arc furnace has a cost of about 0·85 to 0·9. This is, in the latter case, due to the fact that the arc furnace is operated with a low voltage from 60 to 70 volts only in the arcs, and a correspondingly high current, which will cause a lower power factor than usual, owing to the inductance set up in cables, etc. (*see Electro-chemical and Met. Ind. for* 1909). The power fluctuations in an arc furnace may vary between 0 to about 35% overload (*see Transactions of the Iron and Steel Inst. for* 1909) assume, say 25%. The total power supply may in both cases be about 520 kw. This means a generator capacity of 750 kilovolt amps., for the induction furnace and for the plain arc furnace $\frac{520}{0·9} + 145 = 725$ kilovolt amps. The difference is, as will be seen, very slight, and may even be in favour of the induction type, if it is considered that the generator for the plain arc furnace must be built mechanically strong enough to withstand the current fluctuations.

It has been stated that steel produced in arc furnaces shows a lack of homogenity and the presence of "ghost lines." It is probable that for these reasons Stassano designed the device of rotating his furnace on a vertically inclined axis.

In induction furnaces, especially those of the three-phase type, the charge acts somewhat as the rotor in an A.C. motor, and produces a very strong and efficient mixing of the charge. In fact, this rotating effect is sometimes so strong that certain measures must be taken to counteract it.

Finally, a few words should be said to correct a widely spread misconception with regard to the scope of electric furnaces generally. It is frequently assumed that the electric steel furnace is intended to supersede and render obsolete the open-hearth furnace. This assumption is quite incorrect for the following reasons: In order to melt steel or the constituent material thereof, a certain amount of heat at a comparatively low temperature, say about 1,350° C., is required. Now, if that heat is to be supplied by means of coal, as in this country, where water-power is scarce, it seems rather a waste to first convert this into power in a prime mover, then into electric current, and, finally, back to heat again; the losses must, of course, be enormous. What, then, is the proper field of the electric furnace? It appears to be far more economical, at least in cases where large quantities of medium quality steel are required, to first melt the material in a gas-fired furnace, remove the carbon, which requires only a comparatively low temperature, and also the phosphorous for the same reason; then to pour the partially refined steel into the electric furnace, where the phosphorous, sulphur, occluded gases and other injurious compounds can be removed.

The removal of these latter impurities requires a considerably higher temperature than the foregoing stages, and it is obvious that if the temperature must be raised by means of a gas flame applied on the surface of the bath, the heat losses must be very great.

The elimination of the occluded gases is the last and, it may be said, perhaps, most important stage of refining, if a really high quality of steel is to be obtained.

In the case of an open-hearth furnace, gas is constantly supplied, together with oxygen sufficient for the combustion. If the flame is made to be reducing, *i.e.*, not to have any excess of oxygen, it is difficult to obtain the desired temperature; but it is just this very oxygen that is to be expelled, hence it is obvious that the electric heating will be of the greatest use in this latter stage. And this is just what the Continental steel makers have recognised, and have, therefore, installed their electric furnaces in conjunction with open-hearth furnaces; in fact, instead of discarding any existing open-hearths in favour of the electric furnace, new ones are being built. It stands to reason that steel works would not erect, maintain, and extend such a plant if they did not see a definite economical gain in doing so. The list shown proves that this must be the case, as no less than 30 induction furnaces are in existence or under construction, and only one or two of these, of smaller units, are laid idle, for various reasons, but none due to defects in the type of furnace.

In the case of crucible steel, the problem is a different one; here, where no impurity whatever is tolerated, and where the price of the steel is high, the exclusive melting by means of the electric furnace seems fully justified and economical, as experience has clearly shown.

The same also applies to places where natural sources of power, other than coal, are available, where it probably will be found cheaper to produce the steel wholly by electricity instead of transporting the bulky coal.

Finally, a quotation may be made from a paper recently read by Dr. Engelhardt at a Vienna meeting; he says: "I wish to allude to a play of coincidents, although it does not exactly fit in in a technical lecture. The inventors of the most important arc furnaces belong all to the Latin race, Heroult, Girod (and Keller) are Frenchmen; Stassano an Italian. The inventors of the induction furnace types are all of non-Latin race, Kjellin, Grönwall, and Frick are Swedes; Colby, American; Ferranti, Englishman; and Roechling and Rodenhauser are Germans. Seeing this, one may, perhaps, utter the paradoxical expression, that the furnace systems follow closely to the race characteristics of their inventors; the arc furnaces are noisy, throw sparks and shafts of intense light, but show more fire externally than inner heat and power, while the induction furnaces appear to the contrary, not showing on their cool outside the amount of heat at work in their interior."

THE KEARNEY HIGH-SPEED RAILWAY.

DEMONSTRATION OF SINGLE TUBE SYSTEM.

At the Crystal Palace on Wednesday, Mr. E. W. Chalmers Kearney gave the first public demonstration of the Kearney Single Tube System, to be used on the proposed Strand and Crystal Palace and Kennington and Cricklewood Liftless High-Speed Tube Railways. In the Kearney system the cars run upon a single bearing rail which takes the whole of the weight of the train. The cars, Mr. Kearney explained are maintained in the upright by means of a single overhead guide rail rigidly braced and supported by standards placed at intervals of 60 ft., so that derailment is physically impossible unless an actual breakage of the permanent way occurs. Mr. Kearney demonstrated with a model single tube railway 200 ft. in length, equipped with automatic switches and signals. The method of working trains in both directions through one tube without delay and, as the inventor claims, with absolute safety, together with the arrangement for combining the convenience of the liftless shallow station with the advantages of the deep level tube aroused considerable interest. "By this system," declared Mr. Kearney, "the old difficulties in tube railway enterprise are all swept away. We are going to start building tube railways at a maximum cost of only £250,000 a mile, and at the same time reduce working expenses to something like one-third of those of the present tube railways, and also run at double the speed. We will have lower fares—the passengers will be carried from five furlongs to three-quarters of a mile for a half-penny."

Sir Thomas Fairbanks, who was among the party, wished the inventor success, adding that all he wanted was fair play with the system.

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Electrical Progress at Home & Abroad.

A Review by our Special Correspondents.

TYNESIDE.

NEWCASTLE-ON-TYNE.

A demonstration, which is of unusual importance both to electrical men and mining engineers, was given on Monday, the 21st inst., before the local section of the Institution of Electrical Engineers, and repeated on Wednesday, 23rd inst., before the Newcastle branch of the Institution of Mining Electrical Engineers, by Professor Thornton, of Armstrong College. This consisted of a series of experiments designed to show the conditions tending towards the production of explosions in collieries by means of electric sparks. After showing that solid coal was an insulator, and that wet masses of coal dust were conducting and explosible, Dr. Thornton showed that although a carbon flame was not sufficiently conducting to produce short-circuiting at ordinary voltages and air-spaces between terminals, a metallic-vapour flame was highly dangerous. The effect of melting fuses and opening a quick-break switch in clouds of coal dust under various conditions of current were next investigated, and a law depending on the volume or surface of the arc in relation to the percentage of explosions was deduced. At the latter meeting Mr. Clothier, of Messrs. A. Reyrolle & Co., Ltd., gave a further demonstration illustrating the property of wide, roughly machined flanges of a fuse box in arresting the spread of an internal explosion to the outside atmosphere by cooling the gases of explosion below ignition point, as they escaped from the box. The demonstrations were followed by a keenly interested audience on each occasion.

Electrical Activities among the Municipalities.

Among the municipalities in this area electrical matters are very much in evidence at the present time. As regards Sunderland, the Council has been making a claim against Sir James Laing & Sons, Ltd., for £22,500, this being in one sense the amount of money which the Corporation had spent in providing generating plant and mains for the purpose of supply to the shipyard. Owing to the temporary cessation of the works a breach was made in the 15 years contract for supply at a minimum of £1,500 per annum, and a temporary supply was also, it seems, given to the receiver to the company. The summons of the Corporation was heard in the Chancery Division and the appeal was dismissed. From the annual statement of the Sunderland Tramways Committee a capital expenditure of £299,524 has been incurred in this department; £33,809, or 45% of the capital cost has been placed to depreciation, reserve, etc.; the total contribution to rates is now £30,027, and the investments and sum in hand is equal to about 13% on the outstanding debt, which is £208,420. There is nothing to relief of rates this year. At South Shields it is now proposed to extend the generating plant, and estimates for main engine and dynamo have been obtained. There is, however, a feeling among certain sections of the Corporation that this expenditure should not be incurred, in view of the near neighbours which the Corporation has in the shape of large power companies, inasmuch as the extensions are mainly intended to provide for placing the power supply of the district on an efficiently wide basis. The Newcastle Corporation tramway employees have evidently a warm feeling for the late chairman of the Tramways Committee, Sir J. Baxter Ellis, inasmuch as a presentation to him of a large silver cigar box has just been made. Having regard to the way Sir Joseph has championed the cause of the tramway men this presentation is very appropriate.

THE MIDLANDS.

BIRMINGHAM.

Mr. Arthur Hall, M.I.M.E., presided at the usual monthly meeting of the Institution of Mining Electrical Engineers (Warwickshire and South Staffordshire Branch) held on Saturday at the Imperial Hotel. The meeting was devoted to a continuation of the discussion on the paper by the President of the Institution on "Shocks." It was generally agreed that the immediate cause of death was heart failure from syncope due to shock, the shock being caused by some part of the body coming in contact with live wires, terminals, or other parts. A fertile cause was careless construction of the insulation, and unskilful supervising of the plant, with various other causes difficult to classify. It was considered that alternating current was more dangerous than continuous current from the point of view of shock, and that as low an amount as 110 volts under certain conditions might be dangerous to human life. That also depended on the amount of current passing, and the resistance of the individual, but it was considered very difficult to keep coal-cutting machines efficiently earthed, and there was a danger also in the working of motors at overloads even with cut-outs. It was considered that more accidents were due to carelessness, damage of plant, etc., and of cables, than to other causes. It was desirable that cables should have most careful and systematic examination, especially as leakage indicators, although compulsory, are found generally unsatisfactory in their operations and are, therefore, of little utility. On the suggestion of the President it was agreed that members should hand in written statements of their personal experiences in regard to the subject matter of the paper with a view to the concluding of the discussion at the next meeting.

Electricity in Rand Mines.

The statement made recently by the President of the Chamber of Mines at Johannesburg as to the increasing adoption of electricity as motive power in the South African gold-fields is confirmed by the experience of Midland manufacturers. Several local firms are engaged upon contracts for South Africa, among them Bellis & Morcom, who are executing an important order for turbines for Johannesburg. Siemens Bros., at their Stafford Works, are also profiting by this movement in South Africa, and have orders on hand not only for the gold-fields, but for other departments of industry at the Cape. For instance, the firm is sending out an electrical pumping plant and other machinery to Kynoch's Ammunition Works in Durban.

Birmingham's Electricity Extension.

A statement has been made that the Birmingham Electric Supply Committee is negotiating for the acquisition of a considerable area of the now disused sewage farm at Saltley for the purpose of erecting new works. No decision has yet been taken by the committee, and, though the site at Saltley has been under consideration, it is not the only one upon which the committee have an eye. It is well known, however, that the erection of a new station on a large scale would be recommended to the Council as soon as the question of a site has been settled. An area of 15 or 16 acres is spoken of, and the probable capacity of the new station may be judged from the statement made by Mr. Chattock, the City Electrical Engineer, at the recent Greater Birmingham Inquiry. It was proposed, he said, to lay out a station which should have an ultimate capacity of 100,000 kw. Their new works would be four times the size of the Summer-lane station and the idea of Mr. Chattock and his committee is to use the new station for the supply of high-tension current to the present sub-station, and to others that may be taken over or built in the areas which are expected to be added to the city under the Greater Birmingham Scheme. A great deal, however, depends upon the fate of that scheme, though it is quite possible that, even in the event of its failure, certain outside districts, which have not yet had the courage to

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initiate electricity schemes of their own might be glad ultimately to become customers in bulk to the Birmingham Corporation.

Electric Theatres and Demand for Current.

In Birmingham, the electric theatre is beginning to be an important source of custom to the electricity department. The consumption of current for shows of this kind, including those in which the cinematograph is only an incidental, now represents about 20,000 units, and there are signs that it is a growing factor. Three electric theatres of the type which is open continuously in the daytime, have recently been inaugurated, namely, one at the Masonic Hall, in New-street, under the title of "Theatre de Luxe," one at the Theatre Royal, and one at a special building in Station-street. At the King's Hall, in Corporation-street, there are also day and evening shows, as well as at the Queen's Hall, on the Parade. Curzon Hall, too, has for a long time past been the scene of long seasons of this kind of entertainment, which also forms a frequent part of the attractions of the regular theatres and music halls, as well as such places of entertainment as the Temperance Hall and the Digbeth Institute. In the case of the larger consumers for cinematograph purposes motor transformers are in use, as for instance at the King's Hall, the Theatre Royal (where the supply for all purposes is from the Corporation mains), the Masonic Hall, and the Station-street Electric Theatre. At the Queen's Hall, the Bordesley Palace, and the Grand Theatre, the Temperance Hall, and the Digbeth Institute, the current is reduced by resistance. In New-street, adjoining the Theatre Royal, a building is being specially erected for an electric theatre, and this too will be one of the Corporation's customers.

LANCASHIRE.

MANCHESTER.

Nothing of very great importance has taken place during the past week, though there has been no falling off in business. The chief event was the annual dinner of the Local Section of the Institution of Electrical Engineers, with Mr. S. J. Watson, president of the Section, in the chair. The members listened with great attention and in cold silence to Dr. Kapp's explanation of the Council's attitude towards the recent proposals that the Institution should take some interest in the commercial welfare of electrical engineering. This attitude, while not, perhaps, unpopular, is not distinctly popular, to judge from some of the remarks made. The chairman's suggestions for extending to the Local Section members some of the advantages and privileges at present exclusively possessed by London members met with warm approval, and there is no doubt that if there was more opportunity for social intercourse amongst the members, the activity of the section, great as it is now and as it has been for some years, would increase considerably, to the benefit not only of its members, but of the whole Institution.

Corporations and Their Work.

The royal toasts having been proposed by the chairman and duly honoured, Mr. Hugo Hirst proposed "the Corporations of Manchester and Salford." Manchester was the mecca of industry, and was regarded as such not only by the rest of the country, but by the world. They were living up to their reputation and maintaining their proud position. There was only one reason for this: it was the great, wise and efficient government of the town by its Corporation. Manchester had undertaken great enterprises. Their Ship Canal was the greatest of these, and one had to go back to early history to find a parallel to that great work. The Manchester electrical undertaking was the finest in the country, due to the exertions of Mr. Pearce and his committee. Some 40 million units were generated per annum at a very low price, and the electrical development was very large. His firm attributed much of the prosperity of their Salford works to the able ruling of that town. They had received benefits there which they had not received in other towns. In reply, the Mayor of Salford reviewed the important improvements that had been effected in towns during the past 30 years, and enlarged on the happiness to be found in public work on Councils. He said town councils had need of the assistance of men of superior education for public work, and hoped some of the gentlemen present would become councillors. Referring to the early days of electric light in Salford, he said when their provisional order was obtained in 1891, the Gas Committee were delegated to consider its application. Realising their ignorance, they obtained Sir Wm. Mather's advice and made a good start, putting down a £40,000 station. In the same strain Councillor C. Howarth (Chairman, Manchester Electricity Committee) said from his 10 years' experience as chairman he was convinced Manchester had the power of showing what could be done by electricity. The great advantage of a municipal undertaking was that it could find the necessary capital, and was, therefore, in a position to get the best plant and technical service, and so produced the best result. Much as Manchester had done, it would do more.

The Institution and its Work.

Vice-Chancellor Hopkinson, in proposing "The Institution of Electrical Engineers," said in electrical engineering they saw the power of theoretical knowledge when applied in practical life. They also saw the converse, the value of practical work in increasing theoretical knowledge. The history of the Institution was one of most wonderful development. He could only say to his hosts: "You are engaged in fellowship together as members of the same great society, in that noble and important work in which such great strides have been made within the last few years by those great men who achieved very great results even before any language had been invented to express the scientific ideas which they had firmly grasped. Amongst those great men were Kelvin and Edison, and one who, though nearer and dearer to me, I do not mention to-night, but of him I think I may say that he showed equally with the other great leaders, an extraordinary understanding of the hidden forces of nature before they had become fully known."

A Declaration.

Dr. Kapp, the President, said the Institution was designed to promote the advancement of electrical science and its applications. Science by itself was a barren tree. It was often said that the scientific man thought the practical application of science beneath him. That was not so with that institution. With them science was only a means to an end. The Council had always taken a very liberal view of the idea of applications of electrical science. At the present time there were some who wished the "application" to be widened to include business, and a good deal of correspondence had taken place, and the Council had been severely criticised because it would not support movements to promote the particular aims of some members. Some said, "We want Tariff Reform," but an institution such as theirs could not be made a fighting machine. On several occasions they had approached the Government where there was a question of the public good and of the electricians'—what was good for the one was good for the other. The Council would take action if any vexatious laws were proposed, such as a tax on electricity. In Italy, for instance, he had had to pay a Government tax on his electric light. If this was proposed here, then they would interfere in the interests of the public and electrical engineering. He was sorry that the state of business in the electrical industry had been so bad, but it would improve, and was now improving. There was an idea that the Institution should force the industry in some way. Some were malcontent because of municipal trading. They could not interfere there. Others, again, objected to free wiring and the hiring out of apparatus. Trade was now so interwoven that it would be fatal to interfere in any of these matters. At a London meeting a member got up and advocated fiscal reform. There was danger in the Institution taking sides in politics. Some members were Free Traders, others were Protectionists. The country itself was divided on the question. By taking sides manufacturers would offend their customers. They had to serve the community. For these reasons he warned the speaker. At the present time they enjoyed the confidence of the Board of Trade and other public departments, because their previous history is known to these bodies. One step from their position of political neutrality and they

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would not be given the chance to interfere in questions that really concerned them. Only this week the Home Office had asked their assistance in connection with the new regulations for the use of electricity in mines. If they were a biassed body, they might not have an opportunity of expressing their views on such questions, and so the legislation might be against them. The Council would always be glad to consider questions, and if they thought they could do so without departing from their neutral position, would take action. There were many things they could do, and one of them referred to the application of electricity in textile mills. About a year ago the Bradford Committee of mechanical and electrical engineers had considered the question, but had issued a report, which all the electrical members of the committee afterwards publicly repudiated. They could interfere here. The slow-speed mill engine gave a very irregular turning movement. On the Continent the advantages of the electric drive had long been known. Twenty-five years ago it was successfully applied to a woollen mill in Switzerland. The Institution could investigate the question in Lancashire. It had been suggested that they should buy up a mill and after taking tests convert it, and so obtain exact figures. He did not think it necessary to go to this expense. Many mills were already electrically driven in the district, and while the owners would not admit trade rivals to take particulars, they would, no doubt, admit a committee of electrical engineers to take tests. In this way data could be collected to report upon. Let them have a counterblast to Bradford. By so doing they would reverse that decision, and benefit the industry and the country.

Local Sections.

Mr. W. M. Mordey next proposed "The Local Sections." During his period as President of the Institution, the Council had taken great pains to improve the connections between the Local Sections and the Institution in London. The new arrangements were working very well, though some did not think them perfect. Some thought the old way was better, but he asked them to defer the verdict till after the trial. After two or three years they would know whether or not the arrangement was satisfactory. The question of how to deal with the papers read at the local sections was considered. Formerly each local section managed its own affairs with regard to papers, and got papers not only from the members of the section, but from all over the country. These were read as before the Institution. Some of them were not up to their standard, and were not such as any institution would care to publish in its journals. Now all papers proposed to be read before local sections had to be accepted by the editing committee in London. All sections had a right to have any of the papers received by the committee read before them. The standard for London and the local sections was uniform for both. He also wished to emphasise Dr. Kapp's remarks when speaking of the pressure which had recently been brought to bear on the Council. They must rigorously resist all attempts to make the Institution either a Masters' Association or a Trade Union. Dr. Hopkinson had referred to the pioneer work of Kelvin and Edison, but he had not mentioned that of John Hopkinson. His work had also been of the greatest value. In their new home on the Thames Embankment, which would be opened this year, a bust of John Hopkinson, recently presented to the Institution by his widow, would be found. Theirs was an institution, and it was in their hands to keep it an institution worthy of Kelvin and John Hopkinson.

"The First Born."

The Chairman (Mr. S. J. Watson), replying to the toast, welcomed their distinguished guests. He said the Manchester Local Section was the eldest child of the parent Institution in London; it was also the healthiest. This was because of the important electrical work carried on in the district, whether educational, industrial, design or supply. There was the Victoria University and the Municipal School of Technology as educational institutions. They had also their Students' Section. The students of to-day were the men who would have to carry on the work in the future. They carried on the work of their section very energetically, and they might safely leave the future to them. Speaking of the suggestion to appoint a committee to report on the electric drive, he said some useful work might be done by it, but they all knew the rapid advance being made already. In a recent issue of a textile paper, reference was made to the electric drive at the Bannerman Mills, in Manchester. The management there were extremely pleased with the amount of work turned out, and its better quality, since the conversion. Again, at Bury he had been able to put evidence before a recent Local Government Board enquiry, from a manufacturer, in which he stated that he was now getting better results from the electric drive than he had ever got before when using steam or gas engines. They in Manchester were sometimes inclined to think of their Local Section as the centre, and regard London as the branch. At present the only representative from the Local Sections on the Council was the chairman for the time being. Naturally, as his office only lasted a year he could not get very much in touch with the work of the London Council. He thought the Local Sections should be represented by more members in the Council, and suggested that these should be the Chairman of the Section for the time being, the hon. secretary, and the two preceding chairmen. Members living in or near London had many advantages which provincial members had not. They would have very little use for the Institution's new home. He thought the use of the library should be extended so that provincial members could benefit by the books possessed by the Institution. Again, the annual conversazione held in London made country members a trifle jealous, because very few of them could attend. Yet it was a gathering of no little interest. It was the only gathering at which ladies might be present, and was valuable because of the opportunities it gave of meeting old friends. He thought it would be a good thing to have an annual conversazione at the Local Sections. He hoped the President and the Council would consider the matter, and if at a later date they were approached on the matter, would extend their help.

GERMANY.

BERLIN.

The electric street trams of this city showed a continuation last year of the slight falling off in business which began in the last half of 1908. The causes of this were depression of trade all round and the competition of new overhead and underground lines. Bad weather in the summer of 1909 also contributed to an extent not to be undervalued, because such a condition of affairs may recur. At the same time, things showed an improvement towards the close of the year, so that it is safe to hope for a better state of affairs for 1910. In spite of increased speed of travelling and an augmentation of the car kilometers negotiated by 1,275,342 to 68,620,788 km., the cost for current in 1909 showed a small excess only over that for 1908, viz., from 4,542,793 marks to 4,547,342 marks. The number of journeys made by passengers was 396,610,000, only 590,000 less than in 1908, and the takings fell only from 37,836,922 marks to 37,779,274 marks. The working expenses were, however, less than in 1908, viz., 54·82% of the receipts, as against 56·03. This is largely due to increased speed, which has permitted a reduction of the number of employés, and the wages bill fell from 9,593,824 to 9,367,130 marks. The net profit was 9,922,422 marks, only 24,251 marks less than in 1908, so that the dividend can be maintained at the same figure, viz., 8¼%. You may be interested to hear our accident bill. In 1909 we killed 22 people, injured 165 severely, and 1,215 slightly. Eighteen were killed, 139 severely injured, and 906 slightly injured through their own fault.

Obscure Voltage Changes.

About a year ago the Strasburg central station was confronted by a difficulty that evaded solution for a long time. It occurred in the system served by the sub-station at Molsheim, and consisted in great sudden variations in voltage, which, of course, affected the lights supplied by the system. It turned out that the trouble was caused at the sub-station itself, by heating in the short circuit arrangement of an asynchronous motor in a transformer. Hence

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sudden changes of load, entailing periodical interruptions of the rotary current, took place.

Interesting Data.

L. Rosenbaum has deduced some interesting conclusion from the statistics of Austrian electrical works in comparison with other results. His conclusions may be summed up as follow :—

1. The connection value of incandescent lamps per head of people is usually independent of the population in towns containing more than 10,000 inhabitants, but may be largely influenced by the competition of gasworks.
2. The connecting value of arc lamps rarely amounts to as much as 10% of that of incandescent lamps.
3. The proportion between light and power connections varies greatly according to local conditions, but in the larger towns the latter usually exceed the former.
4. The output of the central station and the connection value per 1,000 inhabitants are usually independent of the size of the town, and the former may generally be put at 25 kilowatts per thousand inhabitants.
5. The cost of installation per kilowatt delivered is usually independent of the size of the town if the output exceeds 100 kilowatts, and generally varies between £40 and £60 per kilowatt.

Last Year's Review.

This is the time to sum up coolly last year's results. We are now far enough on in 1910 to regard them without prejudice, and it must be admitted that the results have fallen short for 1909 of what we thought we had good reason to expect. Trade was bad in 1908, but improved towards its close, and there seemed every prospect of what we call an Aufschwung. It is true that things are a little better, but the improvement is largely seen in business in electro-medical apparatus, where quackery has much to say, as we should be the last to deny. The sales of industrial plant, such as dynamos, motors, and storage batteries was decidedly smaller, for the year round, although the trade in electrical lamps was better. This is so far encouraging, but this may prove illusory, for so many new metallic filament lamps have lately been boomed for all they are worth, perhaps more, that it would be curious indeed if there were not at least a temporary excitement in this line. In telegraphy and telephony the course of business was fluctuating, but averaged neither much better nor much worse than for the last two years. Uncertainty in the progress of invention is a sufficient explanation. We seem to be on the eve of considerable developments here. For the first six months of 1909 the weight of electrical machinery exported was less by 516 tons than for the first half of 1908, but its value was greater, having increased from 84,740,000 marks to 87,210,000 marks. As regards present prospects, the state of affairs is far from satisfactory. There is too much price-cutting, for one thing, and there is too much company promoting, for another, especially in building small power stations all over the country. Now that power transmission over long distances by high voltage currents and improved systems of masting and insulating is becoming cheaper and cheaper every day, there can be no doubt that the best policy is to have a few big stations rather than many small ones. Due regard must, of course, be paid to exceptional local conditions, but the decentralisation of electric power generation seems to be a German obsession just now that will inevitably bring disaster if carried too far, and check the reasonable amount of decentralisation which is required to prevent the big concerns from having it quite all their own way.

Further German Developments.

Our friends at Wurzen have given over their project for goods transmission to a company with a capital of £10,000. One of the most important factors in the concern is the working of Schiemann's system of goods transport without rails. Local conditions have determined this method of using electric power.

Company Notices.

The raising of a loan of £75,000 by the Municipality of Meissen for providing a power station and acquiring the Otto & Schlossir factory has been sanctioned by the authorities.

The town of Prague is issuing a loan of £80,000 for enlarging the municipal central electric station.

We hear from Vienna that yet another considerable electrical undertaking is in progress in Austria. The project has been long considered, but has been delayed partly from opposition by the landowners. A concession has now been given to Alb. Buss & Co., and the Lesbersdorfer Maschinenfabrik A.G., and M. Karl Scherbaum to establish a power station at Haai, near Marburg. The power is to be got from the river Drau, by making a valley into a reservior, as has been done in the Vrynwy case, and in others. It is expected that 25,000 h.p. will always be available, and, therefore, more under possible circumstances. This project makes another step forward in the utilisation of electric power.

At the same time, we have to signalise a further increase of electric railways in Austria. A new railway is in progress of construction between Wilten and Scharmitz, *viâ* Innsbruck. We still have boundary regulations, and seeing that Scharmitz is on the Bavarian frontier, the line has to stop there.

We hear that the Italian branches of the Schuckert firm have contributed not a little during 1909 to the prosperity of the present concern. The capital concerned in these branches, five in number, amounts to the large figure of nearly a million and a half sterling. The dividend has increased in four of these concerns, and is quoted at 5, 6¼, 6½ and 10% respectively. The exception is the Societa Industriale ed elettro-chimica di Pont St. Martin, which is in course of reorganisation, and has acquired a new source of power yielding 25,000 h.p. As this same company paid a 5¼% dividend for 1908–9, there can be no doubt that the dividend for future years will be even better, although it may be lower this time as a natural result of the changes which have taken place.

UNITED STATES.

NEW YORK.

The manufacturers of electric cars, both for pleasure and for commercial purposes, have made tremendous strides during the past few years, but in the matter alike of design, efficiency and economy the types now being placed on the market are far ahead of anything which has hitherto been produced. Electric cars are now being made for long distance runs and for hill-climbing and have emerged from various tests with flying colours. In many instances they are rapidly superseding the gasoline (petrol) car, and automobilists who have once enjoyed their smoothness and silence, ease of control, and total absence of smell and danger, declare that nothing would induce them to go back to the gasoline type. One prominent user in this City is quoted as saying, "The electric car is as great an advance on the gasoline car as the electric light is on the oil lamp," and broadly speaking that expresses the general feeling of all electro-mobilists. Among the new types for 1910 there is one made by the Babcock Electric Carriage Company of Buffalo, which is epsecially noteworthy in that it will run 100 miles on a single charge, at seventeen miles an hour, with a forty-two cell battery and a 15 h.p. motor. This car has a foot control and gives five speeds forward and one reverse.

The Baker Electric.

Another noteworthy new type is made by the Baker Motor Vehicle Company, of Cleveland, in which a bevel-gear shaft drive takes the place of the chain drive. The bevel-drive rear axle of the Baker electric is of the semi-floating type. To secure lightness and greater strength, the entire rear-axle housing is drawn from sheet metal. All the bearings in this axle are of the ball-bearing type. The axle shafts and drive shafts are made from special vanadium alloy steel, carefully heat-treated. The differential is of a special type, and all gears in the rear axle housing, including the differential gears, have planed teeth and are hardened by a special process. The differentiating gears are mounted on a three-arm member and careful provision is made for self-alignment of the gears. The fit for all bearings is provided by grinding to limit gauges. A Renold silent chain (provided with an eccentric adjustment) and

inclosed in an oil and dust-proof case is used on the reduction gear, insuring silence, flexibility and high efficiency. The transmission shaft is constructed with two universal joints of the latest design, allowing absolutely free action of the rear springs. The motor is of a special four-pole design, series-wound, with unusually large commutator. It is larger than the motors ordinarily used and possesses an electrical characteristic which makes it almost impossible of injury. The patented controller is of the continuous-torque drum type with six speeds forward and three in the reverse, all controlled by one lever. No special pedals or switches are used. This controller is provided with a safety device which precludes the possibility of slipping into the reverse when shutting off power. The battery equipment is 28 cells, 9 MV Exide in series at all speeds.

A New Magneto.

A new type of high tension magneto, which presents some noteworthy features, has just been placed on the New York market by the United Manufacturers Corporation, acting on behalf of the Connecticut Telephone and Electric Company. It is claimed that the magneto will produce a good-sized spark at the slowest possible engine speed, and that the engine can be started on one-quarter turn of the starting crank, so that a motor car can be driven at slow speed through crowded streets or around corners without changing gear or switching over. It is said to possess all the advantages of the double wound armature type of magneto and the low tension type with separate coil on the dash. The transformer coil screws into the bow of the magnets in cartridge form so in case of a burn out or break down immediate repairs can be made by simply inserting a new coil, same as substituting a new unit in a spark coil. The magneto is fully enclosed and is water and dust proof. It can also be changed from right to left running by simply changing three screws. Construction has been greatly simplified by reducing the number of parts and these parts can be changed in the dark as there is only one way for them to fit. The magneto cannot be short circuited by too much oil as there is a special drain which carries off all except the proper amount which should be used. Four safety gap windows are used, and in case one of the cylinders is missing, the spark will immediately begin to jump across one of the windows, so that the operator can note at a glance in which cylinder there is trouble.

A Year's Electrical Exports.

The official figures relating to electrical exports from the United States during 1909 have been published this week. They indicate some rather remarkable changes. The total of electrical exports for the year was $13,027,550, as compared with $12,613,730 for 1908, and $17,460,775 for 1907. The figures indicate some revival of the export business from the depression of 1908, but an anlaysis of the totals shows a marked change in the character of the exports. The exports of electrical appliances were $7,063,804 in 1909, $5,657,008 in 1908, and $7,725,545 in 1907; exports of electrical machinery were $5,963,746 in 1909, $6,956,722 in 1908, and $9,735,230 in 1907. Thus the machinery exports have steadily diminished from their leading position in 1907 to their present secondary position, whereas the exports of appliances have nearly recovered to the value in 1907 and now form the leading class of electrical exports. The point is made still clearer by an analysis of the exports of December last by other countries. Thus in that month the United States sent to the United Kingdom appliances to the value of $67,862, while the value of machinery exports was little more than half that figure, $35,929. To Canada the exports of appliances totalled $181,406 and of machinery $52,283; to Brazil the totals were $89,886, and $29,186 respectively; and to Mexico, $78,890 and $38,212.

Edison Battery for Street Cars.

A street car company has been formed at Caldwell, New Jersey, to use the newly perfected Edison storage battery The new organization will act as a feeder for the Public. Service Railway Company or the Erie Railroad, and it is proposed to start with about 20 cars. These will be housed in a central station at Caldwell, and will cover the town and the country thereabouts which is not reached by the trolley line or the steam railway.

How they View it in Indiana.

The metal filament has aroused a sleeping lion in Indianapolis. The Indiana Gas Association met there the other day to consider what steps should be taken to check the inroads into their preserves made by tungsten and tantalum. One speaker urged that the gas people "must be on the alert to give the merchants more light, together with an ornamental installation." Salesmen were also exhorted to sell gas arcs outright, as "if a customer has made the investment he will be less apt to discontinue it in favour of tungsten." In these and other Machiavelian arts are salesmen to be instructed, and they are also, it would seem, to be trained in a new form of gas propaganda, for a prominent official of the organization impressed upon his disciples the urgency of convincing all philistines of the fact that "the atmosphere in large stores and public halls is much better when lighted with gas than when lighted by electricity." Another propaganda point was that gas fumes are beneficial in warding off diseases, as well as being an "efficient disinfectant." This sort of teaching seems to be all right as far as it goes, but it lacks completeness. The Indiana Association should also have shown how gas makes ceilings pearly white, and improves lace curtains and the binding of books. They might also have expatiated on the exhilarating effects of gas explosions on human life, with some illustrations of the successes achieved by gas as a fire extinguisher. It seems a pity for Indiana to stop halfway.

A Subterranean Railway Yard.

An undertaking of a remarkable character has just been completed in Idaho after more than a year's arduous labour. This is the construction, blasted out of solid rock, two miles underground, in the heart of a mountain near Mullan, of a fully equipped railroad yard with electrically propelled cars handling the rich lead-silver ore produced by the Morning mine, owned by the Federal Mining and Smelting Company. The yard, which is the only one of its kind in the North-west, and is believed to be the largest underground mine yard in America, is 200 ft. in length and 36 ft. in width, the height ranging from 20 to 100 ft. The electrical apparatus and hoisting machinery are in a chamber, 50 by 78 ft. and 20 ft. high, while in the rear of the four-compartment shaft, now under construction, is an ore bin, 20 by 26 ft., and 50 ft. high, with a capacity of 1,500 tons. The shaft will be sunk to reach a depth of 2,600 ft.

Electric Railway Accessories.

Manufacturers of electric railway equipment are keeping their men working overtime in order to cope with the inrush of orders. A representative of the Westinghouse Electric & Manufacturing Company says that the railway-motor department of that company's plant is working night and day, is scouring the country for additional skilled labour, and is practically congested with motors in process of manufacture. He also says that the company has been delayed to some extent by difficulty in securing the necessary steel castings, the steel mills being in much the same condition. Other electrical companies report the same situation with regard to railway equipment. A representative of the American Locomotive Company, which makes street-railway trucks, said that so many orders had been received within the last few months from street-railway companies that the plant was likely to be seriously behind in its deliveries.

The $1,000,000,000 Copper Merger.

Further details concerning the great $1,000,000,000 copper combine, show, on the authority of Mr. John D. Ryan, President of the Amalgamated Copper Company, that the Anaconda Company, which is the nucleus, will take over the securities of the Cole-Ryan Amalgamated Copper Company and also the Guggenheim companies. The capital will be increased from $30,000,000 to $150,000,000. The companies that will go into the merger include: Amalgamated, capitalisation $155,000,000; Anaconda, $30,000,000; Utah Copper Company, $25,000,000; Boston and Montana, $3,750,000; Butte and Boston, $2,000,000; Parrott Silver and Copper Company, $2,298,500; Washoe Copper Company, $5,000,000; Colorado Smelting and Mining Company, $2,500,000; Butte-Coalition $11,000,000.

Business Notes and News.

LIGHTING AND GENERAL—Home.

BIRMINGHAM.—The Corporation Electricity Supply Committee are in treaty with the Tame and Rea Drainage Board for the acquisition of 16 acres of disused land at Saltley for works extensions.

BOLTON.—Mr. Edgar Dudley held an inquiry on behalf of the Local Government Board into an application for powers to borrow £4,605 to purchase land at Astley Bridge for their electricity works extension. The land, besides being near the railway carries with it valuable water rights.

BOVEY TRACEY.—A company is being formed to supply electricity. It is not decided whether underground mains or overhead cables are to be used.

BRIDLINGTON.—An electric cable is to be laid in Shaftesbury-avenue at a cost of £30.

CAVERSHAM.—Having been assured by the Reading Electric Supply Co. that the charge for electricity in Caversham would not exceed the rate prevailing in Reading, the District Council have decided to support the company's Bill so far as it seeks to obtain powers to supply Caversham and district.

DUNDEE.—It is understood the mercury vapour lamps presently in use at the new works of Dundee Corporation are shortly to be replaced by metallic filament incandescent lamps.

FALKIRK.—A large extension of the borough's electricity works is needed, as the present accommodation is inadequate to meet the requirements of large power consumers in outlying parts of the burgh. Negotiations had been carried on with the Scottish Central Power Co., who had made an offer to supply current at a flat rate of ¾d. per unit delivered at the works for a period of 20 years, with an annual minimum supply of £1,200. In the course of the negotiations the proposal was considered of getting the whole of the town's supply from the Power Co. through sub-stations and dismantling the municipal works. Finally the committee agreed to recommend that the company's offer be not entertained, but that the Council proceed to extend their own works in order to meet the public demand. The acceptance of the Power Co.'s offer would involve a fresh capital expenditure of £10,000, whereas the municipal works could be extended and their capacity doubled at a cost of £12,000. The generating cost last year was lower than the price offered by the company, and the probability was it would be reduced still lower in the future with a larger output. Eventually the motion to extend the works was carried by a considerable majority.

LONDONDERRY.—The Corporation have decided upon a scheme for the extension of the electricity undertaking at a cost of between £8,000 and £9,000. Mr. R. V. Macrory, the city electrical engineer, in explaining his scheme, which was necessitated owing to the increasing demand, said that he would undertake to supervise the extensions at no further remuneration if he was allowed assistance in the drawing office. The scheme may be stated briefly thus: Summary of estimate of extension, plant, cables, etc., for five years' requirements—As Steam turbine, etc, £3,950; B, alternative, reciprocating engine, etc., £3,040; C, switchboard extension panels, etc., £220; D, economiser, piping and flues, £371; E, Feeder cable, etc., £530; F, cable, etc., extensions for five years, £3,370; G, additional boiler, setting of same and piping, which may be required during next five years, £650; total with turbine, £9,091; or total with reciprocating engine, £8,181. Estimate of immediate requirements: Items A, C, D, and E, as above, £5,081; item F for one year's working, £565; total, £5,646. Alternative substituting item B for A, £4,736.

MORECAMBE.—Under a new contract the Town Council are practically supplying the Tower and Casino Co. with electricity in bulk, the company having its own transforming and distributing plant.

SOUTH SHIELDS.—A motion to rescind the Town Council's resolution to spend £8,500 on electricity works extension, was lost, so the original intention will be carried out.

STIRLING.—Mr. Papworth reports to the Town Council that the new feeder cable laid last June from the Craigs to Maxwell Place had worked satisfactorily through the winter. The total cost of the work was £467 16s. 7d., as against the estimate of £500. The Pillar disconnecting boxes are most satisfactory, and he strongly recommends the use of pillars for all future work where possible, in place of underground boxes.

WOKINGHAM.—The Town Council have appointed a committee to apply for a Provisional Order to generate and supply electricity within the borough, and have decided to oppose the Reading Electric Supply Bill.

LIGHTING AND GENERAL—Overseas.

AMSTERDAM.—It is reported that a resident here, acting on behalf of a German company, has made an application for a concession for a large electric power station between Hilversum and Bussum, to supply light and power to all the towns and villages of the Gooi district.

BUENOS AIRES.—An electric light company has been formed in the Province of Giles.

BUENOS AIRES.—As the output of the Compañia Alemana Transatlantica de Electricidad for 1909, for private lighting and power, not including public lighting and traction, was over forty million kilowatts, the reduction of 5% for every five million kilowatts in excess of this, as called for by Art. 2 of its concession, came into force from January 1.

LA PLATA.—The United River Plate Telephone Co. have completed the line between Buenos Aires and Mar del Plata. The distance is 440 km. and there are four lines of copper wire of 3½ mm. diameter. The posts are black Paraguay Palms, 20 to the kilometre. Insultaion, double bell Sinclair. On September 15 the Company obtained the concession from Congress, and 30 days after it signed the contract. Materials were ordered by cable, and work commenced on November 1, and was completed on January 24. The cost of the line is $650,000 paper.

MADRID.—The "Direcciòn General de Obras Publicas," Madrid, have granted to the "Sociedad Valenciana de Tranvias," Valencia, power to substitute electric traction for the present horse traction on their tramways from Valencia to Burjasot and Godella.

MONTEVIDEO.—A co-operative society is being formed to supply electricity, owing to some friction with the local electric light company.

OTTAWA, ONTARIO.—The Canadian General Electric Co. propose to expend from $250,000 to $750,000 in the extension of its Toronto or Peterborough plant, with a view to taking care of its expanding business.

TORONTO.—H.M. Trade Commissioner for Canada (Mr. R. Grigg) reports that an agreement has been arrived at between the Canadian Pacific Railway Co. and the British Columbia Electric Railway Co., in accordance with which not less than 10 miles of car line will shortly be built in Lulu Island, and there will probably be extensions of much greater length. Further, three trunk lines are to be constructed from the town of Vancouver southward to the north arm of the Fraser river.

URUGUAY.—The Uruguayan *Diario Oficial* for January 21 contains a Valuation Tariff for use in the assessment of Customs duty on articles and materials destined for the production and application of electricity, on their importation into Uruguay. This Tariff (in Spanish) may be consulted by persons interested at the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, London, E.C.

TRACTION—Home.

DUBLIN.—By an agreement, sanctioned by the Court of Appeal, the Corporation have consented to the Dublin Tramways Co. making an extension to Inchicore without the payment of wayleave.

HULL.—The Corporation tramways profit having fallen from £26,000 to £20,500, it has been resolved to reduce the contribution in relief of rates from £18,000 to £16,000.

LLANDUDNO.—The shareholders of the Great Orme Tramway Co. have requested the directors not to proceed with the negotiations for the sale of the undertaking to the Corporation.

UXBRIDGE.—The Middlesex County Council are considering the adoption of low open cars for use on the tramways during the summer.

TRACTION—Overseas.

LA PLATA.—The Municipal Urban Tramway is now being electrified.

CONTRACTS OPEN.

HOME.

BARROW-IN-FURNESS.—The Corporation invite tenders for (1) steam coal; (2) oils, engine room stores, tools, ironmongery, etc.; (3) electrical stores, required at the Electricity Works, during the year ending March 31, 1911. Particulars from Borough Electrical Engineer, March 7.

BELFAST.—Borough Council. Annual supplies for Electricity Committee. March 7.

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BELFAST.—Harbour Commissioners. Twenty-two electric arc lamps with tubular mast and cast-iron base columns. (Specifications, Harbour Engineer). March 9.

BOOTLE.—The Corporation invite alternate tenders for the supply of the following plant and the execution of certain alterations at the Electric Light Station:—Section A. Automatic reversible traction booster; B. Circulating pump and electric motor; C. Automatic reverse current breakers and traction feeder breakers; D. Shunt regulating resistances and switches; E. Re-winding 75 kw. generator armatures. Particulars from the Borough Electrical Engineer. March 19.

BOURNEMOUTH.—Corporation Tramways. Annual supplies. (Particulars, 5s., single sections 1s., General Manager, Lansdowne-crescent). March 14.

BRISTOL.—Electricity Department.—Annual Supplies.—Mr. H. F. Proctor, City Electrical Engineer. March 8.

BROMLEY-BY-BOW.—Poplar and Stepney Sick Asylum District Board. Annual supplies. March 8.

CARLISLE.—Corporation. Two water-tube boilers with superheaters, mechanical stokers, and forced draught plant; also two boiler feed pumps. (Specification, £1, City Electrical Engineer). March 14.

CLECKHEATON.—Urban District Council invite tenders for the supply and erection of a Lancashire dynamo type of automatic reversible booster for traction purposes, complete, with switchboard and other accessories. Specification, £2 2s., from Mr. J. H. Linfield, Town Clerk, Cleckheaton. March 9.

EAST HAM.—Corporation. Engineers' sundries for electric lighting and tramways department. (Particulars, Clerk). March 12.

GWAUN-CAE-GURWEN.—Tenders are invited for the erection of an electric power-house at Gwaun-Cae-Gurwen Colliery, near Brynamman. Tenders to Mr. J. Hargreaves at the Colliery, by March 4.

HANLEY.—Tenders are invited from reliable contractors, for the erection of proposed electric theatre, Percy-street, Hanley. The lowest or any tender will not necessarily be accepted. Preference will be given to the builder who undertakes to carry out and complete the whole of the works within five weeks. Applications for quantities to be made to the architects, Messrs. Hickton & Farmer, F.F.R.I.A.B., County Chambers A, Martineau-street, Birmingham, and 15, Bridge-street, Walsall.

HULL.—The Corporation invite tenders for supply of telephone instruments. Specifications (£1 1s.) from Mr. E. Laverack, Town Clerk. March 10.

LONDON COUNTY COUNCIL TRAMWAYS—Construction of tramways from Evelyn-street to Nelson-street, Greenwich, and from Tooley-street to Deptford. Estimate £176,990, as follows: Track, etc., £110,000; rails, £18,500; special work, £11,500; cars, £19,950; cables, ducts, and feeder pillars, £17,040.

LONDON, E.C., for DURBAN.—Corporation. Three hundred steel girder rails, fishplates, bolts, and nuts. (Specifications, £2 2s., Webster, Steel & Co., 5, East Indian-avenue, Leadenhall-street, E.C.). March 14.

LONDON, S.W.—Transvaal Government. Telegraph material. March 7.

LONDON, S.W.—India Office. Overhead electrical travelling cranes. March 8.

LONDON, S.W.—District Railway Co. Thirty-two motor cars and 20 trailers.

PONTYPRIDD.—Urban District Council. Cables, lamps, stores. (Particulars, Electrical Engineer, Treforest Station). March 7.

STOKE-ON-TRENT.—The electricity committee invite tenders for the supply and delivery of "washed pearls or beans" to the Corporation Electricity Works during six months ending September 30, 1910. Probable quantity required about 1,000 tons, delivered as and when required. Tenders, together with samples, must be sent in not later than Tuesday, March 8, addressed to "The Chairman of the Electricity Committee, Electricity Works, Stoke-on-Trent," and endorsed "Tender for Coal."

OVERSEAS.

ALGIERS.—Préfecture at Oran. Concession for electrical tramway from Oran to El-Ancor. March 10.

BAKU.—Municipality. Electrification of tramways.

BRUSSELS.—Vicinal Railways. Sub-station at Liege. (Particulars, 10d., 14, Rue de la Science). March 16.

BUKAREST.—Romanian State Railways. Cables and insulated wire. March 14.

BUENOS AIRES.—The Direccion del Servicio y Conservacion de los Puertos de la Capital y la Plata, will open tenders for one steam crane, lifting capacity 15,000 kilos., and twenty movable electric cranes, each of a lifting capacity of 1,000 kilos., on March 12. Only firms having local representatives and able service could compete from this side.

CHRISTIANIA.—H.M. Consul also notifies that tenders are invited by the Christiania electric works for the supply of cables; tenders, marked "Anbud paa Kabler," will be received by "Christiania Electricitetsverk," Christiania, up to noon on March 7.

CONSTANTINOPLE.—Ottoman Debt Office. Engines and dynamos, motors, etc., for salt mines. March 7.

GHENT.—Municipality. Electric harbour cranes. March 7.

MADRID.—The Government Postal and Telegraphic Department invite tenders for the working of the urban telephone system of Vitoria, the present lease expiring on March 14, 1910. The concession will be for a term of 15 years. To qualify any tender, a deposit of 2,250 pesetas (about £80) will be required, to be increased to treble this amount by the successful tenderer. Tenders, in sealed envelopes, will be received up to noon on March 18 at the "Direccion General de Correos y Telégrafos," Madrid, or by the Civil Government of the province of Alava. The concessionaire is to have the right to modify and extend the present telephone system within a radius of 15 km. *Local representation is necessary.*

TENDERS ACCEPTED.

LONDON.—London County Council Tramways Department.—Supply and delivery of slot rails and conductor tees for London County Council Tramways: P. & W. Maclellan, Ltd., Glasgow, £12,386 5s.; Frodingham Iron and Steel Co., Ltd., Scunthorpe, Lincolnshire, £12,798 17s. 6d. (accepted); Walter Scott, Ltd., Leeds, £13,004. Supply of bends and roof sticks for electric cars: Hurst, Nelson & Co., Ltd., Motherwell, £229 2s. 1d. (accepted); H. Matthews, Ilford, £229 12s. 1d.; Smith, Parfrey & Co., Ltd., Hammersmith, W., £231 11s. 8d.; F. & G. Smith, Bootle, £300 10s. 5d.; Peter Boswell & Sons, Borough-road, S.E., £317 15s. 3d.

COMPANIES' MEETINGS AND REPORTS.

CHARING CROSS, WEST END ELECTRICITY

The directors of the Charing Cross, West End and City Electricity Supply Co., Ltd., have declared a dividend of 2s. 6d. per share on the ordinary shares.

BOURNEMOUTH AND POOLE ELECTRICITY.

The directors have decided to recommend a final dividend on the ordinary shares of the company at the rate of 6% per annum for the half-year ended December 31, 1909, making 5½% for the year, less income-tax.

MANSFIELD AND DISTRICT TRAMWAYS.

The report to December 31, 1909, states that, after payment of the debenture interest to December 31, 1909, and the interim dividend on the 6% cumulative preference shares to June 30, 1909, the amount available at the credit of revenue account is £4,023, from which must be deducted the 6% dividend on the cumulative preference shares for the six months to December 31, 1909, leaving a balance of £2,223. The directors recommend payment of a dividend of 2½% for the year on the ordinary shares of the company, and carry forward £327.

NATIONAL TELEPHONE CO.

At the National Telephone Co.'s half-yearly meeting, Mr. George Franklin contrasted the capital costs per station in the company's system and in that of the Post Office. Their own stations, he said, cost £29 to £30, and the Government stations £50 to £60. Personal observation led them to believe that there was something wrong with the Post Office figures. The negotiations for the purchase of the company's plant earlier than 1911 had had no result. An inventory of the company's assets was in preparation, so that in the case of arbitration they would be able to lay down their claims. Soon after the expiration of their licence the agreement provided for the payment of 3% on the money not paid up when the system was taken over

OXFORD ELECTRIC CO.

The report of the Oxford Electric Co., Ltd., shows a profit for the year to December 31, including £1,202 brought forward, of £15,012. After providing £2,142 for Debenture, other interest and discount on Preference share instalments paid in advance, also writing off £917 on account of hire-purchase installations, the balance available for dividend is £11,952. The directors recommend a dividend at the

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rate of 7% per annum on the Ordinary share capital (whereof 2½% was paid in September), to transfer to credit of reserve and renewal of plant account £2,637, leaving to be carried forward £940. The lamp and motive power connections have been greater than the average of previous years, and, notwithstanding the increased use of metallic filament lamps, the revenue has exceeded that of the preceding year.

CHELSEA ELECTRICITY SUPPLY.

The report of the Chelsea Electricity Supply Co., Ltd., states that the profit for the year to December 31 amounts to £34,701, which, with £1,024 brought forward and £757 for interest, makes a total of £36,483. After deducting interest on Debenture stock, £7,875; interim dividend of 6% on the Preference shares, £900; and interim dividend on the Ordinary shares at the rate of 4% per annum, £4,943, there remains a balance of £22,765, which the directors recommend shall be appropriated as follows: To credit of renewals and depreciation fund, £12,530; to credit of Debenture stock Premium redemption fund, £704; to amount written off cost of extinction of Founders shares, £1,089; to final dividend on the Preference shares at the rate of 6% per annum, making 6% for the year, £900; to final dividend on the Ordinary shares at the rate of 5% per annum, making 4½% for the year, £6,179; leaving a balance to be carried forward of £1,362.

LANCASHIRE UNITED TRAMWAYS.

The Hon. Arthur Stanley, M.P., at the meeting of the Lancashire United Tramways, Ltd., said the profit for the year was £15,417, as against £15,116 for the previous year. The results had not shown that improvement which they all wished, but the year had been an unfortunate one for tramways throughout the country. Trade conditions, especially cotton, had been in a bad state. The Sunday traffic showed a loss of £1,000, mainly owing to the bad weather at week-ends. There were, however, some gratifying features. The number of workmen carried during the year had increased from 2,191,000 to 3,660,000. Arrangements had been made with the Bolton Corporation for reciprocal through-running, with the result that there had been an increase of 220,000 passengers in little more than half a year. The St. Helens dividend on the company's holding was £920. The supply of power to outside consumers had increased from 153,000 to 223,000 units. The report was adopted.

KENSINGTON AND KNIGHTSBRIDGE ELECTRIC LIGHTING CO.

The report to the end of the year 1909 states that the renewal and reserve fund account now stands at £85,464 5s. 1d., being an increase of £7,267 12s. 6d. over the amount of the account at the end of the previous year. After providing for the amount placed to renewal and reserve fund account, and after paying the dividends on the 6% first preference shares to June 30, 1909, on the 5% second preference shares to September 30, 1909, and an interim dividend at the rate of 8% per annum on the ordinary shares for the first half of the year, the balance standing to the credit of the net revenue account for the year 1909 is £8,081 6s. 7d. Of the above sum, £1,500 has been appropriated to the payment of the first preference dividend to the end of the year, and £625 has to be set aside to meet the portion of the dividend on the second preference shares accrued to the same date. It is proposed to pay out of the balance of £5,956 6s. 7d. a further dividend on the ordinary shares at the rate of 8% per annum, for the past half-year, making with the interim dividend paid on August 12, 8% for the year. This will leave a balance of £1,756 6s. 7d. to be carried forward.

BLACKPOOL AND FLEETWOOD TRAMWAYS.

At the meeting of the shareholders of the Blackpool and Fleetwood Tramroad Co., held at Manchester, Mr. George Richardson moved the adoption of the report and accounts, and, this being carried, he proposed that out of the sum of £11,577 17s. 6d. standing to the credit of the net revenue account a dividend be declared for the past half year at the rate of 9% per annum, which would absorb £6,750, that £1,750 be written off to depreciation reserve, £500 to general reserve, and the balance of £2,577 17s. 6d. be carried forward to the current half year. Discussing the expenses of the half year, he said that engine power was practically the same. This was very satisfactory considering they had to pay 6d. per ton more on their coal. In general expenses there was a slight increase, as the guarantee to the Aviation Fund had been charged to this account. To this event the directors guaranteed £100. During the aviation week there was an increase of £386 in traffic receipts. Putting together the extra cost of running, additional wages in the traffic department, and the £100 guaranteed they had just come out on this event on the right side. The directors, the manager (Mr. John Cameron) and the staff were thanked for their services to the company.

LLANDUDNO ELECTRIC RAILWAYS.

Mr. A. W. Tait, chairman, stated at the Llandudno and Colwyn Bay Electric Railways meeting that the profit was £4,436. With the addition of the amount brought forward and the damages received for delay in the delivery of rolling stock (£432) there was a total of £5,185, and after deducting £1,994, law costs, depreciation, and expenses of loan, out of the £3,191 remaining the directors recommended a dividend at the rate of 3% for the year on the issued capital, carrying forward £209. The traffic receipts were £14,372, against £12,067 the previous year, an increase of £2,204. He thought that was fairly satisfactory in view of the fact that part of the line was only open a few months, that the weather, upon which a holiday resort like Llandudno was much dependent, was very bad, and that the additional rolling stock was very much delayed. The traffic expenses had increased owing to 60,000 more car miles having been run. The extension to Old Colwyn was still under consideration, but the directors had been unable to arrive at a satisfactory agreement with the Urban District Council with regard to the cost of road-widening. The action by the Llandudno Council for cost of current was settled by a compromise.

ABERDEEN SUBURBAN TRAMWAYS COMPANY.

The report for the half-year ending January 31 last states that the profit earned for the half-year amounts to £473 16s. 4d., making, with the sum carried forward from last half-year's accounts, a balance of £1,270 16s. 8d. at the credit of profit and loss account. The directors recommend that the sum at the credit of profit and loss account be carried forward as usual at this time. In the reference between the company and the Corporation of Aberdeen with regard to electric supply, the arbiter issued an award ordaining the company to pay to the Corporation a standing charge of £900 per annum and the further price of a half-penny for every B.O.T. unit of electric energy supplied to the company. On the usual supply taken by the company this award would work out at a price of 2d. per unit. The arbiter further fixed the period of agreement between the company and the Corporation at five years. The directors took objection to the part of this award by which the company is ordained to pay a standing charge of £900 per annum irrespective altogether of the supply of electricity taken, on the ground that such a finding is *ultra vires*, and they intimated this objection to the Corporation. The directors also took the opinion of eminent counsel, viz., Mr. J. Avon Clyde, K.C., M.P., ex-Solicitor-General for Scotland; and Mr. J. C. S. Sandeman, K.C., who gave an opinion that the award was illegal, and subject to be set aside by the court. The Corporation has now agreed to depart from the illegal finding of the award if the company will agree to pay a price of 1·75d. per unit, and take a minimum supply of 140,000 units per annum. This offer is at present under the consideration of the directors.

SMITHFIELD MARKETS ELECTRIC SUPPLY CO.

Mr. H. S. Leon, presiding, said that the report for last year stated that the directors were not in a position to recommend the payment of a dividend, the introduction of the lamps named having reduced the receipts for the sale of current by over £4,000. The new lamp used 70% less current, and gave a better light. Naturally, nearly

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all the company's customers had transferred their alleigance from the old to the new lamp. The revenue per lamp had been reduced to $\frac{5}{9}$ of a penny, compared with $\frac{7}{9}$ of a penny—a reduction of 25%. The board had no desire to take advantage of the monopoly they had obtained from the Corporation by charging a higher price than other companies, but they refused to charge less than other companies. They had boldly issued a notice that on and after January 1 of this year the price of current to those using the metallic filament lamps would be raised, but they also showed that the new price would be cheaper than gas, and cheaper than under the old carbon lamp system. The Chairman then proceeded to refer to the arrangements made with the Corporation for an extension of the company's contract until the year 1972. The extension was obtained, he said, by going straight to the Corporation, and putting their (the company's) case frankly before it. Nothing was concealed, and lawyers were not employed. The company made their appeal as business men to business men, and he was delighted to take the opportunity of testifying to the extreme courtesy with which the directors had been met in the negotiations by the Markets Committee. The Chairman also spoke of the valuable services which had been rendered by Mr. Powell, the manager and secretary.

NEWCASTLE AND DISTRICT ELECTRIC LIGHTING CO.

Presiding at the annual meeting, Mr. J. B. Simpson (chairman) stated that, although the trade of the district has been depressed during the past year, the output of electrical energy has increased over 18%, and the profits of the Newcastle and District Electric Lighting Co., Ltd., have been increased by about £4,000. He mentioned that the increased business had been largely due to the demand for electrical energy for power purposes, which had given them a better day load, and in part made up for the drop in the revenue, due to the more general use of high efficiency metal filament lamps.

"The public are, however, appreciating the lower lighting costs, and we have considerably added to our consumers," Mr. Simpson observed. There was also a growing demand, due to the more extended use of electricity in the home for various domestic purposes, which was being pushed as improved designs of apparatus were put upon the market. A pleasing feature in the balance sheet was the improvement shown at Newburn, which was chiefly owing to the increased demand at Messrs. Spencer's Works, and with improved trade a good profit should result from the Newburn undertaking. The cost of coal was an important matter to the company, and it was pointed out that in the present unsettled state of the mining industry it was difficult to say how far the price of coal might become affected. The directors had, however, made satisfactory arrangements for the present year. The report an accounts were adopted, on the proposal of the chairman, seconded by Mr. Arthur Scholefield, and a dividend of 3% for the year, less income tax, was declared.

METROPOLITAN ELECTRIC SUPPLY CO.

The report for the year ending December 31 states that the capital expenditure, which at the end of 1908 amounted to £1,874,559 3s. 2d., has now reached a total of £1,898,421 11s. 5d., being an increase during the year of £23,862 8s. 3d. The gross revenue for the year amounted to £174,367 0s. 9d., as compared with £180,671 18s. in 1908, being a decrease of £6,304 17s. 3d. The working expenses amounted to £79,847 1s. 5d., as compared with £80,697 17s., being a decrease of £850 15s. 7d.. The balance at the credit of the revenue account, before providing for depreciation, is £94,519 19s. 4d. The directors have set aside £15,000 as an addition to the depreciation and reserve fund, carrying to the credit of the net revenue account (No. 5) the sum of £79,519 19s. 4d. This sum, with the balance brought forward from last account, interest and dividends on investments, and other receipts, makes a total of £92,296 11s. 8d. After deducting interest on Debenture stocks and loans, dividend on Preference shares, and other charges, there remains a balance of £49,377 5s. 4d. To this the directors have added £1,500 from the undistributed balance of the Marylebone purchase money, which was set aside towards the maintenance of dividends during the development of other business to replace the loss of Marylebone. This increases the balance at the credit of the net revenue account to £50,877 5s. 4d. An interim dividend of two shillings and sixpence per share (being at the rate of 5% per annum) on the Ordinary share capital, amounting to £25,000, was paid on August 10, and the directors recommend that a further dividend of two shillings and sixpence per share (being at the rate of 5% per annum), on such shares be now paid, making a total distribution for the year of five shillings per share of 5%. This will absorb a further sum of £25,000 and leave a balance of £877 5s. 4d. to be carried forward to the next account. The balance at the credit of the depreciation and reserve fund now amounts to £248,855 5s. 5d. During the year new connections representing the equivalent of 43,398 8 c.p. (or 30 watt) lamps were added to the Company's system, making a total connection at the end of the year of 847,702 lamps. Agreements have been entered into with the District Councils of Hanwell and Southall-Norwood for the transfer to the company for a period of 42 years of the Provisional Orders granted by the Board of Trade to these Councils, and it is anticipated that a supply of energy will be available in these districts during the present year.

WASTE HEAT AND GAS ELECTRICAL GENERATING STATIONS, LTD.

The third annual general meeting of the shareholders of the Waste Heat and Gas Electrical Generating Stations, Ltd., was held, on February 28, at the offices of the Company, 86, Collingwood-buildings, Newcastle-upon-Tyne, Mr. J. B. Simpson (chairman) presiding.

The Secretary having read the notice convening the meeting and the auditors' report, the chairman said: When we met a year ago, I told you that we proposed to make a further issue of capital and for the first time to invite the co-operation of the public. The response to our invitation was gratifying, as the whole amount of £65,000 which was offered was subscribed for, and our issued and paid-up capital is now £150,000. The result of the issue was that 176 new shareholders joined the Company, representing persons in all parts of the country and of all classes, and the total number of shareholders is now 241. Before leaving the capital account I should like to refer for a moment to the paragraph in the report which you have before you, that we propose to ask you to-day to further increase the authorised capital of the Company; we do not propose at the present time to make any further public issue; in fact, we do not propose to make any issue at all except 10,000 shares to the Weardale Steel, Coal and Coke Co., Ltd., which we undertook to allot to them when we entered into our agreement with them three years ago, for the erection of our first generating station. These shares will be issued at par, and paid for in cash. We shall not, of course, require to issue any further capital until we have made some new agreements for additional generating stations. It will interest you, however, to know that some negotiations are in hand with this object in view, but it will doubtless be some little time before they are brought to a conclusion, or at any rate before any further capital is required to carry them out. The report we have sent you shows, I think you will agree with me, that the results of the year we are now reviewing have been very satisfactory. The profits earned during the year amount to £16,731 5s. 6d,. or after paying interest on calls which shareholders paid in advance, to £16,475 6s. 7d. These profits amount to within £300 of the figure which was estimated for the year when we issued our prospectus to the public last February, and this in spite of the fact that one of the smaller generating stations, which we expected would be running continuously several months ago, is not yet doing so, so that some of the revenue which we expected to get last year has not yet been earned. We hope, however, that this station will soon be running satisfactorily, and that the coming year will benefit considerably thereby. You will, I think, agree with me that it is gratifying to find the actual results so near those foretold. The other generating stations have run very satisfactorily throughout the whole year, and have quite come up to the results which we expected from them. You will see that we are writing off and transferring to reserve a total amount of £4,865 2s. 6d., carrying out the policy which I explained to you a year ago, that it is out intention to make regularly every year a proper reserve

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out of profits for depreciation and other purposes. Turning now to the balance sheet which you have before you, you will see that our paid-up capital, as I have already explained, is now £150,000. Our reserve account amounts to £6,312, which is apart from an amount of over £2,000 which has been written off during the last two years for preliminary expenses and brokerage on the issues of capital; these items being now eliminated from our balance sheet. The capital expenditure on our own stations now amounts to £115,370, an increase of £13,940 in the year, the total representing the cost up to date. Two of our stations are not yet fully paid for, but the capital which we have raised to pay for them has been deposited at interest, so that in the meantime it may not be entirely unproductive. We have taken up shares at par of a value of £19,996, which is approximately one half of the share capital, in the Bankfoot Power Co., Ltd., which owns the generating station for utilising waste heat at Bankfoot in County Durham. The other half of the capital is held by Messrs. Pease & Partners, Ltd., who supply the waste heat from their coke ovens. We have every confidence that this investment will yield us a satisfactory return in the form of dividend. As we have now so many new shareholders, some of whom may perhaps not be familiar with the details of our business, I have been asked to give a short explanation, as I did last year. In the production of coke from coke ovens, and in the production of pig iron from blast furnaces, and in the steam engines used in rolling mills, large quantities of heat are produced in the form of gases or steam. To a large extent these have hitherto been wasted because, although their value was known, it was not possible to dispose of the power which they could produce. But when the large electric power companies began to spread themselves over the north-east coast they naturally wished to obtain power as cheaply as possible, and they showed themselves willing to assist us in putting down plant for converting this waste heat into electrical power, and to purchase as much as they could get from us. The first owner of the waste heat, either a colliery, or a blast furnace, sells us the waste heat; we convert it into electricity, sell him what he wants for his own works or for his mine, and dispose of the rest to the power company which transmits this power to whatever part of its cable network may be convenient at the moment, and there disposes of it to its own consumers. We act, in fact, as intermediaries in the buying, transformation, and sale of power. And I may say that it is now amply proved, and appreciated by those who have agreements with us, that without such a Company as ours and without the electric power companies, it is not possible for the owners of waste heat to use their waste heat economically or to make anything like the same profit out of it. The chairman then moved that a dividend at the rate of 7% per annum in respect of the past year be paid from the dates on which the share capital has been paid up till January 31, 1910, the dividend to be payable on March 1. This was seconded by Mr. Pease and carried unanimously. Mr. J. B. Simpson was re-elected a director, and Messrs. Monkhouse, Goddard & Co. were appointed auditors for the ensuing year, and a formal resolution was passed authorising an increase of £100,000 in the nominal capital of the Company.

COMPANIES REGISTERED.

Appleby Crane and Transporter Co.—Capital, £150,000, in £1 shares (100,000 Preferred Ordinary and 50,000 Ordinary). Objects: To carry on the business of makers of and dealers in electric and hydraulic cranes, hoists, lifts, and all kinds of lighting and conveying machinery, engineers, tool makers, etc., and to adopt agreements (1) with W. B. Peat, as liquidator of Appleby's, Ltd. (in liquidation), and (2) with C. Appleby's, Ltd. (in liquidation), and E. G. Appleby. Private company. The first directors (to number not less than seven nor more than eleven) are to be appointed by the signatories. Remuneration, as fixed by the company. Registered office, 58, Victoria-street, S.W.

"Float" Electric Co., Ltd.—£10,000, in £1 shares. Business: That indicated by the title. Private company.

Floorundum Flame Carbons.—£5,000 (£1). To acquire from F. M. Lewis and H. S. Hatfield licenses to manufacture, use, and vend certain inventions relating to enclosed electric flame lamps and electric lamp electrodes, etc. Private.

Holsworthy Gas and Electric Supply Co.—Capital, £10,000, in £1 shares. Objects: To take over (1) the assets and liabilities of the Holsworthy Gas Co.; and (2) the business and undertaking of electric lighting and supply of electric light and power, carried on by W. H. Barkell, of Holsworthy. Minimum cash subscription, 1,000 shares. The first directors (to number not less than five nor more than seven) are: W. T. Kivell, W. H. Barkell, W. Harris, S. Parsons, W. Daniel, W. S. Bray, and A. K. Peter. Qualification, £200. Remuneration, as fixed by the company. Registered office, 8, Fore-street, Holsworthy, Devon.

Turbiro Syndicate, Ltd.—Capital, £5,000, in £1 shares. Objects: To carry on the business of mechanical engineers, machinists, electricians, manufacturers of and dealers in goods for iron mongers, tool makers and others, etc. Private company. The first directors (to number not less than three nor more than five) are to be appointed by the signatories. Remuneration, two guineas each per board meeting attended.

TRADE NOTES.

Messrs. Electrical Installations, Ltd., of Bassishaw House, Basinghall-street, London, E.C., inform us that owing to the satisfactory growth of their business, they are removing to larger and more commodious premises on quarter day next, March 25, 1910, at 27, Martin's-lane, Cannon-street, London, E.C.

Messrs. Nortons (Tividale), Ltd., colliery equipment specialists, have opened London offices at 145, Cannon-street, E.C., where Mr. C. J. Seaman, M.Inst.Mech.E., who recently resigned the position of general manager and managing director of Messrs. Heenan & Froude, Ltd., will be in charge.

Owing to the enormous increase in the "Tantalum" lamps and fittings business, Messrs. Siemens Brothers Dynamo Works, Ltd., have found it necessary to install an additional telephone line. Hence they have now four lines: 8587, 8388, and 8389 Central, and Dalston 4.

The British Thomson-Houston Co., Ltd., electrical engineers and manufacturers, Rugby, have opened a branch office at Royal Chambers, Cardiff, to care for their business interests in the South Wales district.

The Electrical Co., Ltd. (lamp department), inform us that they have decided to reduce the list prices of Aegma electric metal lamps, as from March 1, 1910.

Messrs. Marryat & Place, of 28, Hatton Garden, E.C., advise us that they have appointed Messrs. Marshall Osborne & Co., of 55, Newhall-street, Birmingham, as agents for the sale of their automatic lifts in the Midland district.

FINANCIAL NOTES.

British Columbia Electric Railway Co., Ltd., which has an issued share capital of £1,800,000, offers for subscription at par £530,000 4½% Perpetual Consolidated Debenture stock. The stock is secured by a trust deed, dated February 23, 1907, in favour of the British Empire Trust Co., Ltd., whereby the whole of the company's assets and undertaking, including its uncalled capital, are charged by way of first floating charge according to English law, subject to the existing mortgages and charges created to secure £230,800 First Mortgage Debentures and £210,600 Vancouver Power Debentures now outstanding. The proceeds of the present issue are required for new constructional work. The company's net earnings for the 12 months to June last were £226,892. Over 25 million passengers were carried, an increase of nearly four millions. The company controls various subsidiaries. Net earnings for the six months to December last, £156,053. On January 1, 120 miles of railway were in operation, and an additional 65 miles is expected to be ready shortly. To pay interest on the company's Debenture stock, inlcuding this issue, requires £76,388.

The directors of the Newcastle Electric Supply Co., Ltd., recommend a dividend of 4% for the year on the Ordinary shares for the year to December 31, after transferring out of profits the sum of £16,500 for depreciation.

The directors of the County of London Electric Supply Co. have declared a dividend at the rate of 6% per annum on the ordinary shares for the half-year ended December last, making 5% for the year A sum of £16,000 is applied to depreciation out of revenue, being the same as for the previous year, and the balance forward of something over £3,000 being nearly the same.

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EDUCATIONAL.

ELECTRICAL, STANDARDISING, TESTING AND TRAINING INSTITUTION.

An examination for a "Faraday" Entrance Scholarship, value fifty guineas per annum and tenable for three years, will be held on Wednesday, March 30, 1910, from 10 a.m. to 5 p.m.; Thursday, March 31, 1910, from 10 a.m. to 5 p.m.; Friday, April 1, 1910, from 10 a.m. to 4 p.m. Notice, upon the prescribed form, of intention to compete should reach the secretary, Mr. Howard Foulds, not later than March 21.

DIARY.

FRIDAY, MARCH 4.

NORTHAMPTON INSTITUTE ENGINEERING SOCIETY.—At the Institute, Clerkenwell, "D.C. Liquid Starters," by J. K. Hwoo.

SATURDAY, MARCH 5.

NORTHAMPTON INSTITUTE ENGINEERING SOCIETY.—Visit to Robertson's Lamp Works.

ROYAL INSTITUTION OF GREAT BRITAIN (Albemarle-street, London, W.).—At 3 p.m., "Electric Waves and the Electro-magnetic Theory of Light," by Professor Sir J. J. Thomson, D.Sc., F.R.S.

TUESDAY, MARCH 8.

INSTITUTION OF ELECTRICAL ENGINEERS (Manchester Section).—At the Physical Laboratory, University, Manchester, at 7.30 p.m., "The Short Circuiting of Large Electric Generators, and the Resulting Forces on Armature Windings," by Mr. Miles Walker.

WEDNESDAY, MARCH 9.

INSTITUTION OF ELECTRICAL ENGINEERS (Birmingham Local Branch).—At the Chemical Theatre, University of Birmingham, at 7.30 p.m., "Some Notes on Standardisation of Electrical Machines," by Mr. R. Orsettich.

ASSOCIATION OF ENGINEERS-IN-CHARGE (St. Bride's Institute, London, E.C.).—At 7.30, "The Application of Recording Instruments to Steam Generation," by Mr. J. Abady.

THURSDAY, MARCH 10.

INSTITUTION OF ELECTRICAL ENGINEERS.—At the Institution of Civil Engineers, "Short Circuiting of Large Electric Generators and the Resulting Forces on Armature Windings," and "The Design of Turbo Field Magnets for A.C. Generators, with Special Reference to Large Units at High Speeds," by Mr. Miles Walker.

FRIDAY, MARCH 11.

ROYAL INSTITUTION OF GREAT BRITAIN (Albemarle-street, London, W.).—At 9 p.m., "Ionisation of Gases and Chemical Changes," by H. Brereton Baker, D.Sc., F.R.S.

PHYSICAL SOCIETY OF LONDON.—At the Imperial College of Science, South Kensington, at 8 p.m., "On Coherers," by Mr. W. H. Eccles, D.Sc.; "Earth-air Electric Currents," by Mr. G. C. Simpson, D.Sc.

SATURDAY, MARCH 12.

ROYAL INSTITUTION OF GREAT BRITAIN (Albemarle-street, London, W.).—At 3 p.m., "Waves and the Electro-magnetic Theory of Light," by Professor Sir J. J. Thomson, D.Sc., F.R.S. (Lecture V.).

ELECTRICAL ENGINEERS TERRITORIALS (London Division).—Orders for week ending 12th inst.: Monday, Mar. 7, "A" Company, Recruits Infantry Drill, 6 to 7 p.m.; Technical Drill, 7 to 9.30 p.m.; Tuesday 8, "B" Company, Technical Drill, 7 to 9.30 p.m.; Wednesday 9, Gymnasium, 6.30 to 9.30 p.m.; Thursday 10, "C" Company, Technical Drill, 7 to 9.30 p.m.; Friday, 11, "D" Company, Recruits Infantry Drill, 6 to 7 p.m.; Technical Drill, 7 to 9.30 p.m.; Saturday, 12, "C" Company, Week end run at Coalhouse Fort, Parade and Dress, as usual.—(Signed) J. H. S. Phillips, Capt., Acting Adjutant.

SOUTHAMPTON ELECTRICITY.—An application is to be made to the Local Government Board for sanction to borrow a further sum of £8,000 for sundry mains and services; that meter rents for houses below £25 rateable value be reduced from 2s. 6d. to 1s. 3d. per quarter as from March 31, 1910, and that when a second meter is required for heating, no additional meter-rental be charged. The tender of Messrs. Gent & Co., Ltd. (Leicester), to supply and erect an electric cable for the water level indicator at the waterworks, at a cost of £82 18s. 2d., was accepted.

FIRE AT MESSRS. JOHNSON & PHILLIPS. A slight fire occurred at Messrs. Johnson & Phillips' works at Charlton, near Woolwich, on Tuesday night. Thanks to prompt action the damage was confined to one floor, and will cause no interruption to business.

ROSARIO ELECTRIC.

In a recent issue we mentioned that the Belgian Co., the Société Financiére de Transports et d'Entreprises Industrielles (which, it will be remembered, bought from the English shareholders the Barcelona Tramways), had made an offer to purchase the Rosario Electric Co., Ltd. The provisional agreement to sell has now been ratified by the shareholders. In placing the matter before the shareholders, Mr. W. T. Western (chairman) said: The terms offered are, shortly, the sum of £6 10s. for each £5 first preference share, and £9 for each second preference convertible and for each £5 ordinary share—the partly paid shares receiving the same sum, less the amount of unpaid calls—or, what comes to practically the same thing, £518,000 in cash. The purchasers require, in the first place, an option until May 1, which may be extended until July 1, to give them time to verify the particulars furnished to them concerning the business and to settle their plans. The transfer is to take effect as on July 1, and the purchase money is to bear interest from that date, and to be paid not later than December 31. Inasmuch as the purchasers are working in conjunction with some of the most powerful commercial and financial groups in Berlin, there is no doubt as to their capacity for carrying out the business; they have already, in fact, successfully carried out other large transactions of a similar nature. In addition to the price of £518,000—or £6 10s. and £9 per share—the purchasers offer to pay a further sum of £12,000, to be at your disposal, for the purpose of compensating the directors. In dafting the agreement we have, with the assistance of our legal advisers, made it clear that this additional sum is not a gift to the directors, but a payment to the company, which the members of the company can dispose of as they think fit.

THE EDISON-BEACH ELECTRIC CAR.

"P. J. G." writes with reference to the details sent by our New York Correspondent of the Edison-Beach Storage Battery Car: "I should be glad if Mr. Edison would give me, through THE ELECTRICAL ENGINEER, the weight of a car of the same size, running on the Overhead system, as the one he made his trial test on, and which weighed 10,000 lbs. One of the chief reasons that the Storage Battery Car has not been in service up to the present time is owing to the fact that the weight of the cells and car is very great compared with the passengers carried, so that I am sure a comparison of the different weights for the different systems would greatly interest your readers." Perhaps Mr. Edison will oblige.

BRITISH ELECTRICAL FRIENDLY SOCIETY.

The fifth annual dinner of the Potteries Branch of the British Electrical Friendly Society was held last week at the Crown and Anchor Hotel, Longton. Lieut.-Col. Sir Thomas Pilkington, Bart., presided, and he was supported by Mr. F. W. Chanter and Mr. S. Mear, directors, Mr. W. Thom, general manager, Mr. F. Hatch, assistant manager, Mr. W. F. Herring, secretary of the Potteries Electric Traction Co., the Mayor of Hanley and a representative body of visitors. In the course of the speechmaking the "fair fares" system was adversely criticised. It was stated that within the last eight years the Society had paid out very nearly £3,000 in sick pay alone, which in itself was close upon £1,000 more than the members had paid in, the deficit being made up by contributions from the directors. Mr. Washington Hall, the local secretary, gave particulars as to the disbursements of his branch.

EXTENSIONS AT BEDFORD.—The Town Council have sanctioned the expenditure by the Electricity Committee of various sums, chiefly for extension purposes. One item of £30 is for materials, £200 is for new electric street lamps, and £1,080 for an extension of the high tension cable to a furniture factory about to be erected by Messrs. C. & R. Light, Ltd. This will also entail the purchase of additional switchgear at the works, at a cost of £100, and the erection of a sub-station at an estimated cost of £120. Messrs. Light are to undertake to make a minimum payment of £770 per annum for current, during a term of five years.

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ELECTRIFICATION IN JAPAN.

H.M. Commercial Attaché at Yokohama (Mr. E. F. Crowe) reports that several works of improvement on the railways of Japan are being considered by the Railway Board. Of these the most important are as follows :—

(1) The quadrupling of the Yokohama-Tokio line, and the addition of electric power to the present system of steam traction. Mr. Crowe is given to understand that it is proposed to lay an electric tramway track of standard gauge along the present railway line; power would be supplied from the Rokugo river.

(2) The construction of a temporary ferry between Shimonoseki and Moji at an estimated cost of some 150,000 yen (about £15,300), the service being intended to facilitate the conveyance of goods. This temporary ferry will be reconstructed as a permanent one when all the necessary arrangements have been completed.

This project (says Mr. Crowe) must not be confused with a proposal to build a boat bridge between Moji and Shimonoseki and to dredge the Straits. The bridge is to be constructed by the Home Department, and it is said that a vote of 3,000,000 yen (about £306,000) for the purpose will be included in the next Budget.

(3) The electrifying of the Usui section.

(4) Increasing the speed on the Kobe-Kioto section. Some trial runs have been made, but, as considerable changes will be required, no definite decision had yet (December 9) been arrived at.

(5) Building a large central station at Tokio, and linking up the railway with the harbour works at Osaka and Yokohama.

PATENTS.

Supply and Regulation of Electrical Energy for Train Lighting.

1820—1909. The Tudor Accumulator Co., Ltd., Westminster. This is an improvement in systems where current is generated by a dynamo when the train is in motion and utilised for lighting or stored in secondary batteries. The object is to provide a system of supply and regulation so that excess of output over lighting can be used for charging the batteries without danger of exceeding the proper charging current or over-charging the batteries. In the

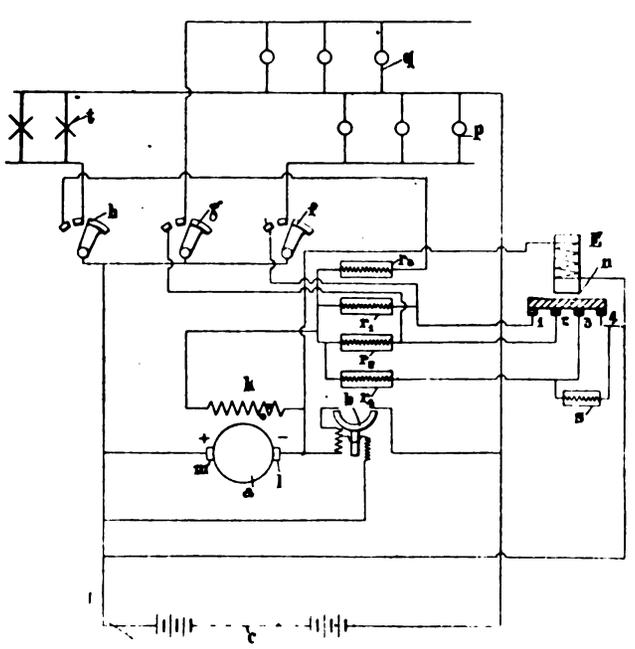


Fig. 1.

diagram the armature *a* of the dynamo is connected through an automatic switch *b*, in parallel to the battery *c*. The armature of the dynamo and the battery are connected to the switches *f*, *g*, of the lamps *p*, *q*, and to a switch *h* for fans, *t*, the dynamo being of a type which above a certain speed gives a nearly constant current independently of speed. The field *k* of the dynamo is in series with a number of resistances, r^1, r^2, r^3, and r^4 of the iron wire type, which allow an approximately constant current to pass through them independent of a considerable voltage fluctuation across them and in parallel with one another, so that supposing one end of the field is joined to the negative brush 1 of the dynamo, the circuit for the current passes from the negative brush through the field winding and then splits up into separate circuits through the resistances, r^1, r^2, r^3, r^4, if they are in circuit and thence to the positive brush. The resistances r^1, r^2, and r^4, are connected to three terminals of the magnetic switch *n*, controlled by the electro-magnet E, so that when this switch is closed they are always in circuit; resistances r^1 and r^2 are also connected to the switches *f* and *g*, so that, even if the magnetic switch is open and the switches *f* and *g* are closed, the resistances r^1 and r^2 are kept in circuit. The resistance r^3 is connected to a terminal on the switch *h*, and is only in circuit when this switch is closed. It is clear that the output from the dynamo controlled by the resistance r^3 can only be taken from it when the switch *h* is closed. As long as the magnetic switch is closed all the resistances connected to it are in circuit and the dynamo gives a corresponding output: as soon, however, as the battery is charged, the magnetic switch opens and all the resistances connected to it and also connected to a closed circuit switch are cut out, thus reducing the current being given out by the machine to suit the load in circuit. If there is no load in circuit the machine still gives a small current as two of the magnetic switch terminals 1, 2, 3, 4, are shunted by a high resistance *s*, this prevents the automatic switch opening and avoids hunting. The operation of the arrangement is as follows: When on starting the dynamo the voltage reaches a certain value, the automatic switch *b* closes, placing the dynamo in parallel with the battery. The magnetic switch *n* is then in the closed position and if all the lighting and like switches are closed, the field is energised to the full extent and the dynamo supplies lighting current to all the lighting circuits or to fans, etc., and also supplies the charging current for the battery. If now any particular load circuit is cut out the field current corresponding to that circuit is cut out unless this field current is carried by a conductor, which is connected to the magnetic switch and the latter is in the closed position as well as to a contact on the main circuit switches and therefore the constant current given out by the dynamo is correspondingly decreased. Further, when the battery becomes fully charged the magnetic switch operates and cuts out the portion of the field current carried by the resistances connected to it unless these latter are also connected to a contact on a circuit switch which is closed or an alternative current path is provided for keeping them in circuit, thus reducing the output to suit the load in circuit.

Controlling the Speed of Bodies Driven by Alternating Current Electric Motors.

12917—1909. Mavor & Coulson, Ltd., Glasgow. In a previous patent (11183—1907) the motors are independent machines, but whilst these are satisfactory in certain services, it is found desirable in other cases to simplify the arrangement so that a single rotor and a single stator having equivalent characteristics to the multiple motors may be employed. In this improvement the required

Fig. 2

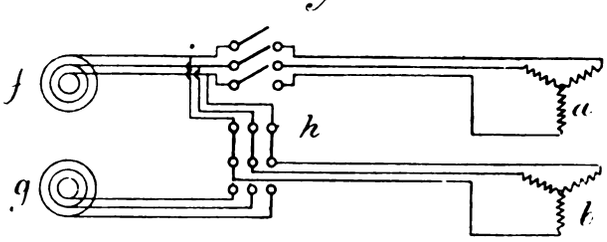
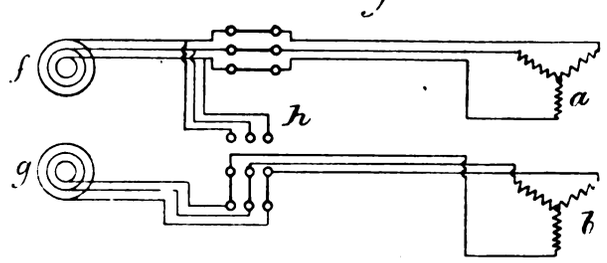


Fig. 3



stator windings are combined in one framework in which slots are arranged to take the windings that give respectively the required numbers of poles. This stator with its multiple windings is caused to actuate a squirrel cage rotor disposed in the usual manner with respect to the stator. Fig. 1 is a longitudinal section of the upper half of the motor and Figs. 2 and 3 diagrams of the circuit connections. In Fig. 1*a* is a four pole winding and *b* a six pole

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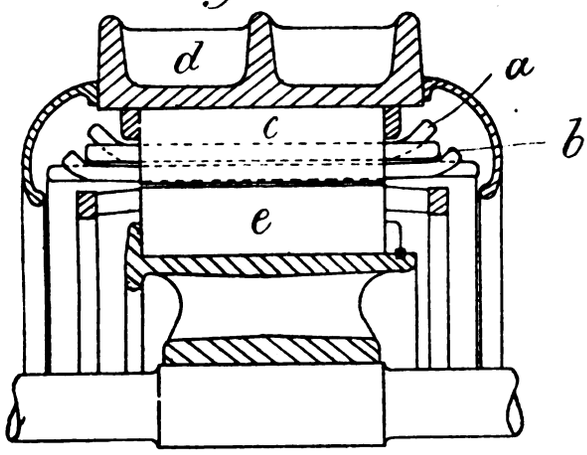
winding, occupying the slots in the laminated ring *c*, which is mounted on the stator frame *d*; *e* is an ordinary squirrel cage rotor. In Figs. 2 and 3 *f* represents a 20 period alternator and *g* a 30 period alternator. In Fig. 2 current is supplied from the 20 period alternator *f* through the switch mechanism *h* to the six pole winding *b*, the winding *a* and alternator *g* being out of use. In this way the motor will run with a low speed of the rotor *e*. In Fig. 3 the 20 period

Fig 1.



alternator *f* is connected to the four pole winding *a* and the 30 period alternator *g* to the six pole winding *b*, thereby obtaining high speed of the motor. It will be obvious that by the arrangement described, the generators supplying to the motors currents of differing periodicity, may have their powers superimposed in the application to a common work and this without the necessity or the possibility of synchronising the alternations of the two systems.

Electric Insulators.

12477—1909. BULLERS, LTD., London, E.C. The oil cup at the base of the insulator is supported by projections on the stem. The central hole of the oil cup through which the stem passes has a slot. When the slot and projections are coincident the cup can be lowered on the stem. The base of the cup has recesses into which the projections enter, thus supporting the oil cup when in its normal position.

Telephone Systems.

17473—1909. P. STRAGIOTTI, Philadelphia. The invention consists primarily in the application of an auto-induction coil to the differential microphone in such manner as to render the microphone more efficient and sensitive. The battery circuit feeding the microphone is made to extend from the central to the subscriber's box. The effective telephonic line resides in the secondary of the transformers which may pass through a condenser. This secondary is a derived circuit of the telephonic box.

Electric Telephone Relays.

17542—1909. P. STRAGIOTTI, Philadelphia. In differential electric telephonic relays a pair of separated microphone electrodes are connected to a support that can turn freely around a vertical axis. The separated electrodes co-operate with a central electrode carried by a plate supported at its four corners.

Electric Dry Batteries.

17824—1909. D. FULLER, Woodford. In an electric battery which is provided with an annular reservoir at its upper part to contain the electrolyte and in which the carbon electrode extends through the central opening of the reservoir and through the top closure, the upstanding part of the carbon is enclosed from the carbon block to the exterior end of the upstanding part, in a tightly fitting sleeve of celluloid. The terminal is fitted upon the exposed top surface of the extending carbon.

Dynamo Electric Machines.

19393—1909. F. W. LE TALL, London, W.C. The commutator of the dynamo comprises rings supported on the machine shaft by longitudinal ribs attached to the rings or to a bushing surrounding the shaft. Commutator segments are mounted on the rings but are insulated from the rings. Relatively thin conductors connect the commutator segments in longitudinal rows, while external rings secure the commutator segments in position.

Electric Lighting Device for Lifebuoys.

19424—1909. J. F. TRENTMANN, Hamburg. The contact device is housed in a chamber closed by a membrane. When the lifebuoy is thrown into the water the pressure pushes the membrane against the contact, which is thereby actuated for igniting the electric lighting device of the buoy.

Electric Furnaces.

19466—1909. SALPETERSAURE, INDUSTRIE-GESELLSCHAFT, G.m.b.H., Gelsenkirchen. In working with electric flame arcs, used for the treatment of gases, it is found that when large quantities of energy and gases are dealt with the arc is liable to be blown out by the stream of gas. The object is to provide means whereby the arc is immediately remade after being blown out. Two inter-connected electrodes are arranged between two main electrodes to form with the latter two glared gaps separated from each other at their wider parts by a gap between the unconnected ends of the auxiliary electrodes.

Spring Switches.

19662—1909. SIEMENS BROS. & CO., LTD., Westminster. This is an improvement in spring switches for electrically setting railway points and signals. The supports are so shaped that they are at once brought into position by pressure on the switch lever and without the assistance of a spring.

Electrical Ignition Mechanism for Internal Combustion Engines.

20241—1909. A. GIBAUD, Paris. The manner in which the mechanism is arranged enables the contacts to be easily inspected without necessitating the dismounting of the principal parts. The entire contact breaking mechanism can be instantaneously withdrawn from the machine and replaced with the same rapidity. The part enclosing the distribution can also be quickly removed and replaced.

Electric Driving of Looms.

20004—1909. SIEMENS BROS. & CO. LTD., Westminster, S.W. This is an improved coupling for looms driven through friction couplings. The rubbing surface of the coupling only occupies a portion of the total possible rubbing area and consists in a disc embraced by a friction band which bears on the outer circumference of the disc. In this manner the rubbing pressure is increased for the same turning movement and consequently an equally great extension of the band or expansion of the disc will only give rise to a smaller percentage variation in the total turning movement than would be the case with the known form of coupling.

Controller Operating Handle for Electric Cars.

20378—1909. E. K. HOFMANN, Andover, U.S.A. The handle is removably applied to and supported by the controller shaft, which extends centrally upwards from the controller cylinder of the electric car. The handle can be easily adjusted and tightened, while by reason of its construction it is not easily removed by those not familiar with its method of fitting. This makes it difficult to be tampered with by mischievous persons.

Automatic and Selective Switching of Telephone Lines.

20841—1909. J. E. KINGSBURY, Westminster, S.W. The sets of contact brushes in this selector switch are normally held out of operation. Electro-magnetic means are provided for releasing any set of brushes to bring it into contact with line terminals over which the brushes are moved when the switch carrying the sets of brushes is advanced.

Interrupters for Magneto Ignition Purposes.

21962—1909. J. L. MILTON, Chicago. The cam which operates the interrupter through the wiper is so shaped that at low speeds the wiper will follow the whole cam surface, but at high speeds will jump part of that surface so as automatically to vary the timing of the spark over the entire range to obtain a spark of constant voltage.

Electro Motors.

22317—1909. M. JOHANNET, Paris. In order to balance the variable strains of electro motors with movable framing, a spring attached to the framing is connected to a lever and a roller. A cam having a given contour and projecting from the framing engages with the roller. By rotating the cam the point of fastening of the spring can be moved so that the natural rate of tension of the compensating spring is modified.

Electric Switches.

22385—1909. T. G. HOWE, Tottenham. This is an improvement in electric switches of the type in which the junction of a plug and socket and a switch are combined. This switch has a lateral pin attached to one of the plug pins. This lateral pin engages a hook on a switch arm and moves the arm into and out of operative engagement with its contacts.

Joining Cable Ends.

10052.—1909. J. F. DYSON, Manchester. The joining box is made in two parts, one acting as a base and the other as a cover. Upstanding slotted lugs attached to the base form a support to the cable ends. Flanged collars between the lugs and mounted on the cable ends receive the wire armouring of the cable. The collars prevent longitudinal displacement and rotary movement of the cable ends.

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TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns per week.			Increase or decrease.		Miles of track open.		Accounts for past year.				Receipts per			Cost per car mile.
	Ending	1909-10.	1908-9.	Week.	Current year.	1909.	1908.	Ending	Total receipts.	Passengers carried.	Car miles run.	Passenger.	Car mile.	Mile of track.	
		£	£	£	£				£						
Aberdeen Corporation	Feb. 23	1,174	1,169	+ 5	— 876	27½	27½	May 31	71,930	17,517,304	1,566,119	·98	11·02	4,940,	5·93
Ayr Corporation	Sept. 18	671	562	+ 108	—	8	8	—	—	—	—	—	—	—	—
Baker Street and Waterloo Ry.	Nov.	8,141	6,070	+2,071	—	4·25	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	Feb. 20	978	970	+ 8	+ 60	24·003	13·52	—	—	—	—	—	—	—	—
Birmingham Corporation	Feb. 19	6,832	6,191	+ 641	—	56·792	58 52	—	—	—	—	—	—	—	—
Blackburn Corporation	Oct. 6	1,100	1,293	— 173	— 1,036	24·53	28·3	—	—	—	—	—	—	—	—
Blackpool Corporation	Aug. 26	2,152	2,050	+ 102	+ 732	—	—	—	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams	„ 8	2,304	2,309	— 24	—	—	—	—	—	—	—	—	—	—	—
Bolton Corporation	Oct. 10	2,416	2,337	+ 79	— 259	42	42	Mar. 31	117,799	25,492,902	2,492,147	1·1	11·34	2,804	6·50
Bournemouth Corporation	July 21	1,681	1,723	— 42	— 23	29½	29½	„ 31	86,225	13,991,328	1,766,068	1·47	11·71	2,912	7·22
Bradford Corporation	Feb. 19	4,682	4,328	+ 354	+ 8,976	98	54·81	„ 31	235,258	47,839,569	5,331,007	1·17	10·59	2,378	—
Brighton Corporation	Feb. 27	740	609	+ 131	+ 2,297	9·5	—	—	—	—	—	—	—	—	—
Bristol Tramway Company	Feb. 25	5,126	4,691	+ 435	—	57	51½	Dec. 31	265,362	46,652,389	5,756,842	—	—	—	—
Burnley Corporation	Feb. 26	1,112	1,139	— 27	—	19½	19½	Mar. 31	64,261	12,355,958	1,202,330	1·23	12·83	5,971	7·92
Burton Corporation	Feb. 27	248	214	+ 34	— 56	6½	6½	„ 31	14,918	3,221,595	430,913	1·04	8·30	1,460	5·85
Cardiff Corporation	April 3	2,000	1,957	+ 43	—	—	—	„ 31	109,979	25,058,146	2,497,169	—	10·57	—	—
Carlisle Tramways Company	June 19	170	175	— 5	— 89	—	—	—	—	—	—	—	—	—	—
Central London Railway	Feb. 26	5,587	5,569	+ 18	— 592	6·32	5·77	Dec. 31	350,150	41,898,373	1,456,781	2·01	5·769	55,404	30·27a
Charing X, Euston, & Hamp. Ry.	Nov.	6,822	6,092	+ 730	—	7·75	—	—	—	—	—	—	—	—	—
City and South London Railway	Feb. 27	3,417	3,430	— 13	— 417	7·26	7·26	—	—	—	—	—	—	—	—
Colchester Corporation	July 14	200	219	— 39	—	8	—	Mar. 31	10,983	2,308,721	349,539	1·09	7·74	1,477	6·56
Cork E. T. and L. Company	Feb. 24	412	418	— 6	+ 39	9·89	9·89	Dec. 31	24,044	5,737,478	896,945	—	6·43	—	4·43
Croydon Corporation	Feb. 11	1,444	1,214	+ 230	+ 7,040	11½	—	Mar. 31	74,132	16,277,418	1,884,137	1·06	9·56	3,703	7·109
Darwen Corporation	Oct. 1	239	256	— 17	— 201	7·23	7·23	„ 31	13,899	2,557,654	245,584	1·30	13·68	1,922	9·40
Dover Corporation	Sept. 18	230	252	— 22	— 395	7	—	„ 31	11,593	2,697,672	316,754	·98	8·78	—	—
Dublin and Lucan Electric Ry.	Feb. 25	101	112	— 11	— 81	7	7	—	—	—	—	—	—	—	—
Dublin U.T.	Feb. 25	4,686	4,652	+ 33	+ 745	54½	54½	—	—	—	—	—	—	—	—
Dundee City Tramways	Oct. 6	1,332	1,305	— 27	— 569	—	26½	May 15	60,573	16,367,911	1,281,552	·875	1·9	2,371	7·46
East Ham Corporation	Feb. 26	949	827	+ 122	+ 5,398	15	15	Mar. 31	47,430	15,355,703	1,091,586	·73	10·26	—	6·96
Glasgow Corporation	Feb. 19	17,036	16,369	+ 667	— 6,406	189	185	May 31	907,494	226,948,290	20,766,722	·96	10·49	5,080	5·89
Gloucester Corporation	Oct. 6	395	425	— 30	+ 535	15	—	—	—	—	—	—	—	—	—
G.N., Piccadilly and Brompton	Nov.	13,429	9,354	+ 4,075	—	9·25	—	—	—	—	—	—	—	—	—
Halifax Corporation	—	—	—	—	—	52·574	37	Mar. 31	81,872	20,378,672	1,786,390	11·40	11·13	1,528	8·40
Huddersfield Corporation	Dec. 4	1,613	1,357	+ 256	+ 2,663	28	28½	„ 31	84,704	16,200,020	1,960,329	1·29	10·37	2,421	5·10
Hull Corporation	Feb. 26	2,682	2,292	+ 390	+ 6,638	29	26	„ 31	128,722	30,964,254	3,022,844	1·	10·22	—	6·04
Ilford Corporation	Feb. 12	451	391	+ 60	+ 1,969	10	10½	„ 31	25,328	6,385,466	634,446	·87	9·58	2,066	6·42
Ilkeston Corporation	Feb. 23	120	123	— 3	— 149	4	4	„ 31	7,214	1,968,850	198,415	9·1	7·9	1,803	7·04
Kirkcaldy Corporation	Sept. 8	269	266	— 7	—	7½	7½	May 15	14,993	4,874,199	459,066	·711	7·838	1,856	5·26
Lancashire United Tramways	Feb. 23	1,166	1,215	— 49	— 28	39	39	Dec. 31	68,904	12,554,593	2,244,344	—	—	—	—
Leeds Corporation	Sept. 18	6,896	6,624	+ 272	+ 3,662	108	96½	Mar. 31	340,368	75,734,083	7,694,989	1·06	10·62	3,527	5·51
Leicester Corporation	Sept. 11	2,162	2,130	+ 32	—	—	—	—	—	—	—	—	—	—	—
Liverpool Corporation	Nov. 6	10,803	10,687	+ 116	— 1,977	109	104	Dec. 31	572,822	124,043,239	12,231,799	1·108	11·24	5,508	7·94
Liverpool Overhead Railway	Feb. 20	1,245	1,271	— 26	— 259	6·65	2·40	June 30	79,004	11,171,515	1,106,386	—	—	—	—
London County Council	Feb. 12	37,882	32,539	+ 5,343	+ 114338	129½	122½	Mar. 31	1,274,660	279 166,461	25,591,028	1·08	11·74	—	6·79
Lowestoft Corporation	Dec. 11	155	150	+ 5	+ 30	3½	—	Sept. 30	11,399	2,645,206	370,320	1·03	7·36	2,279	6·12
Maidstone Corporation	Feb. 19	130	132	— 2	—	7·4	—	—	—	—	—	—	—	—	—
Manchester Corporation	Sept. 11	15,631	15,297	+ 334	— 2,871	183	181	—	—	—	—	—	—	—	—
Metropolitan District Railway	Feb. 26	11,253	9,766	+ 1,487	+ 7,550	24	24	—	—	—	—	—	—	—	—
Metropolitan Railway	Feb. 27	16,239	15,580	+ 659	+ 4,249	24½	24½	June 30	680,357	99,846,735	—	1·46	—	—	—
Nelson Corporation	Oct. 16	151	131	+ 20	+ 7	2½	2½	Mar. 31	7,362	2,060,712	204,740	·85	8·63	1,907	—
Newcastle-on-Tyne Corporation	Feb. 19	3,826	3,652	+ 174	— 1,322	60½	59½	„ 31	211,085	46,203,164	4,411,745	1·10	11·48	3,504	6·36
Newport (Mon.) Corporation	Oct. 9	663	638	+ 25	— 311	14½	14½	„ 31	35,531	8,174,003	798,029	1·04	9·89	2,450	7·21
Oldham Corporation	Jan. 24	1,778	1,516	+ 262	— 386	—	—	—	—	—	—	—	—	—	—
Portsmouth Corporation	Oct. 10	2,046	1,809	+ 237	—	28½	28½	Mar. 31	97,741	21,247,048	2,309,439	1·10	10·15	—	—
Reading Corporation	Feb. 24	538	502	+ 36	+ 43	13½	13½	„ 31	32,769	7,933,572	915,481	—	8·93	—	4·65
Rochdale Corporation	Dec. 26	1,240	1,126	+ 114	+ 746	20·9	20·93	„ 31	56,558	10,196,148	1,252,925	1·32	10·83	2,693	6·47
Rotherham Corporation	Feb. 4	555	587	— 32	—	—	—	—	—	—	—	—	—	—	—
Salford Corporation	Sept. 27	4,096	4,662	— 66	— 3,326	78	74½	Mar. 31	244,065	45,771,611	5,486,150	1·25	10·67	3,185	—
Scarborough Tramways Co.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Sheffield Corporation	Feb. 20	5,681	5,285	+ 396	+ 6,203	39½	37	Mar. 25	289,745	17,568,686	7,065,380	·896	9·842	4,225	5·04
Southampton Corporation	Feb. 16	964	868	+ 96	+ 262	18	18	„ 25	52,647	10,121,887	1,157,451	1·25	11·33	—	7·30
Southend-on-Sea Corporation	Aug 21	995	557	+ 438	+ 1,483	—	—	—	—	—	—	—	—	—	—
Stockport Corporation	—	—	—	—	—	25	25	Mar. 31	52,004	9,155,172	1,335,911	1·34	9·342	1,830	4·75
Sunderland Corporation	Jan. 27	1,310	1,336	— 26	— 7,984	—	—	—	—	—	—	—	—	—	—
Swindon Corporation	Dec. 11	126	114	+ 12	—	—	—	—	—	—	—	—	—	—	—
Torquay Tramways	Aug. 26	630	647	— 30	—	8·41	—	Dec. 31	15,065	2,880,420	353,297	1·40	1·023	—	—
Wallasey U.D.C.	Feb. 26	757	774	— 16	+ 829	12·68	12·45	Mar. 31	43,823	8,331,038	891,540	1·2	11·79	3,453	7·72
Warrington Corporation	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
West Ham Corporation	Feb. 17	2,266	1,984	+ 281	—	27	14·7	Mar. 31	122,881	35,502,836	2,556,854	·789	10·95	4,417	6·79
Wolverhampton Corporation	Nov. 3	841	823	+ 18	— 206	21¾	—	„ 31	44,432	9,440,369	975,714	—	10·929	2,190	6·509

a Train Miles. *h* Half-year's figures.

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WITH WHICH IS INCORPORATED "ELECTRIC LIGHT."

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NOTES.

ELECTRICITY EMERGENCY COMMITTEE.

It will be remembered that in the matter of the correspondence carried on by Mr. E. Garcke with the Institution of Electrical Engineers, with regard to the Institution's attitude on the legislative, industrial and commercial aspects of electrical engineering, we took a decided stand. In our leading article for December 24, while acknowledging that much could be said to support Mr. Garcke's contention that an authoritative body was required to safeguard the commercial side of the industry, we held that that body should not be the Institution of Electrical Engineers, which should remain, for the higher benefit of all concerned, an essentially scientific society, above the turmoil of politics and trade or industrial considerations. Returning to the question in our Notes in our issue for December 31, we suggested under the heading "The Institution and its Mission," that by far the best way out of the difficulty was to form some kind of Emergency Committee of Electrical Societies, on which every branch of electricity could be represented, and whose special mission would be to watch material interests of all those concerned. We pointed out that such a body could be so constituted as to retain the greatest amount of freedom, and yet prove effective in dealing with legislative or other action which might be deemed likely to become inimical not only to the general progress of electricity, but to the commercial interests of any section of the industry. It will be seen on referring to our Correspondence Column that a step in this direction has been taken. We welcome this new move, as the need for some action has certainly been shown, and by the constitution of this organisation a danger threatening the best interests of the Institution of Electrical Engineers has been dissipated.

FINANCIAL RESULTS.

Now that so many electricity companies have published their annual reports, it is possible to form an idea of general results. It is clear enough that the slump in demand for current, and in income, caused by the introduction of the metal filament lamp is now over. Here and there we may meet with continued depression, but on the whole, both in London and the Provinces, the worst is over. The lamp is proving the blessing in disguise that we ventured to predict would be found to be the case, for the notable economies it effects have induced that steady spread of the use of electricity as an illuminant which will prove to be the mainstay and hope of many electricity undertakings. On the other hand, the alarm caused by the slump has had excellent results in tuning up the undertakings. There has been a general overhauling of generating stations and of methods of carrying on business, bringing about economies and also more up-to-date methods of trading. Wise measures of publicity in many and varied directions are being taken. Consumers are being sought after and educated as to the manifold uses of electricity, and so we see the generation and sale of units doing something more than creep up to their old levels. It is pleasing to see that there are no signs of relaxing efforts either in the way of perfecting methods of production or in securing a wider basis of supply. In one direction there is still ample room for improvement; there is far too great a discrepancy in most cases between units generated and units paid for. Loss between the supply station and the consumers' meter is inevitable, but it should be lower than it generally is, and very much lower than it is in many cases. For some reason or other this discrepancy is more noticeable among municipal than company undertakings.

SOME PARTICULARS.

Metropolitan returns are really encouraging. Of eleven London electricity supply companies only four companies had to reduce their dividends. The drop from 3 to 2% of the London Electric Supply Corporation was to be expected, considering the expiry of its contract with the London County Council Tramways, a loss which could not be made good within the past year, though it will in the future, by the gain of the new contract with the Brighton and South Coast Railway. In this case the loss caused by the London County Council was 4,407,000 units, yet the net loss was only 3,000,000 units, showing that there was genuine expansion going on. The drop from 2½% to nil in the South Metropolitan Electric Light & Power Co., and from 5½ to 5% in the Metropolitan Electric Supply Co. are regrettable. The latter showed a falling off of £6,300 in profits and a mere £800 in saving of working expenses. However, both companies have been busy with a certain amount of pioneer work, and it is to be expected that the offspring of the South Metropolitan (the Kent Electric Power Co. and the new West Kent Electric Co.), and the new contracts with Hanwell and Southall-Norwood entered into by the Metropolitan, will bring about prosperity. The Smithfield Market concern is so restricted in its opportunities that the depressing tendency of current saving lamps could only be expected to continue. Looking on the brighter side, we see the City of London jumping from 6 to 7%, and Notting Hill improving their position by ½% (the Founders' shares getting £3 10s. in place of £3 for 1908). In the five other cases, although dividends did not go up, the position was improved. Turning to the provinces we see, as a rule, the same happy buoyancy prevailing. There have been increased dividends, a strengthening of reserves, expenditure on revenue producing extensions, and a general elasticity in demand for current—both for lighting and power. Turning, again, to municipal concerns, we find the same recovery. Allowing for certain exceptions, there has been a rise in the consumption of units among private consumers, and, generally speaking, economy in working. Contributions in relief of rates have been fairly maintained, in some cases only being dropped owing to the need for extensions, which it was wisely held had better be paid for out of revenue than by borrowed money. The lamp scare has been boldly faced; the lamp is now found to be a useful ally. The optimistic tone we so gladly recognise in reports of electricity undertakings is also finding an echo, though at the present moment on a slightly minor key, among electrical manufacturers. We may be fairly satisfied with 1909 and hopeful of 1910 and the immediate future.

KILOWATT CAPACITY OF MACHINES.

Mr. Miles Walker, M.I.E.E., in his paper on "The Design of Turbo Field Magnets for A. C. Generators, with special reference to large units at High Speeds," took the view that the future is for the large central station fitted with high capacity machines, and he was inclined to place the kilowatt capacity of large machines in the near future at 15,000 to 20,000 kw. This, indeed, seems prodigious, when we remember that in 1880, 10 kw. was regarded as large. Mr. Walker argued that "the cheapening of the cost of generation of electricity and the reduction in the capital required per kilowatt installed are already

being felt in the widening of the field in which electricity is being used, so that in the near future we may expect the output of electricity stations in all our large towns and manufacturing districts to be enormously increased, and the great requisite will be large generating stations at low capital cost. For capital cost is one of the main items which go to make up the price at which electricity can be supplied. These large units will in many cases consist of impulse turbines of very high speed and very large capacity." He held that for large machines of this kind the field magnet should be the rotating element and the armature stationary, because it is difficult to satisfactorily support a rotating armature-winding wound for a high voltage, and it is not desirable to collect current generated at 6,000 to 11,000 volts from slip-rings. After considering the ideal conditions, he discussed the merits of the salient pole, but concluded in favour of the cylindrical type of construction, because by placing the winding in slots between iron teeth it is possible to utilise a great part of the periphery both for carrying flux and for carrying ampere-turns. Finally, he instanced a rotor for a 4,000 kw. generator built for the Glasgow Corporation, which holds its voltage constant within 2% from no load to full load at 0·93 power factor. In this machine the density in the air-gap is 11 Kapp-lines.

SHORT-CIRCUITING OF LARGE GENERATORS.

Mr. Miles Walker's second paper, in which he dealt with the currents flowing when large electric generators are short-circuited at their terminals, and the forces operating on armature windings, was re-assuring. He considered a large variety of machines and the special methods of winding adopted by different firms. His experiments, and the many oscillographs shown, went, on the whole, to demonstrate that manufacturers have made very real progress in the direction of securing safety.

ELECTRICITY IN QUARRIES.

Recently, we pointed out the extensive use to which electricity was being put in working Belgian quarries. We are glad to see that a decided move in this direction is being made over here. A large electrical equipment is now being fitted up in the quarries controlled by Easdale Ltd., and another Scotch slate quarry at Ballachulish is also being electrified. It is in this way that quarries and stone works can be made to pay, for with electrical appliances come larger output at less cost.

TRAMWAYS AND LIGHT RAILWAYS CONGRESS.

The annual Tramway Congress of the Tramways and Light Railways Association will be held this year in Dublin, on May 12 and 13. Members will be officially received by Mr. W. M. Murphy, Chairman, and Mr. W. Anderson, Managing Director, of the Dublin United Tramways. Papers are to be read, which will also be discussed, and, weather permitting, the tramway system of the Irish capital will be inspected.

"WIRELESS" USES.

Our Berlin correspondent's announcement that a school of radio-telegraphy is being established for German merchant sailors, is most interesting, as affording another instance of the progress made by this invaluable invention. Last week we mentioned new uses to which it was being put. Now we learn that ship's officers are employing "wireless" as a means of saving time and expense in the event of damage, sending messages ahead to ports of call, so that everything may be made ready and demurrage cut down. Then, again, it is good news to hear that North Sea fishing trawlers are to be fitted with "wireless" apparatus.

ELECTRICITY AND TEXTILE MACHINERY.

A notable display is to be made at the Brussels International Exhibition, which opens sometime in May next, by Messrs. Dobson & Barlow, Ltd., of Bolton. They are sending a very complete range of textile machinery, all the more interesting because it is all to be driven by electricity. One fine drawing frame, fitted with many novelties, has an electric stop motion. Brush motors, by the Brush Electrical Engineering Co., are fitted to all machines, except a weft-ring-frame, which is driven by a Brown-Boveri motor, and the opener, saw gin and bundling press. It is an equipment which is sure to attract attention. Indeed, from what we hear, the Brussels Exhibition will in every way be well worth visiting.

EDISON ON CURRENT PROBLEMS.

Mr. T. A. Edison has been talking to some of the New York newspaper men about the scientific problems of to-day and to-morrow. "The wastefulness of our present methods of combustion," he said, "is tremendous. A pound of coal has enough energy in it to carry itself around the world. We are able to extract only a small fraction of its heat and power; the greater part goes to waste. Our best steam-engines use about 15% of the energy of the coal they consume. With gas-engines probably 20 to 25% of the energy is utilised.

"There are various methods being tried out to convert coal directly into electricity without the use of a boiler—eliminating fire and steam. Some of these are oxidation methods. They are scientifically successful, though not yet commercially successful. The only difference between rusting, burning, and exploding is the speed of the chemical reaction. We may discover the germ of getting all the power from fuel to-morrow; and then again it may take a long time to find out.

"To get rid of friction in our machines," Mr. Edison continued, "is one of the future problems. The only machine without friction that we know is the world, and it moves in the resistless ether. The mono-rail does not appeal to me. The aeroplane of the future will have to be on the helicopter principle. A successful air-machine must be able to defy the winds. If Wright's aeroplane had one-twentieth of its surface, the wind would not affect it. The helicopter principle is the only way to rise above atmospheric conditions. By increasing the velocity of propeller revolutions the size of the machine can be diminished, and thereby we vanquish the hostility of the wind. A helicopter could have foot-size planes distributed on a 100 ft. to 150 ft. circle and controlled from the centre by wires.

"We know very little of physics," he said in conclusion; "we only just suspect a few things. It will take an enormous evolution of our brains to bring us anywhere. Art will be increased and distributed as we emerge more and more from the dog-stage. Society will have to stop this whisky business, which is like throwing sand in the bearings of a steam-engine. In 200 years, by the cheapening of commodities, the ordinary labourer will live as well as a man does now with $200,000 annual income. Automatic machinery and scientific agriculture will bring about this result. Not individualism but social labour will dominate the future; you can't have individual machines and every man working by himself. Industry will constantly become more social and interdependent. There will be no manual labour in the factories of the future. The men in them will be merely superintendents watching the machinery to see that it works right."

DOCKYARD ELECTRICAL APPRENTICES.

One evening last week the members of the Portsmouth Royal Dockyard Electrical Fitter Apprentices' Association held their second dance of the season at the Masonic Hall, Lake-road. About 100 guests assembled, and enjoyed a varied programme of 30 items. A feature of the evening was the introduction of "L'Electra," a new round dance, composed by members of the association. The M.C.'s, who performed their duties admirably, were Messrs. Chas. Shepherd and Gerald Brown, and the whole arrangements were carried out by members of the Association Committee—Messrs. Woolley, Avery, Parsons, Reeves, and Bull (hon. secretary).

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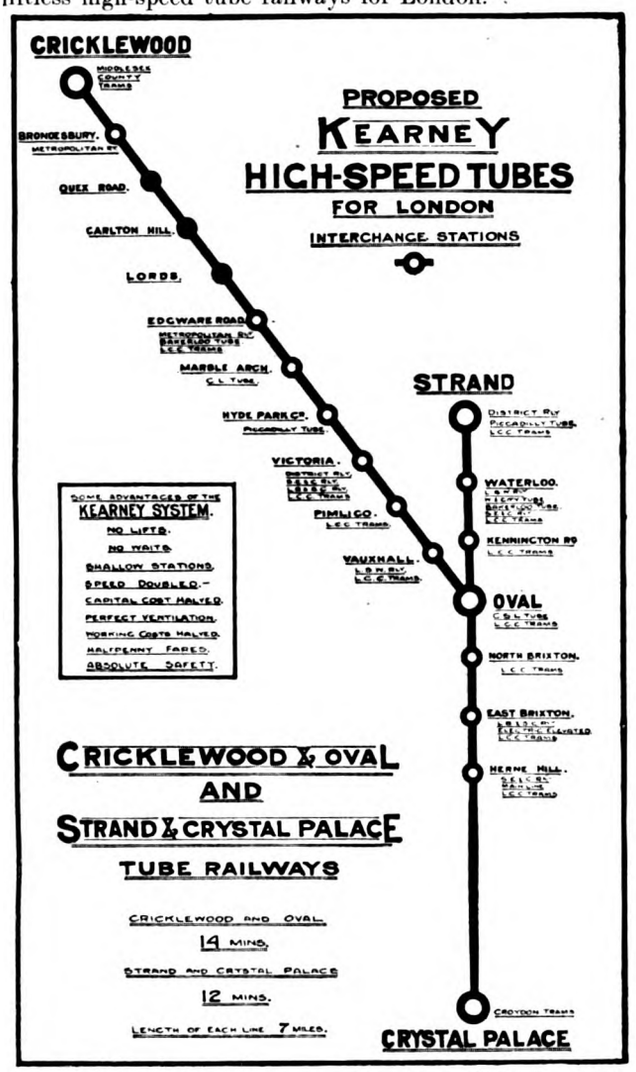
KEARNEY HIGH-SPEED RAILWAY.

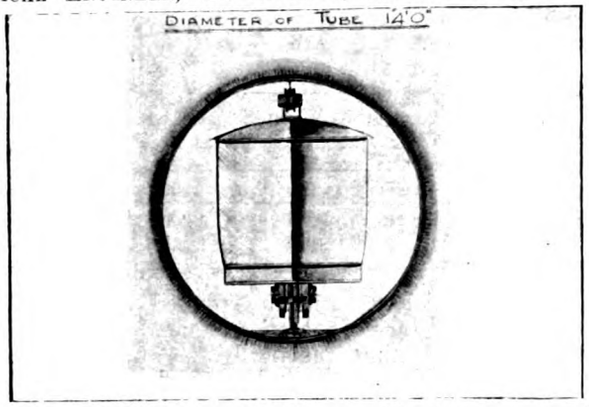
DEMONSTRATION OF SINGLE TUBE SYSTEM.

The claims made for the Kearney High-Speed Electric Railway system, the first public demonstration of which was given by the Kearney High-Speed Railway Co., Ltd., at the Crystal Palace, as briefly announced in our last issue, are so revolutionary in character that a detailed description is especially interesting in view of the projected liftless high-speed tube railways for London.



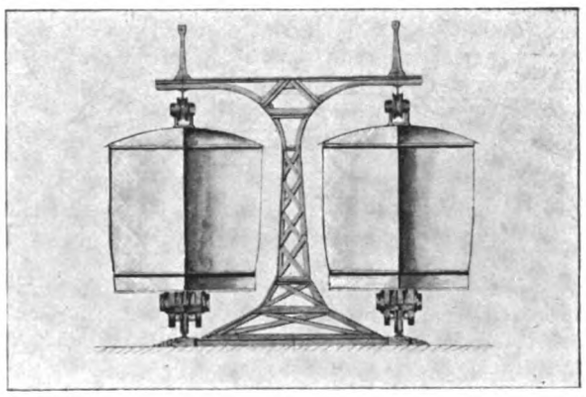
We understand that an application will be made to Parliament next November for a Bill authorising the construction on the Kearney system of two new lines to be known as the Strand and Crystal Palace and Kennington and Cricklewood Liftless High-Speed Tube Railways.

The main features of the Kearney system will be fast trains, halfpenny fares, no lifts, and single tubes with double track stations. To a representative of THE ELECTRICAL ENGINEER, the inventor, Mr. E. W. Chalmers



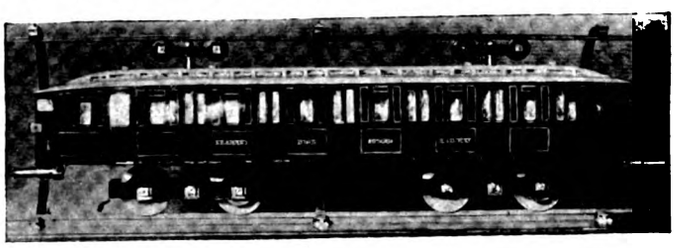
Kearney, declared that his scheme will solve once and for all the tube railway problem. The construction of tubes on his principles will reduce the capital cost from between £450,000 and £850,000 to a maximum of £250,000 per mile. Moreover, the working expenses will be very materially lessened as compared with the present tubes, Mr. Kearney figuring the saving due to his system at from one-half to two-thirds. The cost per mile of the permanent way for a first-class high-speed double line of railway built on the Kearney system is estimated at £6,050. The proposed Kearney railway from Herne Hill to the Crystal Palace is calculated by the inventor to cost a total of £99,000 (including rolling stock, electrical equipment, etc.), against £207,900 for an ordinary electric railway.

By the Kearney system only one tube is required between stations—the method of working in perfect safety is shewn in the single tube system diagram—and, by reason of deep levels, the displacement of pipes, etc., need only occur at the entrances to the stations. The tubes will be 14 ft. in diameter. The cars will travel on a single bearing rail which takes the whole of the weight of the train, the cars being maintained in the upright by means of a single overhead guide rail. In the case of tube railways this guide rail will be fixed to the top of the tube, while on surface lines the guide rails



will be upheld by means of standards placed at intervals of 60 ft. The two rails for the up and the down lines are braced together to give the necessary rigidity, and sag between the standards is effectually prevented by means of tie rods.

The calculations for the Kearney system certainly appear to have been very carefully worked out, and should attract considerable attention among those interested in electrical and other railways. A factor of safety of 5 has been allowed for as compared with a factor of safety of 1·7 on standard railways. Reduced to equivalent wind pressure on the side of the car, this means that while a pressure of 34 lbs. to the sq. ft. would bring a standard car to the point of overturning, it would require a pressure of 100 lbs. per sq. ft. before a Kearney car, supported by its overhead construction, would be capsized. As the equivalent wind pressure practically never exceeds 20 lbs. to the sq. ft., it will be realised that the claims for the safety of the Kearney system merit the most serious attention.



The guides to be used will be 70 lb. rails, braced together with struts and ties, vertical strength being secured by placing short columns on the standards from which ties forming a truss are connected to the rails. Both vertical and horizontal adjustment is provided for to ensure the top rail taking true alignment.

Special automatic adjustments have been devised for the guide wheels, so that they will always press on the under part of the top rail, and safety devices have been designed which will make it impossible for the guide wheels to leave the top rail.

The latter arrangement was not shown in the models which worked so successfully at an actual speed of 25 miles an hour at the Crystal Palace, but will, we understand, be provided in the full-size cars as an additional safeguard against derailment.

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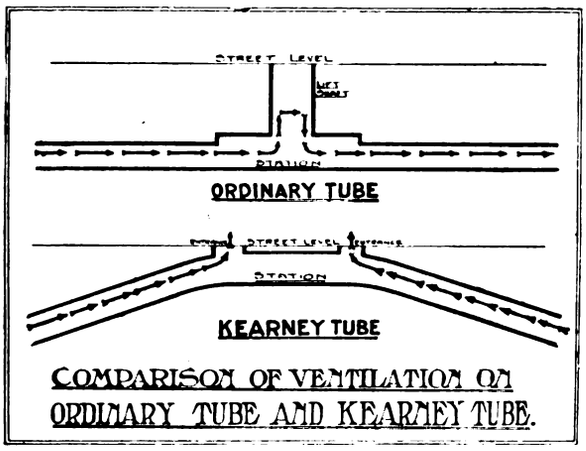
Telescopic columns connect the top and bottom bogies, thus allowing the cars automatically to adjust themselves to a variation in gauge extending over 4 ft. This extreme extension would, of course, only be necessary where the system is constructed as a tramway on a public highway.

The proposed Crystal Palace line will start from Norfolk-street, Strand. There will be intermediate stations at Waterloo, Kennington-road, Oval, North Brixton, East Brixton and Herne Hill, at which point the railway becomes a surface line to the Crystal Palace. From the Oval (which will be an interchange station between the two new lines)



COMPARISON OF VENTILATION ON ORDINARY TUBE AND KEARNEY TUBE.

the proposed Cricklewood tube will have intermediate stations at Vauxhall, Pimlico, Victoria, Hyde Park Corner, Marble Arch, Edgware-road (Harrow-road), Lords, Carlton Hill, Quex-road, and Brondesbury.

The stations on these tube railways will be constructed immediately below the street surface, thus giving the maximum convenience to the travelling public. Directly the trains leave the stations they will run down gradients of 1 in 7 to a depth of about 100 ft. below street level. This drop will accelerate the trains to a speed of 50 miles an hour due to gravity alone, the motors merely working to overcome resistances. Similarly, at arriving at the stations the steep gradients will obviate any excessive use of brakes.

Another, and certainly important, point claimed for the Kearney system is that ventilation will be practically perfect on account of the shallow stations and owing to the fact that each station will be approached simultaneously by two trains.

The progress of the scheme will be watched with the closest interest, both by railway and electrical engineers.

STANDARDISATION OF ELECTRICAL MACHINES.*

By R. ORSETTICH, M.I.E.E.

The last papers dealing mainly with the manufacture of electrical machines were those of Messrs. Scott and Esson in 1903, and they had in view principally the construction of large machines. Since that time a large number of important developments have taken place, which, without causing any striking departure, have changed very considerably the position of the electrical industry. Amongst the most important ones are those connected with the increase in speed and output which made the present turbo-generators possible, the adoption of the interpolar and compensating windings which have now become a normal feature of continuous-current machines, the advent of the single-phase commutator motor for power and traction work, the several electro-mechanical systems of balancing fluctuating loads which are employed for winding gears and rolling-mill service, the use of separate forced ventilation on large units, together with the adoption of special steel alloys for the laminations, and many others. The least apparent, however, but one of the most important steps, appears to me to be the improvement in the nature and systems of insulation and the far greater care taken in the execution of all details, which has resulted in making the present electrical machine a thorough mechanical unit.

The price of all classes of electrical machines at the same time has been reduced considerably. The price of the materials, and especially of copper, has risen considerably in the last ten years, and it is therefore apparent that the reduction in price must have been brought about only through improvements in the design and in the arrangements for the manufacture. Increased competition having on one hand reduced greatly the profit, but on the other having increased almost in the same proportion the cost

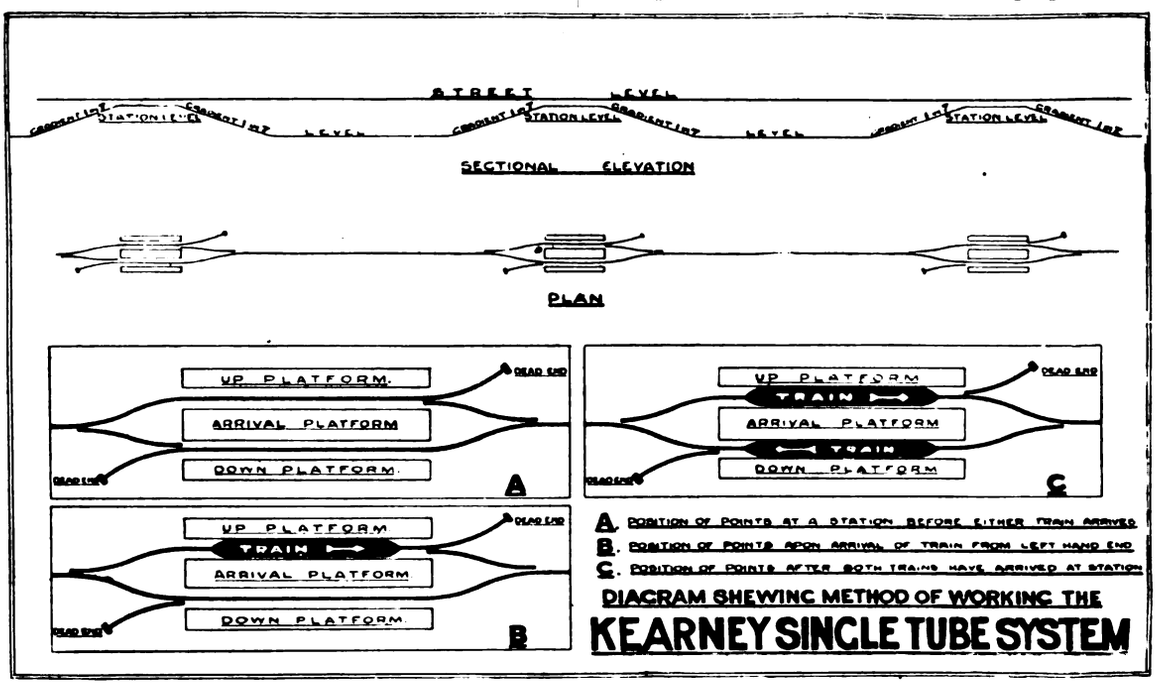


DIAGRAM SHEWING METHOD OF WORKING THE KEARNEY SINGLE TUBE SYSTEM

In construction, the cars will be somewhat similar to those on the present tubes, except that numerous side swing doors will be provided in order to facilitate loading and unloading, the trains being run between two platforms to separate the outgoing from the incoming passengers.

As with a single bearing rail there is no lateral oscillation, it is intended to use ball bearings to all moving parts of the rolling stock, thereby reducing journal friction. The first and last cars of each train will have parabolic wedge-shaped ends in order to minimise air resistance.

of the commercial departments required to obtain the orders, the percentage of the price required to cover these two items has remained practically the same.

The author proposes to discuss mainly in this paper some of the arrangements generally adopted for production, as numerous papers have been published from time to time dealing with the changes and improvements, purely from a designer's point of view. The continually increasing

* Paper read before the Birmingham Section of the Institution of Electrical Engineers.

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field for the use of electrical machines, and the competition for new markets have necessitated the adoption of new measures in the design and manufacture, so as to make the machines comply with a large number of various requirements and stricter specifications, and at the same time enable them to be produced cheaper and better. The sum of these various measures is commonly included under the headings of "Standardisation" and "Production in Quantities."

The standardisation consists in selecting for manufacture a definite number of types and sizes as answering average requirements and in designing them in such a way that they are eminently suited for production in large quantities. All details of these types must be fixed so as to make it possible by partial modifications to fill requirements of special conditions with the minimum of alterations to patterns and stock, and therefore with the minimum of expense.

The production in quantities has the object of reducing the cost connected with putting the machine through the shop by distributing this cost, which is up to a certain extent independent of the quantity over a large number of machines. This cost comprises office work, such as designing, drawings, issuing of instructions to the shop, the cost of procuring, inspecting, and testing the materials, the making of special tools and the setting of these tools to work. The general shop management expenses and the inspection and testing of the finished products are also included to some extent. The manufacture of large quantities of the same type also enables the shop to acquire the materials in larger lots and therefore in the most suitable market, with consequent reduction in cost. It further enables the shop to adopt all modern methods of checking interchangeability of parts by the use of limit gauges and jigs, which would be too expensive if only a few machines were made. The flow of materials through the shops can be arranged in a uniform way so as to keep all departments equally busy. The benefit of keeping one's workmen constantly employed on the same line of work shows itself in the increased skill they acquire in the performance of the operations or in the handling of a given machine. The time required for the work is in this way reduced to the minimum, as well as the time lost in between operations, and the efficiency of the machine tools becomes higher, whilst the man at the same time obtains part of the gain in some form of bonus for his extra exertion. There are, however, several disadvantages which must be considered, such as reduced flexibility in the manufacture, which makes very troublesome and undesirable any alteration from the standard, however small; also the longer time required for producing any new article owing to the necessity of making samples to avoid errors, which would be multiplied into very large figures.

The requirements of the market being of a fluctuating nature, it is impossible to fill the demand otherwise than by estimating the average requirements over a period corresponding to the time necessary for the manufacture of the goods. From the above it follows that the conditions for carrying out successfully the production of machines on a large scale should be :—

1. The manufacture for stock only and not for individual orders.
2. To have as few types as possible and to use as many parts as possible in common amongst the different types.
3. To concentrate the aim of the design in the production of perfectly interchangeable and mechanical details, even if the cost of machining is somewhat high, with a view to reducing the cost of assembling the different parts, which can only be done individually.
4. Regularity of the demand of the market.
5. Even and continuous supply of raw materials and labour.

Commercial Considerations.

The requirements of the selling side of the business have to be taken into careful account when fixing the basis of a line of machines. This usually offers great difficulty, as it is generally found that they are almost in direct opposition to the requirements of the shop. A compromise has therefore to be arrived at embodying the most important propositions from either side.

1. *Number of Types.*—The salesman in his daily touch with competition requires the number of types which he can offer to be kept as high as possible, so as not to be underbid by another salesman offering a type which comes nearer to the requirements of the client. The shop will find that this necessitates a much larger capital outlay in stock and plant and a much smaller turnover on each individual type than if only a small number of different patterns should be adopted. The designer will find it to his advantage to agree as far as possible to the large number of patterns, as it will be easier to find in every instance a suitable type to fill any specification, and also because it will have the effect of reducing the number of alterations to standard machines. The recommendations of the Standard Committee, who went into this matter very thoroughly, have unfortunately not met with complete success, because they reduced the number of sizes below what had been accepted as normal practice by a number of firms. These, having already gone to the expense of producing a larger number of patterns which represented a large investment, could not agree to this reduction, so that at the present moment most firms still manufacture many more sizes than are mentioned in the Committee's report. My experience is that for a line of standard continuous-current machines between 1 h.p. at 2,000 r.p.m. and 100 h.p. at 1,000 r.p.m. there are usually employed from eighteen to twenty types, and practically the same number for a line of 3-phase motors between 1 h.p. at 1,500 r.p.m. and 100 h.p. at 750 r.p.m. These numbers are based on an approximate output of some 500 machines per year of the smaller size up to about 25 machines per annum of the larger size. Of course, should the expected yearly turnover be less than this the number of types would have to be reduced somewhat, so as to keep the initial expenditure within smaller limits. For the splitting up of machines of larger outputs into types technical considerations are more decisive, and these will be discussed later on.

2. *Delivery.*—A few standard types should be always available for immediate delivery. This necessitates the keeping of a stock of fully finished machines wound for current voltages and speeds. This does not offer any difficulty in connection with continuous-current machines, as the great majority of the supply companies and corporations have arranged their mains on the 3-wire system, with 460–500 volts between the outers. Motors up to 3 h.p. are allowed between an outer and the neutral; larger sizes must be connected on the full voltage between the outers. With the addition of a few larger motors up to 25 h.p. wound for 230 volts as required by small independent plants, the stock is quite complete. With alternating current the matter is very much more difficult, as one has single-phase, 2-phase, and 3-phase supplies, the voltages of which vary considerably as well as the frequency. For 2 and 3-phase plant, the most usual ones appear to be a voltage of 440 and a frequency of 25, 40, and 50. For single phase the matter of fixing a stock is almost impossible, owing to the frequencies ranging between 25 and 133.

Next in importance is the delivery of semi-standard machines—that is, machines which are obtained by adapting the ordinary type to special requirements, such as special voltages or abnormal speeds. This would be effected either by winding a standard armature or field with a special set of coils, or by fitting a longer commutator to an otherwise standard machine.

3. *Flexibility of Types.*—As it is a most difficult matter to fix the exact amount of power required for performing certain work, and as this might even vary at different times of the day, machines have to be made with ample margin in all directions—viz., mechanical strength heating, sparking, wear, etc. The recognised six hours' run with a definite temperature rise, whilst it is perfectly sufficient to cover the responsibility of the designer, does not help the salesman whenever a client finds that the motor is just below his expectations. Shunt regulation in continuous-current motors, together with overloading capacity, is one of the points which offers most of the difficulties.

4. *Special Machines.*—These cannot be entirely avoided, as it is impossible to make standard machines cover the

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entire range of applications. It is a most complicated question to inquire into the extra price that should be charged for the making of an entirely special machine. This price should not only cover the expense of design, drawings, and patterns, which are usually included, but the extra attention required in following it through the shop, the delay caused by stopping important work at the machine tools, the extra adjustments in fitting a new design together, and the risk of alterations after test, due to it novelty. The whole of these items cannot be expressed in figures, and can only be guessed from experience, and for this reason it will be impossible to persuade anyone not connected with actual manufacturing that such jobs are hardly desirable from the turnover and profit point of view. Even if a firm does not wish to undertake this kind of work, it will sometimes be unavoidable if special machines are required in connection with large contracts for standard work. It will therefore be in the interest of the designer to keep the standard types always in front of him when dealing with this kind of special pattern, so as to reduce the expense for new parts to the minimum and at the same time give a reasonable delivery. As examples, one could quote a 25 h.p. continuous-current motor for 100 volts and 2,800 r.p.m., as often required for driving centrifugal pumps.

The Store Department.—Successful manufacture is necessarily based on the smooth operation of the department concerned with the supply of raw materials, and it will be well to begin by considering the organisation of the store department. Exact knowledge of the position of this section of the works will enable the designer of the machines to move within practicable and economical limits as much as the correct knowledge of the requirements of the designer will enable the storekeeper to run his department as a really useful auxiliary to the shop.

(*a*) *Materials.*—The materials to be kept in stock have to be fixed by the engineers with reference to the nature and extent of the manufacture, and a schedule of standards has to be drawn up stating the number and quality of the different materials; of each kind a definite number of varieties only is accepted, and no deviation is allowed from these unless special permission is obtained from the management. Charcoal iron sheets, for instance, will be kept in stock in certain thicknesses only, say of 16, 19, 24, and 29 S.W.G.; copper and brass rods in standard-drawn sections of $\frac{1}{8}$, $\frac{3}{16}$, $\frac{1}{4}$, $\frac{5}{16}$, $\frac{3}{8}$ in. etc., in diameter. Special sections which are not obtained in the trade should be avoided whenever possible, but if indispensable, their number should be definitely fixed and rigidly adhered to.

In a similar way tables should be prepared for steel bars, mild steel keys, copper sheets, micanite, fibre, etc., bolts, screws, nuts, and rivets require similar limitations, not only as regards size, but also as to length; copper wire should be distinguished in bars and insulated, and the latter again in two or three sections according to the thickness of covering, braiding, etc.

At the same time, specifications have to be prepared giving full particulars of the material, the tests to which they have to comply, and the limits for their acceptance. The inspection of incoming materials is no light task for the storekeeping department, and in large works requires a wide experience and often scientific training, this all the more as the inspector has very often to exercise his own discretion as to the advisability of accepting certain material, which might not be to the letter of the specification without being faulty, and the rejection of which might seriously handicap the shop output.

(*b*) *Amount of Stock.*—The variety of materials required excludes the possibility of individual attention to the oscillations of the amounts kept in stock. The stores must therefore work on a basis of automatic replacement, keeping the idle stock down to the minimum without running the risk of not being able to supply the current demand. This is done by fixing maximum and minimum limits of stock. The maximum is settled on practical considerations of the value of the stock, and the smallest amounts which it is advisable to put on order at any times. The minimum limit is fixed on the basis of the time required to replace the material so that a zero stock should not be reached under any conditions. These two limits cannot be taken in any way as absolute quantities, but must vary according to the conditions of the sales of the finished machines. It is therefore important that the limits should be revised periodically, and for this purpose it is advisable to show on the cards, on which the oscillations and the positions of the stock are usually entered, the amounts used over regular periods of any three months. By glancing at these totals, it is possible at any moment to see whether the demand for a certain piece is increasing or decreasing, and this shows at once whether a revision of the limits is required. A point of importance in settling the numbers which have to be kept in stock is the consideration whether a certain part will be used in the form in which it is stocked or whether it is to be subjected to further modifications limitating its range of application. For each frame of a machine, for instance, which is used in the form in which it is kept in stock, it would be necessary to keep in stock two or three armatures, because these are intended to be stocked wound for different voltages.

(*c*) *Stock in Progress of Manufacture.*—In addition to raw materials a large quantity of the stock consists of half or fully finished parts, and this kind of stock can be kept in three different ways:—

1. Only parts which are common to several types being built for stock, all other parts being manufactured to fill a definite order.
2. A more advanced stage is when in addition also parts belonging to individual types are manufactured in advance and kept in stock, because of their requiring either a long time to obtain the material or because the machining has to be done with special care or with expensive appliances. The windings of the machines would also come under this class.
3. The third stage, and the most complete one, is when all parts without exception, belonging to any of the machines manufactured, are kept in stock, so that all machines are assembled complete from the components. The third stage, of course, is the ideal one, but is only possible when there is a large demand for entirely standard and identical machines.

The usual condition for an average factory would be corresponding to stage No. 2, because this combines the advantages of a fairly flexible system with minimum expenditure. The parts are made up to a point where they can be worked in either for an entirely standard machine or for a special type, or, on the other hand, any part can be omitted from a standard machine so as to make it answer to a particular specification, such as, for instance, the manufacture of a line of continuous-current motors, where the complete shells, shafts, commutators, brush-gear, terminal boards, and armatures, are each kept in stock, to be assembled into standard machines whenever the occasion arises, and where at the same time a special longer commutator for a lower voltage can be used when required without necessitating any other alteration but a change of the commutator itself and the brush-gear.

One of the points of great importance in dealing with standard or semi-standard machines is that whenever an alteration is required in a standard design for any reason, the machine has always to be assembled from components, and the alteration must not be done under any conditions from a finished machine. This because, firstly, the parts which are substituted have already been used once, even if only for assembling, and therefore cannot be regarded as new parts; secondly, because it is difficult to watch that these are returned to the storeroom in good condition; and finally, and above all, because the cost of assembling the machine originally and of disassembling for the alteration will be entirely lost.

Another question of importance in the handling of stock parts is to be found in the method of allocating the stock to the different orders. This can be done either by entering on the stock card a requisition for the number of parts to be used for a certain order, and regarding these parts as being appropriated for this order whilst they are remaining on their shelves. In this system the "minimum" quantity might be reached on the card at any time, whilst a larger number of parts still exists in the stores. The other system consists in removing the parts as soon as requisitioned for an order to a different part of the shop where

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all items belonging to a certain order are collected. This second method has the disadvantage of requiring an additional handling of the material and of tying up parts beforehand and in advance of the time when they are actually required. The expenditure for stock is therefore higher than with the other method, but at the same time it is safer, as it makes absolutely certain of the parts being in existence and not only on paper.

Mechanical Considerations.

In dealing with the standardisation of a new line of machines the subject can be divided into two sections: one containing general measures affecting all sizes, the other dealing with the arrangements for making any one machine most suitable for the conditions of manufacture already explained.

The considerations of the first kind must be affected by the extent of the intended manufacture, as a very thorough and rigid standardisation of every part individually can only be carried out if the number of machines to be produced is very large. In the ordinary course for an average manufacture of a few hundred machines of each size per annum the main consideration will be to keep the cost of patterns and tools within reasonable limits, and to try to use the same part over again in common for different sizes.

General Standardisation: (*a*) *Diameter of Bore.*—This will be fixed as a starting-point of the whole line of machines and will be based on the most suitable dimensions to obtain a given output. The length of the core will have to be settled at the same time, and here the great question arises as to whether there should be one or more lengths of cores for each diameter. For continuous-current machines where the types of the frame and the number of poles is settled beforehand, it is always advisable to have a separate diameter for each length unless the manufacture is very small indeed. For alternating-current machines, where the same frame can be used for two or more lengths of core or different numbers of poles, it will be quite satisfactory to reduce the number of diameters and obtain the required number of types by having two lengths for each. The longer one can preferably be used for a smaller number of poles than the narrow one.

(*b*) *Commutators.*—The length of the commutators should be made sufficient to carry the amperes corresponding to a voltage of 230, with the maximum output allowed for in the standard list. As commutators are intended to be kept in stock as finished articles it will not be advisable to reduce this length when the motor is supplied for higher voltages, especially as the excess in length will be reduced when narrow brushes are used for a higher voltage. The question of using a longer commutator than standard for very low voltages has to be considered, and space has to be allowed for this purpose on the shaft of the machine.

(*c*) *Slip-rings.*—The position of the slip-rings of a line of machines has not been finally agreed upon by designers. It would appear that the best position would be in a place corresponding to the commutator on continuous-current machines, but as the connections between the winding and slip-rings cannot be made in the same simple way, and as there is a great chance of dust lodging itself in between adjacent rings working with high difference of potential, it appears that it is very advisable to fix these on the outside of the bearings and to carry the conenctions through a hole in the shaft. In this way they can always be easily cleaned and inspected and made enclosed or protected as the case may be. The shaft length between the bearings is not increased, a point which is of great importance in view of the very small clearance between stator and rotor. As a disadvantage must be mentioned that the shaft cannot be extended on both sides as required sometimes for crane motors.

(*d*) *Small parts.*—Small parts, such as terminals, brush-holders, spindles, insulating bushes, will be always arranged so as to be suitable for several types. The terminals will be arranged either individually on small pedestals and assembled on any machine to suit the current, or else on standard slate slabs, classified by the current which they can carry. The centres of different slabs should be kept the same, so that any machine could be fitted with a heavier or lighter terminal whenever the winding specification is issued.

Individual Standardisation: (*a*) *Frame.*—The frame, made of cast-iron for the sake of quick delivery, should be shaped in such a way so as to be suitable for use as a semi-enclosed machine—that is, one in which the openings over the commutator and at the shaft end are left without any further protection. It must at the same time be suitable for conversion into a protected machine by the addition of small stamped or perforated covers, which prevent the entrance of foreign matter. These covers will be of the solid type whenever the machine has to be used as enclosed. Two further varieties would be the "enclosed ventilated" and the "dust-and-gas-proof" one. The first is a machine where the openings are shaped so as to prevent the entrance of water or rain, and can be produced without requiring any structural alteration of the standard frame. The second one in late years has been abandoned in favour of the "explosion-proof" type, after the experiments carried out with several makes having proved that it is impossible to prevent the entrance of gas into a machine, however well enclosed, and that in cases where this is dangerous the only protection is afforded by making the frame with accurately machined joints and sufficient mechanical strength to withstand an internal explosion. A specification of this kind, however, requires the making of an entirely special pattern, and cannot be provided for in the standards. The construction of the frame is also affected by the question of the commutating poles, which are often required to be added. In machines with fairly large diameters it will be still possible to retain round poles, which are the most economical as far as weight of copper is concerned. The commutating poles will then have to be fixed either on flat facings provided on the inside of the shell and bolted on from the outside, or else will be secured by means of one large central bolt forged in one piece with the commutating pole. In the case of machines where the pole-pitch is kept rather small, the addition of commutating poles will make the space for the winding of the main poles so restricted that it will be necessary to adopt a square section of poles, and therefore square field spools. The most suitable way to make these poles will then be to assemble them out of laminations in a similar way to what is done for the poles of synchronous machines. This would be all the more advantageous if there are two lengths of core for each diameter, because one die only would serve two machines. The method of fixing this type of poles as well as the commutating poles will then be by machining all round the internal cylindrical surface of the shell, and bolt the poles to it from the outside. This method will result in a slightly increased expenditure on the labour for fixing the poles, due to the fact that it is not advisable to cast-weld the laminations in the iron of the frame, as is often done for round poles, but it will reduce in its turn the charge for fixing the commutating poles as well as do away with the cost of making separate pole-shoes, these being punched in one piece with the pole itself. A point to be considered in the settling of details of the frame will be the advisability or not of having an entirely open frame, with bearing of the pedestal-type to take the place of the protected-type machine. This is very often required, especially for direct-coupled sets, on account of the better ventilation and the easy access to all parts as well as because of the better appearance of the unit in itself. As there is not a very great sale for the last type of machine, it would not be advisable to have a duplicate pattern for all sizes, but it will be sufficient to start from units of some 12 in. to 15 in. in diameter, both for continuous-current and alternating types.

(*b*) *Bearings.*—The recognised type of bearings for small machines is the "shield" type, in which the bearing itself is fixed on a spigot all round the frame by means of bolts. The first question to settle will be the diameter of the bushes, namely, whether both should be alike and interchangeable, or whether the one at the driving end should be stronger than the one at the commutator end, respectively at the slip-ring end. After some consideration it will appear that, both from the customers' and from the manufacturers' point of view, it is advisable to keep both bearings alike, as the saving in using a large and small bush is hardly worth mentioning. The bushes will be conveniently made of phosphor bronze, as they offer the least wear combined with minimum of weight. They can

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however, be made in white metal for diameters above 3 in. The bushes will be fitted with suitable oil grooves on the top half and with draining rings at the two ends so as to prevent the oil from creeping along the shaft. The bolts holding the bearings must be arranged in such a way that the bearing can be turned by 90° or 180° when the motor is required to be fixed to the wall or ceiling. For this reason it will not be advisable to cast the feet of the machine on the bearing brackets, as is done by some firms, even if this might result in a slight saving in the price of the frame. If the feet are on the bearings, to avoid the necessity of supplying new castings whenever a different position of the feet is required, it will be necessary to turn round the bearing bush together with part of the bearing centre carrying the oil well, but this, besides being an expensive arrangement which will wipe out the saving in the shell, will also carry with it the danger of oil leakage from the joint. A great advantage will be found both for manufacturing and storing in making the two end shields of the machine alike, and this both for alternating and continuous-current types. In this case the frame will be made perfectly straight or slightly curved to give a pleasant appearance to the machine, and the two bearings can be of the shield type of the same outside diameter as the frame. In another design they are made in the form of small discs and the frame is brought down at the two ends to the diameter of these discs. Both constructions are equally satisfactory, but the first one is very much stronger and affords a much ampler space all round the commutator. A similar construction can be adopted for 3-phase machines, and especially if the slip-rings are placed outside the bearings. Some firms adopt the plan of putting the slip-rings inside the bearings for the purpose of using the same type of bearing brackets for the continuous-current machines and for the alternating ones. This has a good deal of attraction from the stores point of view, and should be recommended excepting for the objectionable position of the slip-rings. The main point claimed—viz., the reduction in cost of patterns—cannot weigh much, as a duplicate set of patterns would be required if the output in these types is at all large.

(*c*) *Reduction Gear.*—This is an addition which is very often required to standard machines, and provision must be made in the standard design for it. The usual way is to fix a set of bearings cast in one piece on bosses provided on the outside of the frame. These bosses, however, have to be cast on specially, so that a small stock of frames will have to be carried on this account. The best arrangement from the manufacturing point of view is to fix the countershaft of the reduction gear on a separate stool fitted with two bearings and to mount the motor on this stool. The two bearings can be taken from a standard machine of larger size. The space taken for the combination is the same as taken for the plain motor, but the method has the disadvantage of being rather expensive, and of raising the centre of gravity of the motor from the floor-line. A third arrangement put forward by some makers is to fix the countershaft on two brackets which are fixed to the outside flange of the bearing brackets. The distance between the bolts for fixing these brackets can be the same as the distance between the bolts for fixing the end shields, so that the countershaft can be rotated round the motor in a number of positions. In this construction, of course, the body carrying the self-oiling bearings of the countershaft must be rotated round so as to bring the oil well always into the vertical position. The advantage of construction of this kind would be that the countershaft could be fixed on the machine at any time after it has left the shop without requiring any structural alteration.

(*d*) *Spider.*—The necessity of adopting a spider in the armature has been debated very often between different designers without a definite conclusion being arrived at. There is no doubt that there is some advantage in having a spider to which to fix the stampings and the commutator, so that the shaft can be withdrawn at any time, either for repair or to exchange it with a shaft of different dimensions; but at the same time it must not be overlooked that the adoption of a spider carries with it great inconvenience; for machines with an inside diameter of the stampings of 10 in. or less, the addition of a spider would mean an extra expense, as the value of the stampings which are saved is not sufficient to balance the expense in material and labour in making the spider. Also in smaller types the thickness of the centre boss of the spider will become so small that it will be hardly possible to make it in cast iron satisfactorily and will necessitate making it in steel. The ventilation of the stampings of the armature will be particularly handicapped by the presence of a spider, and the diameter of the commutator boss will also be increased to admit its being mounted on to the extension of the spider, so that there will be hardly any space left for ventilation. From the manufacturer's point of view no spider should be used up to an inside diameter of stampings of 10 in.

(*e*) *Terminals.*—Apart from the question of the size of the terminals which has been already mentioned, the position of the terminals requires some consideration. The best solution would be, no doubt, to have a special recess cast on one side of the machine and to protect by means of a cast-iron cover the terminal board in this recess. This, however, means that the position of the terminals will not be flexible, as it should be, and might cause great inconvenience if the motor should be fixed, for instance, close to a wall with the terminal boards towards it. The fixing of the terminals on the top of the machine will not solve the difficulty, because on the one hand it interferes with the position of the eye-bolt, and on the other it makes the terminals come on a horizontal line, or at the bottom, if the machine is fixed to a vertical wall or to a ceiling. The last mentioned position would be a very awkward one, because it would make any oil which might find its way out of the bearing run into the terminal box. Some makers have selected the top of the bearing shield, which has to be turned round when fixing the motor in any way out of the normal; even this position, however, might be unsuitable if the space where the motor has to be placed has very restricted headroom. The solution will be found by using independent terminals fixed to small pillars which can be mounted, as a standard way, either on the top or on the side, and which can be shifted without great difficulty whenever a special occasion demands it. Another method which has been adopted very often is, not to have any fixed terminals at all, but to end the leads into loose split sleeves, shaped so as to build a sweating socket for the cables of the supply. After connecting up, each sleeve is insulated by itself by means of a tube slipped over it, and the three or four cables are bunched together into one group, which can be protected either by a large conduit pipe or any similar appliance. This method can be also adopted with advantage with totally enclosed explosion-proof motors, the only alteration being that instead of using bushes at the point where the cables leave the frame, it is necessary to use gas-tight glands.

(*f*) *Brush-holders.*—The design of the brush-holder lends itself better than any other part to thorough standardisation. Although any type of well-constructed brush-holder will be found perfectly satisfactory, the opinions of the users are divided very much between two classes: *i.e.*, the one in which the brush-holder is tightly gripped at the end of a long arm hinged on a spindle, and the other in which the carbon is free to slide between two guiding surfaces carried rigidly from the current-collecting gear. It will therefore be advisable to arrange for both types of brush-gear to be exchanged for one another whenever required. Both types of holders should be also designed so as to allow satisfactory running of the commutator in either direction and fairly noiselessly. They should be further suitable for different thicknesses of carbon blocks as might be required to suit the different voltages, and provision should be made to prevent the loose arm of the brush-holders from dropping on to the commutator surface in case the carbon should wear away entirely. The construction should be such that the wearing surface of any carbon can be examined at any time, and the carbon removed if necessary without disturbing the others. The current should be collected from the carbon to the brush-holder spindle without passing through any hinged joint.

Standardisation of Large Machines.—The general standardisation of large units cannot be carried out to the same extent as for the small units, on account of the fact that only a few of these types are usually required, and that the specifications for these vary to a very considerable extent.

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It is, however, quite possible to institute a system of sizes independently of any particular output, and to select the most suitable size out of this series when estimating or when executing any order to a specification. It will often happen that the type selected is slightly above the requirements, especially as regards weight, but the apparent loss which might be incurred in using this would be amply equalised by the saving in design, patterns, and tools.

A standard series of direct-current machines is started upon by fixing certain standard diameters of bores, which, beginning with, say, 25 in. or 28 in., will extend up to, say, 120 in. by differences of 4 in. to 5 in. in the smaller sizes, up to 10 in. in the larger ones. In this way one will obtain some fifteen different sizes, and as the length of the core can be made of two different dimensions, say 10 in. and 14 in., the result will be a line of thirty standard types, which should be quite sufficient for ordinary requirements.

The stampings for these machines will be conveniently made in sectors, and for this purpose the periphery will be divided into six, eight, or twelve equal parts, and a standard set of blanking dies will be provided for these. The spiders for the armatures will be made with a suitable number of arms to correspond to the sections of the armature stampings.

In settling the dimensions of the frame one could keep the flux per pole practically constant or increasing very slightly only, and increase the number of poles in proportion to the diameter. This practice is quite suitable for slow speeds, as used by Continental makers, but has the disadvantage of giving too many bars on the commutator when using lap winding. It will therefore be advisable, in order not to obtain machines which are too light for large outputs, to increase the flux per pole at the same time as the number of poles. As long as commutating poles were not used it was important to increase the number of poles considerably for machines of low voltage. Since the adoption of the interpoles has become less necessary, as the heating of the commutator is very much less than before, and there is not the slightest difficulty in commutating some 600–700 amperes per spindle, whereas 300 amperes was the average previously. If laminated poles are decided upon, a line of standard dies will have to be arranged to correspond to each armature sector. Any of these could then be also used amongst different machines, whenever it should be found that a more satisfactory design could be obtained by using a stronger or a weaker flux per pole. Of course, whenever a stamping obtained from a die not belonging to the respective type is used, it is necessary to bore the inside and the outside of the poles to obtain the correct curvature, but if this is done for a single design only it would only affect very slightly the cost of the machine, whilst it will save the expense of a new die.

The line of commutators will also be settled independently of any output or current. The diameters will be fixed with gaps of 3 in. to 5 in. in between, and an average length of 1 ft. will be taken corresponding to about 300–400 amperes per spindle. As the two end rings will be made of steel and independently from the body of the commutator, should any additional length be required it will be sufficient to lengthen the rim of the spider of the commutator, which can be done at very slight expense. It is most important to adhere rigidly to the dimensions of the clamp rings because any change of these will mean a new set of micanite moulds for the V-rings of the commutator. It follows that whenever a special wearing depth of the commutator copper is specified, the extra amount will have to be added on to the standard outside diameter of the copper bars and not from this diameter inwardly, although a certain extra expense for copper is thus incurred.

The bearings of such a line of machines will also be fixed in standard sizes in steps of ½ in. in the diameter. They will be about 2½ diameters in length, and will be fitted with automatic ring lubrication. The best arrangement would be to select a large centre height, so that whenever a smaller centre is required an additional temporary flange is fitted to the pattern and the remaining is stopped off in the moulding. This is done very economically if a large core box is put in hand from the first, with which any length of core can be obtained for the stopping off, and in this way in many instances an expensive new pattern will be saved.

Another considerable item when dealing with large machines is the bed-plate. The patterns for these can be reduced greatly by settling on standard sections, and making up the bed-plates in a square with round corners and cutting it up at right angles into four parts, so that four patterns of the four corners are obtained. By fitting distance-pieces of suitable length bed-plates of any dimensions can be obtained with very little expense. In some instances, for types which are used very often it will even pay to make these standard patterns in iron, in order to prevent deformation.

The brush rocker-gear, which, for small sizes can be fixed on the bearing, and which on larger sizes is usually carried from the magnet yoke, can be standardised on the same lines as the shell. It will be necessary to arrange the ring in such a way that more or less arms can be fitted to it without inconvenience, according to the number of poles selected for the machine at any time. Some means of adjustment will also have to be provided for raising or lowering the arms carrying the spindles, so as to allow for different wearing depths on the commutator, or, when the diameter on the commutator is exceedingly small, for a different type of arms.

The terminals and cable connections will be easily standardised by selecting a series of flexible cables for all currents up to 600 amperes, and by using 2, 3, or 4 of these in parallel so as to be able to deal with currents up to, say, 2,400 amperes. The respective sockets will be then fixed together with suitable insulating bushes, and supported on independent pillars. Any combination of these will then be possible, and they will therefore cover the range of shunt, compound, interpole, or compensated machines.

For large alternating-current machines a similar system of standardisation can be adopted. A line of diameters is settled upon, but in this case more latitude is allowed on account of the possibility of varying the length of the core without affecting the pattern of the frame or of the magnet-wheel. In this way between a diameter of 2 ft. and a diameter of 10 ft. approximately 12 diameters will be found sufficient, the gap in between the smaller sizes being approximately 5 in. and the larger ones 12 in. On account of the varying number of poles to suit the various periodicities and speeds, it will not be advisable to make complete dies for the stampings of the stator, but it will be more suitable to arrange independent cutting dies for each diameter, viz., one for the inside diameter and one for the outside, these to be so made that any combination of cutting dies can be arranged for, so that either very deep or very shallow stampings can be produced. The shells themselves will be best made without fixed end-plates so that these can be shifted further in or further out according to the width of the laminations, and without necessitating new patterns or alterations to the core boxes. The poles should be made out of stampings, and here again a line of standard poles can be conveniently designed to suit a number of pole-pitches varying between 7 in. and 14 in., which, assuming a periodicity of 40 or 50, would give all combinations between the very slowest and the very highest speeds, as well as average dimensions for poles for 25-cycle machines. Any of the dies for these can be arranged to suit a wide range of machines, but, of course, whenever pole stampings not belonging to the correct curvature are employed it will be necessary to bore these out on the inside surface and turn on the outside.

All the mechanical details such as bearing, foundation-plates, guards, and terminals provided for the continuous-current machines, can be easily worked in to suit the alternating-current machines.

Electrical Considerations.

Most of the arrangements explained previously are really limitations of the freedom in the electrical design. They are, however, necessary for the economical production of the machines and have been recognised as such by all makers. The art of practical designing for manufacturing purpose will therefore consist not in fixing at haphazard in every instance the very best dimensions that can give the correct output, efficiency, regulation, and temperature rise, within a certain specification and at an apparently satisfactory price, but in trying to obtain a design which will give an equally satisfactory commercial machine, made up with existing elements, patterns, dies, tools,

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etc. The reason for this is that the "cost price" of a machine includes often a factor of considerable uncertainty, namely, the percentage for general expenses, which is very often supposed to cover the cost of patterns and tools. As this percentage can only be fixed on the assumption of an average expenditure on this account, it will be apparent that unless a continuous check is exercised on the expenditure a heavy loss might be the result at the end of the year if the stock of patterns is booked at their correct low value, although every cost might have shown a satisfactory return. On the other hand, the alternative way of charging to each design the full cost of new patterns and tools would result in making the cost price of a machine so high that it would be most difficult to obtain any orders. Against this it is clear that there is a great advantage in fixing the number of patterns and tools as far as possible beforehand, and arrange the general charges for them in such a way that they can be distributed on the average number of machines produced during the year. On account of the slight handicap in arranging the design a slightly smaller margin will be available in some directions, and more attention will have therefore to be paid to the quality of the materials employed and to the execution of all details. That this is quite sufficient to make up for it is proved by the fact that there is not a large successful factory in which these conditions have not prevailed. Thus the adoption of two lengths of core for each diameter is no doubt a disadvantage from a purely electrical point of view, as for each output, strictly speaking, there is only one diameter and one length which will give the best proportions. When using a long core as required for laminated poles, it will be found again that this is not quite as satisfactory as a round core, but if in order to obtain a suitable ratio to give the room required for round poles one had to go to the expense of adopting a much larger diameter, there is no doubt whatever that the little sacrifice in the electrical design will be fully repaid in the cheapening of the production of the machine and in increasing its field of application, apart from the fact of a better efficiency obtained with the machine of smaller dimensions. In alternating-current machines the inducement to use long cores would be larger than for continuous-current machines, but the effect of the length of core will have to be accurately investigated on account of the altered conditions of the leakage. This will, however, be met best by adopting machines with long cores for fewer poles, and narrow machines for slow speeds, as they have necessarily a shorter pitch.

The stampings of the continuous-current machines should be arranged for one, or at the maximum two numbers of slots only, and these can be provided with such a wide range of windings as to cover all practical requirements. The number of commutators for a given type of stampings should not be more than two at the most, and should be arranged in such a way that the higher number of bars can be used for 500 volts with the slowest speed, and, therefore, with the largest number of turns per commutator bar, and the lower number of bars should be still sufficient to give the highest speed at the lowest voltage, *i.e.*, when the number of turns per bar is the lowest. As two commutators for each of the two stampings would represent a stock of four different types of commutators per machines it will be advisable to arrange the diameter of the commutators so that the same one can be used again in the next larger size machine. This will be easily possible if the brush rocker-gear is arranged mechanically to fit both the smaller and the larger machine.

With regard to the carrying of the current for the lower voltages, it will be advisable to make the commutators of sufficient length for the highest output at 230 volts and to use the same commutator, but with narrower brushes for 500 volts, as explained previously. For special outputs, or lower voltages than 230, and for higher speeds, it might be necessary to make a special commutator, and an allowance of 30% on the standard lengths should be more than sufficient to carry any of the standard outputs at 100 volts, especially if one uses wider brushes covering a larger number of sections. Provisions for this extra length must be made in the design of the frame, and of the bearing brackets, so that no alteration should be required on the standard shaft.

The fixing of the windings for the different outputs should be done by starting from the best possible average output of the machine, and by systematically trying all possible combinations of coils in the slots, without alteration to the number of commutator bars. The armature coils must, of course, be wound in such a way that the same coil can be connected up in "wave" or "lap" winding, according to the requirements. Taking a 12 h.p. 4-pole motor as an example, and assuming that to obtain a speed 1,000 r.p.m. at 460 volts, a coil of 4 turns per commutator bar should be required, the coils being connected in parallel, the same coils will be used again to give 6 h.p. at 500 r.p.m., with the coils connected in series, provided always that the heating allows of this output. By connecting up this coil so as to have only half the number of active conductors of double the section, the armature will give 12 h.p. at 1,000 r.p.m., and again 6 h.p. at 500 r.p.m. for 230 volts, as well as 6 h.p. at 115 volts, all with suitable connections. Taking now another coil with six turns per commutator bar, this will give when connected in series approximately 8 h.p. at 750 r.p.m. at 460 volts, and 3½ h.p. at 375 r.p.m. at 230 volts, as well as 8 h.p. at 750 r.p.m. at 230 volts, with coils in series or parallel as before. Although less latitude is possible with an uneven number of turns per commutator bar, it will be seen at once that with one commutator only a large range of outputs and speeds and voltages is obtainable. The outputs at 500 volts are usually obtained by speeding up the machines by 10% from the output at 460 volts.

The question of stocking complete armature coils suitable for standard winding is a difficult one to settle, as a stock of this kind has only a limited life. The tape covering after being varnished becomes oxidised and brittle, so that it would be impossible to place the coils in any slot even with the greatest care if the coils have been made many months beforehand. As at the same time a certain amount of stock must be at hand to give quick deliveries it is important to regulate this stock as closely as possible to actual requirements.

When using bar winding, and especially in large machines, a series parallel winding of the armature offers the greatest attractions from a standardising point of view, because it makes the numbers of bars in the commutator practically independent of the flux of the machine. The bad experience made by several designers with this kind of winding has, however, greatly reduced its use, although lately it has been brought forward again in connection with a special system of balancing.

The question of the carbon brushes to be stocked is a trying one, as it is only by having a large variety of carbons that sometimes it is possible to work in a type to give a certain output, and in this direction the high conductivity brushes and those made by the Morgan Crucible Co. have done much to help the designer. On the contrary, the brushes with graded resistance also issued by the same company have not met with much success, on account of their unsatisfactory behaviour when heating up, and of the difficulty of not being able to reverse the direction of the machine without changing round all the brushes.

The ventilation of the machines will also have to be considered very carefully as the modern high ratings are only possible if the losses are carried away continuously by an efficient flow of air. The methods of obtaining this ventilation are really part of the mechanical design and need not be discussed here.

In fixing the winding of 2 or 3-phase machines, a suggestion has been made very often of the possibility of leaving the coils disconnected, so as to obtain a winding suitable for a large number of voltages by grouping together the poles in one or more parallel circuits, also by bringing out both terminals of each phase and connect them up on receipt of the order either in star or mesh. Both suggestions are correct, but it will be found in practice that they are only suitable for exceptional cases because the stocking of a motor which is not completely wound is not a satisfactory arrangement. The machine has to be returned to the winding department for connecting up on receipt of the order, and is often not in its best condition if it was kept in stock for months with a large number of loose connections hanging from it.

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SPECIALISING IN MANUFACTURE.

Lecturing manufacturers on the way in which they should manage their affairs is a popular pastime. Occasionally, however, such utterances, though they need not be taken as the finality in economic wisdom, deserve a certain amount of consideration. Such consideration might advantageously be extended to the suggestions thrown out by Sir Walter Hely Hutchinson, Governor of Cape Colony, in his speech at the annual meeting of the Sheffield Chamber of Commerce. Acknowledging the excellence of British manufactures, he pleaded for more thorough organisation, with the special object of securing specialisation. He thought America was ahead of us in this direction, which enabled various classes of American goods to obtain a world-wide circulation. He instanced the case of American saws, files and hammers. These goods found their way everywhere, in face of the keenest competition, because they were at once cheap and adapted to particular kinds of work. This cheapness, combined with excellence, resulted from the almost minute specialisation in the United States, where firms confined their energies to turning out a particular grade of saw, of hammer, or range of files. They were thus able to make the saws and hammers the best of their kind for the work for which they were intended, and could manufacture on a large scale most economically. Sir Walter thought that British manufacturers could go and do likewise; not, he hastened to add, in a haphazard manner, but on some concerted plan. A group of manufacturers, he hinted, might come together and decide that each one should specialise along agreed lines, so that the whole energies and resources of the different works could be devoted to turning out one article on a great scale, perfect and cheap. This is, of course, merely a form of combine or trust, for if successful it would

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almost necessarily lead to a repetition of the screw manufacturing situation of years gone by. If we apply this reasoning to the electrical industry it would be easy enough to point out instances where direct specialisation has been, and is, most successful, as well as to other cases where firms embracing practically the whole field of industry do an enormous trade both at home and abroad. It may be said, and with some truth, that in the latter cases we have virtually the sort of combination advocated by Sir Walter, these large firms with reputations extending to every quarter of the globe, being nothing less than a group of specialised factories, every department being autonomous under the general supervision of the supreme chiefs. But, however autonomous the departments may be, the interdependence is also real enough, and we find that all usually merge into one group at the selling end. Would not the amical arrangement between independent manufacturers, of which Sir Walter speaks, eventually culminate in a very positive combine, whether on the American or German lines? Sir Walter Hely Hutchinson also dwelt on the financing aspect of industrial organisations, as we have all done for a long time past. He pointed out, for instance, the immense advantage the German electrical engineers had in their banking system, and instanced the capture of the Victoria Falls and Rand Power Co. by German electrical manufacturers, thanks to the substantial backing of the Dresdner and the Deutsche Banks, which found the money on the condition that machinery was taken from the Allgemeine Elektricitats Gesellschaft (in which the banks are interested) and Siemens' Schuckert Werke. The financing of vast industrial enterprises is unquestionably a weak spot with us. We have seen continental manufacturers triumph again and again owing to their strong financial backing by banking organisations purposely designed to promote industrial enterprise. We need only point to the activity of the Société Financiére de Transports et d'Entreprises Industrielle of Belgium, which is buying out the British shareholders of the Rosario Electric Co., Ltd., as it did before the shareholders of the Barcelona Tramways. These are triumphs, not only for Belgian finance, but for Belgian electrical machinery manufacturers. Without a doubt it would have paid handsomely for British electrical manufacturers to have come to terms with British finance to take over the Rosario Co., as it would with the Barcelona Tramways, for the Rosario enterprise is bound to be the centre of far-reaching developments in the future, and the benefits of these developments will now go to Belgium. It is impossible to blame the directors and shareholders of the Rosario Co. for their capitulation to Belgian strategy. Shareholders and directors know nothing of patriotism; they are merely there to take their profit, and an immediate handsome bonus has greater temptations for them than larger prospective profits which would be divided up with other concerns. But with some such organisation as we see in Belgium and Germany, the Spanish tramway developments and the South American electrical trade might have been more effectually guarded for British enterprise.

CORRESPONDENCE.

TO CORRESPONDENTS.

All communications intended for the Editor should be addressed "The Editor, 149, Fleet Street, London, E.C." Anonymous communications will not be noticed. Letters should reach the Editor not later than Tuesday afternoon to be included in that week's issue of the Journal.

The Editor is not responsible for, nor does he necessarily endorse opinions advanced by correspondents.

ELECTRICAL TRADES COMMITTEE.

Sir,—The undermentioned have decided to constitute themselves into a provisional Committee to take such steps as may be found advisable in furtherance of the legislative industrial and commercial interests of electrical industries.

Every effort will be made to work in co-operation with all existing electrical societies.

Any member of the industry in sympathy with this movement is asked to communicate with the Hon. Secretary or with any member of the Committee.

A further announcement on the subject will be made at an early date.

G. L. Addenbrooke, M.I.E.E.
A. Bruce Anderson.
A. K. Baylor, M.I.E.E.
Lt.-Col. H. R. Beddoes.
E. Bergtheil, M.I.E.E.
J. Cecil Bull, A.I.E.E.
E. Charrington, A.M.I.C.E.
A. N. Connett, M.I.C.E., M.I.E.E.
A. Dickinson, M.I.C.E., M.I.E.E., M.I.M.E.
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W. B. Esson, M.I.C.E., M.I.E.E.
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W. M. Murphy, J.P.
H. B. Renwick, A.I.E.E.
A. A. Campbell Swinton, M.I.E.E., M.I.C.E.
A. P. Wood, M.I.E.E.

R. Borlase Matthews, A.M.I.C.E.,
Hon. Sec.

Bank Buildings,
Kingsway, London, W.C.
March, 1910.

TRAMWAYS IN ASIA MINOR.

Under a receiving order made in May, 1908, at the London Bankruptcy Court, against Mr. Joseph Thomson Murray, described as an accountant, of 77, Gunterstone-road, West Kensington, a meeting of the creditors was held last week before Mr. G. W. Chapman (Official Receiver). The debtor's statement of affairs showed liabilities £3,212 against assets valued at £73, exclusive of a bad book debt, £30,250. During the six years preceding the failure the debtor was engaged in the formation of the Scutari Tramways, in Asia Minor, and the meeting of creditors has been adjourned from time to time with a view to the business being carried to a successful issue. In reply to the chairman, the debtor said the business in Turkey was proceeding slowly, but satisfactorily. Upon the debtor undertaking to pay the costs the meeting was further adjourned until September.

TRADE OPENING IN AUSTRALIA.

We are apprised that H.M. Trade Commissioner in Australia, Equitable-buildings, Melbourne (from whom full particulars may be obtained), has received inquiries from a firm of general merchants at Melbourne, who have a large number of agents and travellers within Australia, are desirous of obtaining agencies for British firms in various articles, including, among other things, timber, iron work, roofing materials, calcium carbide, calcium chloride, cream separators, dairying machinery, general supplies for the dairying industry, agricultural machinery, household refrigerators, tin plates, acetylene gas fittings, and electric fans. The firm are also desirous of getting into touch with British manufacturers of telephone insulators, telephone cables, bare iron and copper telephone wires, insulated telephone wires, electric fans, and sundries used in connection with Government telephone services.

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BRIGHTON ELECTRIC LIGHTING.

HIRE PURCHASE SCHEME FOR SMALL PROPERTIES.

A report of the Lighting Committee was considered. It stated that the Committee had again had under consideration the report of the engineer and manager with reference to a proposal submitted by Messrs. Page & Miles, Ltd., for the wiring and fitting of houses and other premises upon a mutual hire-purchase agreement between the contractors and the owner and tenant of the premises. Briefly put, the suggestion is that Messrs. Page & Miles would provide all the wiring and fixtures, free of expense, risk or responsibility so far as the Corporation are concerned, the consumer being supplied through a prepayment meter at one penny per unit above the ordinary lighting rate, this extra penny being paid over to Messrs. Page & Miles in respect of the purchase of the installation, and when the consumption reaches 240 units per point installed, the fixtures become the property of the owner of the premises. In the course of their report the Committee state :—

In accordance with a request made by the Brighton, Hove, and District Ironmongers' Association Incorporated, and Associated Electricians of Brighton, the Committee forwarded a copy of the proposed hire-purchase agreement for the consideration of that Association. A copy of the proposed agreement was also sent to each of the electricians trading in Brighton, and the Committee have received from the Association their observations. The Committee have also received a letter from Councillor Butt-Thompson, enclosing a copy of the observations of the Association which had been forwarded to him by Mr. George Norrish. The Committee have received from Messrs. Hignett & Co. their observations upon the proposal. The Committee have submitted these communications to Messrs. Page & Miles, Ltd., and have received a statement from them. The Ironmongers' Association regard the scheme as an attempt of Messrs. Page & Miles, Ltd., to secure the principal electrical fitting work of the town, and not to assist the consumption of electricity amongst the humbler members of the community. The Committee do not agree with this view, and would point out that it is open to every firm carrying on the business of electrical wiring to undertake work on the same terms as those proposed under the heads of agreement submitted by Messrs. Page & Miles. The Committee are satisfied that the proposal is a practical one, and would be of considerable advantage to the Corporation in enabling a supply of electricity to be given to small properties in cases where the owners or occupiers are not in a position or are not prepared to meet the initial cost of wiring and fitting the premises. The Committee have received a letter from Councillor Skinner, pointing out that the agreement would generally be entered into by the owners of the premises to be wired, but that in most cases the payment for the installation would be made by the tenants or succession of tenants, and suggesting that the scheme should provide that all tenants supplied with current under the scheme be given notice, that they are also paying for the installation and of the amount expended for this purpose. It has been suggested to Messrs. Page & Miles that the tenant should in all cases be made a party to the agreement, but they do not think it necessary that this should be done. It appears to the Committee that the matter is one between the landlord and his tenant, and that the Corporation are not concerned in the matter. With regard to the proposed abolition of the charge of ½d. per unit, at present charged in lieu of meter rent to consumers supplied through prepayment meters, the Committee are informed by the engineer that the revenue at present received from this source amounts to about £41 per annum. They are advised by the Town Clerk that they cannot charge customers, under the new scheme, a less rate for their electricity than that which is paid by customers taking a supply by prepayment under the existing tariff, viz., 4½d. per unit. The Committee are of opinion that the advantages to be derived from the present scheme are sufficient to justify the abolition of the charge of ½d. per unit referred to, and they recommend that for the future the charge for the supply of electricity by prepayment meter be 4d. per unit, in lieu of 4½d. per unit as under the tariff approved and adopted by the Council on April 16, 1908. They also recommend that the Council do approve of the above conditions as amended, and offer to all wiring contractors in the borough, who will undertake the wiring and fitting of premises on those terms, to collect on their behalf, and to pay over to such contractors the sum of 1d. per unit received by the Corporation over and above the sum of 4d. per unit for each unit consumed by the occupier of the premises in which electric wiring has been installed or fittings supplied in accordance with the terms of the agreement above set out.

After deliberation in full Council, the proposal was rejected, ten members voting for and twenty-one against.

THE PRESENT ASPECT OF ELECTRIC LIGHTING.

By H. W. HANDCOCK and A. H. DYKES.

MANCHESTER DISCUSSION

Mr. C. C. Atchison : The paper dealt with the small alternating current station having only a lighting load. From the direct current station's point of view, the question was altogether different, as there they looked to a good power load, and depended on this load for the bulk of their income. Lighting in manufacturing towns where there were many cottages, electric lighting was very difficult, as the landlord was awkward to deal with, and regarded gas as the only correct thing. He had been successful in getting some cottages wired after gas piping, with heating services, had been put in, but the gas people would not connect the heating unless the gas lighting also was used, as otherwise the consumer might use the gas at power rates, since the pipes were there. Under these circumstances, the electric lighting had to be abandoned. In Rochdale the metallic filament lamps had done them good, they had not lost much of their output. The standard of light was increasing, and he found the tendency was to get as much light as possible for the amount formerly spent on carbon lamp lighting. This was particularly so with shops. Regarding the authors' figure of 15·6 units per lamp per annum, he had taken same figures for eight years, based on 8 c.p. carbon lamps, and found the consumption measured 7·62 units per lamp per annum. When the change to wire lamps came at various times, it was impossible to trace the effect of the change on these figures. He agreed that small houses gave a better return than the large houses. They had to overcome the prejudice of gas users before they could do much. The system of charging per unit plus a fixed payment at the beginning of the year is not good, as the consumers do not like it. He did not think the check on waste would work out. If a consumer was going to cheat the station, he would buy his lamps elsewhere, and if there was a demand, special lampholders would not prevent its being supplied. So the profit on the sale of lamps expected by the authors could not be depended upon. The contractor usually wired up as many points as possible, since his price depended on the number of points, and often there were too many, so that the lighting was not as economical as it should be. He had gone very carefully into the costs of supply. After trying to standardise service cables, joint boxes, etc., and cheapen the whole as much as possible, he found by bringing down the size of service cables to half the usual size, he only saved about 1s. This was such a small proportion of the total that it was not worth while. He liked the idea of wiring along the walls of houses where this could be arranged. Dusk to dawn supply was not always possible ; one small motor would entirely kill it.

Mr. R. B. Slacke : He had been met by the objection that the metal filament lamp depreciated at the rate of 1d. per unit consumed. Some people preferred gas, because, they said, it warmed the rooms, and this was particularly so in mills, where they thought it warmed the machines. He thought the rate to charge per lamp must vary with the number of points, since this varied according to usage.

Mr. J. Frith : He spoke as a mere consumer, and had been analysing his bills for the past three years. Using 32 lamps, with an average of 36 watts, and an average candle power of 17, he consumed about 400 units per annum, costing 12*5*s., or about 3·9 shillings per lamp per annum. He would object to paying 10s. per lamp per annum, as the authors were suggesting. The life of the metal lamp was rather glorified, and they did not compare with the carbon lamps. The tendency was to force

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up the candle power. North country consumers would not be dictated to by the supply authorities as to lamps. His experience of cottage property was that the average tenancy was of about a fortnight's duration, and so it would be difficult to get payment.

Mr. A. C. Cooper: It cost about the same to connect up a consumer with six lights as it did to connect one with 20. He had had cases where the builder put in electric light in the downstairs rooms, in a row of houses. In that case they ran the cables through the row, with a cut-out at each house. In most places it was difficult to get business from gas consumers, owing to the gas and electricity being managed by committees of the same body, and the gas committees becoming alarmed, and opposing any vigorous efforts to take their business.

Mr. & L. E. Stewart: A new scheme would go well in the South, because people there were willing to try a new thing, but in Lancashire it was different. He had tried a dusk to midnight supply, but owing to various causes it was found necessary to run continuously. The practice of charging per lamp robbed electricity of some of its advantages, such as staircase lights, etc., which were not in use many minutes in the year, but were yet very much appreciated. The waste water analogy of the authors was not strictly true, because waste water was a nuisance from the noise and splashing, whereas light in use, when not needed, was no inconvenience at all. The average Lancashire man did know quite well what units, etc., were, and appreciated a flat rate. They worked in mills and factories, and learned a good deal about electricity in that way. The very small cottages did not use 10s. worth of gas a year, and he did not think they were worth catching. Free wiring was bad from the station's point of view, owing to frequent changes in tenancy. New tenants very often wanted the position of lights completely altered, or they would not use the light, and so the station had to spend more money.

Mr. S. J. Watson (Chairman)*:* Although the question of tariffs had been greatly discussed, they were still as far away from a settlement as ever. This was doing the industry a lot of harm. He hoped any changes made would tend in one direction, so that ultimately there would be uniformity. The advent of the wire lamp had altered the aspect of the question. If a private house wanted light and heat, two services were necessary. This was not satisfactory. The authors' method did not overcome this difficulty. The system of charging on the rateable value of the house was good. Take a percentage of 10 or 15% on the rateable value as the standing charge, and supply at, say, 1d. per unit. On a £32 house at 12½% standing charge, this amounted to £4 plus, say, 480 units at 1d. costing £2, giving £6 for the year. He thought other systems would tend to restrict the use of electric light to the best rooms only. In most towns units were again on the increase, having recovered from the coming of the wire lamp. Whatever was done in the matter of tariffs, all classes should be encouraged, and it was not good to keep any off. It was no part of municipal work to install wiring or fee systems. Owing to changes of tenants, it was impossible to recover any great amount so expended. Dusk to dawn he could not agree with. Irons, heaters, and such apparatus demanded a 24 hour supply.

Mr. Handcock (in reply)*:* The paper was only intended to deal with lighting stations; where a power load existed, the case was altogether different. The standard of illumination was increasing rapidly, perhaps to an undesirable degree. It was in some places possible to get powers to run wires along the front or preferably backs of buildings. The cost of depreciation of the wire lamp per unit consumed was large, because the consumption was so small. For street lighting it had been found that renewals of mantles, chimneys, etc., worked out at about equal to wire lamp renewals. Two apparently similar districts might vary as much as 50% in the actual results attending the working of any given system. It was, therefore, necessary to be open-minded and adopt the tariff most useful in the district. Taking the £40 house, some tenants burn £9 to £12 worth per annum of gas, but the value of the house varies considerably in different districts. Limiting devices for restricting the unit of current a consumer could take had proved very successful on the Continent. In the design of small transformers, a great advance had been made during the past two years. Very high efficiencies could now be obtained with small open circuit losses. They were now very satisfactory, provided a suitable one was chosen for the particular purpose in view. Where the lighting station was starting a dusk to dawn supply relieved the station and gave it a better start. The Board of Trade would authorise dusk to dawn supply on application, with the consent of the local authority. The scheme described in the paper was not a paper system by any means. It was in practical use, and was being extended. He had seen some 10 c.p. 200 volt 15 watt lamps burning under test, about six months ago, and understood that manufacturers were quite ready to supply them whenever there was a demand for them. Harrogate had tried their scheme successfully, before it was applied in the South at all. It was purely a matter of local conditions. They were not at all suggesting any alteration for present consumers; they would remain exactly as at present. The contracts' system they intended was only to apply to extensions in competition with gas. He quite agreed that a certain proportion of coal should go to standing charges, and this would apply more to an alternating current station than to a direct current one. Consumers had been found to respect quite simple agreements, and there was no trouble in that direction. The contract system had been tried years ago abroad, but was before its time. He suggested that when new developments were brought in, such as the wire lamp, they should go through their old stock of discarded ideas and see what was applicable under the new conditions.

TECHNICAL PROBLEMS, WITH SOLUTIONS BY PRACTICAL MEN.

RULES.

Under the above heading we insert questions of a practical character relating to power stations, electrical railways and tramways, mining installations, electric power in workshops, electro-metallurgical plant, and electrical engineering work generally.

QUESTIONS.—For each suitable question we offer one shilling. Questions of a practical character stand a better chance of acceptance than those of a theoretical nature. Questions may be sent in at any time.

ANSWERS.—A fee of 10s. will be paid for the best answer, and 5s. for every other published.

QUESTION.

It is proposed to put down an electro-galvanizing plant, for galvanizing thin steel strips and small stampings. Would the deposit be thicker on the edges and on small projecting lugs than elsewhere? Strips would be up to 6 ft. long; up to 2 in. wide, and of 24 to 26 G. Stampings of same material. Output, say, 1 ton of strips and 2 cwt. of stampings per week. Describe best method and cost of working, including material and labour. Floor space required? Cost of plant? GALVO.

BRITISH ALUMINIUM CO., LTD.

Petitions presented by Dick, Kerr & Co., Ltd., and A. Schonfield & Co., of St. Enoch-square, Glasgow, for the compulsory winding-up of the British Aluminium Co., Ltd., again came before Mr. Justice Neville in the Companies' Winding-Up Court.

Mr. A. G. Wright said that he appeared with Mr. Martelli, K.C., for the petitioners on the first petition, who were creditors, but he had been given to understand that the company had proposed a scheme of reconstruction. They had held the necessary meetings, and there was a proposal to pay the unsecured creditors in full. The necessary resolutions for the purpose had been passed, but a certain time was required for carrying out the scheme, and on behalf of the first petitioners he had no objection to further time being given.

Mr. Korby, who with Mr. Younger, K.C., appeared for the company, said that things had been proceeded with to a great extent, and all the necessary meetings had been held. The new company had not yet been registered, but that would be done, and he asked that the petitions might stand over for two months. There would be no unnecessary delay in the matter.

Mr. Gore Browne, K.C., for the second petitioners, said that after what Mr. Korby had stated he did not propose to press his petition. As the scheme provided for payment of his clients in full it was worth running a little risk.

Both petitions were allowed to stand over until the first petition day in May next.

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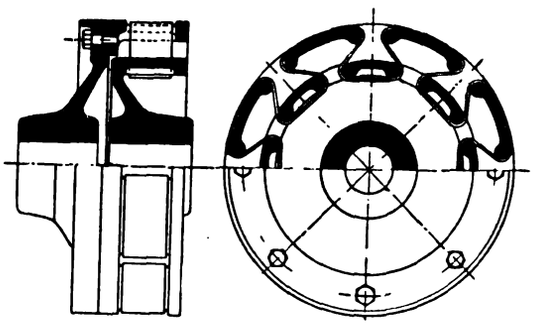
PUBLICITY.

In this Section of "The Electrical Engineer" we give Publicity to New Inventions and Specialities.

FLEXIBLE COUPLINGS.

When driving shafting direct from an electric motor, it is important that there should be a flexible coupling between the two. For example, a shaft for a number of sewing machines or a row of linotype machines is usually run on heavy brackets resting on the floor, the motor being coupled up to one end. Now the vibrations of the shaft and of the floor may be very pronounced, and, further, there may be settling of the floor besides wear of

Fig 1



the bearings. Therefore, however accurately the motor and shaft may be set, there will come a time when the shafts will tend to get out of alignment. A rigid coupling wall, under such circumstances, cause much frictional loss.

A flexible coupling which meets the case very well is that converted by Mr. Zodel, of Escher, Wyss & Co., and an engineer in Messrs. Vorth's works. It is sold in this

OUTER RING CAST SEPARATELY (as shown). OUTER RING CAST SOLID WITH DISC

HP r.p.m.	Outside diam.	Bore diam. Min	Bore diam. Max.	Boss diam. Min.	Boss diam. Max.	Length of boss.	Clearance.	Coupling Belt dimensions.	Weight in lbs
	D	B		O		L	S		
0·002	4"	½	¾	1½	—	1¼"	⅜"	2' 0" × ⅞" × 3/16"	5
0·005	6"	⅝	1¼	2¼	—	1⅞"	⅜"	3' 6" × 1" × 5/32"	11
0·01	8"	1	1⅞	3¼	—	2"	⅜"	4' 10" × 1" × 5/32"	20
0·01	" 8"	1	2	3	3⅜	2"	⅜"	4' 10" × 1" × 5/32"	22
0·02	10"	1⅛	2¼	3	4	2¼"	⅜"	6' 3" × 1⅜" × ⅛"	45
0·03	11⅜"	1¼	2½	3½	4½	3"	⅜"	7' 1" × 1½" × ⅛"	66
0·05	13⅜"	1⅜	2¾	4	5¼	3¼"	⅜"	8' 8" × 1⅞" × ⅛"	90
0·075	15⅞"	1½	3	4⅞	5½	4"	⅜"	9' 5" × 2" × ⅛"	110
0·10	17⅞"	1⅞	3¼	5	6	4½"	⅜"	10' 9" × 2" × ⅛"	165
0·15	19⅞"	2	3⅜	5½	6⅞	5"	⅜"	12' 4" × 2' × ⅛"	243
0·27	21⅞"	2⅜	4¼	6	7⅜	5½"	⅜"	13' 8" × 2⅜" × 3/16"	335
0·46	23⅝"	2½	4⅜	7¼	9	6"	1¼"	15' 0" × 3" × 3/16"	440
0·75	27⅛"	3¼	5⅜	8	9½	7"	1¼"	17' 1" × 3½" × ¼"	706
1·12	31⅛"	3⅜	6	8¾	10	8¼"	1¼"	20' 0" × 4" × ¼"	1000
1·6	35"	4¼	6¾	9⅜	11	9½"	1½"	21' 6" × 4¼" × ¼"	1330
2·13	39"	5¼	7⅛	10	12	10¾"	1¼"	25' 0" × 4½" × ¼"	1700
3·8	47"	6	8¼	12	14½	12"	1½"	33' 6" × 5" × ¼"	2320
5·25	55"	7	9½	15	15	13"	2"	39' 10" × 5½" × ¼"	3360
8·0	63"	8	10⅞	16	16	14"	2"	47' 8" × 6¼" × 5/16"	4420
10·	71"	9	12	17	17	15"	2"	54' 6" × 6¼" × 5/16"	5840

country by Mr. J. O. Boving, of Union-court, and Messrs. Croft & Perkins, of Bradford, are also manufacturers of it.

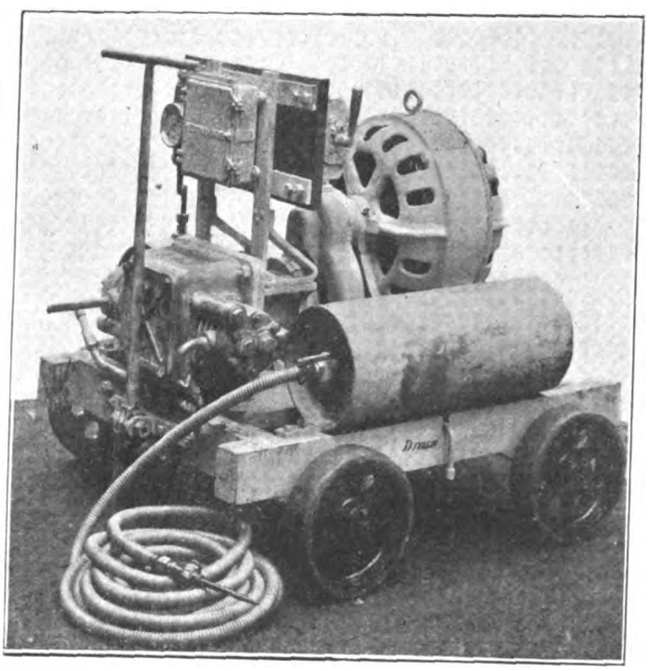
As will be seen from Fig. 1, it consists of two drums between which a leather strap is interwoven. The strap is made endless, and, after being tightened up, there is sufficient play to allow the shafts to be ¼ in. or even more out of line. The first column in the table of dimensions gives the size of coupling, and it is arrived at by dividing the horse-power by the revolutions per minute.

Before fitting the belt, it should be immersed in water for a short while so as to make it quite supple. It is then threaded through the alternate spaces on the inner and outer halves until both ends meet at a point on the outer half. On either side of the belt wedges are driven in to hold the belt fast, and then the belt fasteners are hammered in.

PORTABLE AIR COMPRESSOR SET.

The operation of small portable equipments by electric motor has so much to recommend it in the way of convenience and economy, that very extended use is now made of the method. The accompanying illustrations show a small portable air-compressor equipment recently supplied, through Mr. C. J. Wharton, consulting engineer, London, to the Rio de Janeiro Flour Mills & Granaries Co., Ltd., by the British Westinghouse Electric & Manufacturing Co., Ltd., Manchester, which firm a short time before carried out the complete electrical equipment of these mills.

This equipment is used for blowing out the 600 h.p. Westinghouse motors and for cleaning the other machinery. It consists of a standard Westinghouse air-brake compressor, driven through single reduction gearing by a 3 h.p. three-phase Westinghouse squirrel-cage motor complete



with control panel mounted on a strongly-built wooden trolley with rubber wheels, so that it can be easily moved from point to point. The current for operating it is taken from plug boxes on the walls by means of a flexible cable to a three-pole, double-throw enclosed switch on the control panel which is constructed of slate and mounted on strap-iron frame work; whence the supply is led to the motor through a unit-type fuse box. The connections are so arranged that when the motor is thrown on the line at starting the fuses are cut out, and after the motor has attained a fair speed the switch is thrown over to the other side, putting the fuses in circuit.

The importance of keeping electrical machinery free from dust cannot be over-estimated; and compressed air direct from a compressor is the best form of dust-remover, as it blows out all the crevices and cleans the windings thoroughly without affecting the insulation.

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Electrical Contractors' Section.

A Survey of New Things and Business Prospects.

THE USE OF LAMP CORD.

Perhaps this note would be more appropriately headed the "abuse of lamp cord," because it is the one part of an electric light installation which is roughly handled. One danger in connection with the use of lamp cord is that it can be installed by everybody; it is run around promiscuously, placed under ordinary bell wire staples, among inflammable material and treated generally as though it could never cause fire, no matter how abused. Incomplete as are the records of the fire insurance offices, they are, nevertheless, sufficient to show that the majority of fires caused by electricity can be traced to the abuse of lamp cords. No surprise need be occasioned by the recommendations emanating from certain quarters that the use of lamp cords or flexibles should be prohibited. But with all its defects, lamp cord is one of the conveniences of electric service, and its prohibition would remove some important conveniences. When used purely as a drop cord without being placed where it can be abused, it is as safe as any other feature of electrical construction. Most of the trouble arises when an attempt is made by inexperienced persons using ordinary lamp cord as a portable cord, where it is subject to all sorts of abrasion. Fortunately, in lighting installations there is not so much use for portable or drop cord as formerly. We are now providing sufficient light for general illumination all over a factory or office, and are doing away with many of the individual drop lamps that were formerly necessary.

CABLE JOINTING.

The Metal Jointing Co., Ltd., 71 and 72, Strand, London, W.C., have introduced a new process for the jointing of lead in pipe, which has been invented by Mr. T. Harden. The process is known as "Amalgaline," which is simply a strip of pure tin 0·55 mm. thick treated with a patent composition to prevent the formation of oxides during heating. The lead surfaces to be joined are cleaned in the usual way, and a small strip of Amalgaline placed in between them and heated by means of a blow-lamp, and the action of the Amalgaline under heat causes the lead surfaces to melt at a lower temperature than the normal temperature of lead. In the case of a joint in an ordinary lead-covered cable, after the conductors have been joined and insulated, the lead sleeve is drawn over the joint round which some of the flux has been wrapped, and the sleeve is dressed down to this. All that remains to be done is to heat the outside of the sleeve, and the joint is completed. The system has been in use in the Borough of Fulham with satisfactory results.

ELECTRIC FANS.

In view of the approach of spring, it will be advisable for the contractor to prepare his stock of electric fans in view of emergencies. It is, perhaps, a little too early in the season for supplies of these useful devices to be purchased, but it is not too soon to prepare for an active publicity campaign among the public. The new season's goods have not yet been pushed by the manufacturers, so that it is premature to draw attention in these columns to the features which will distinguish the fans of this year. Of late years, the cost of electric fans has been considerably reduced, and the small lampholder fan should become very popular. The blades of this type of fan are fitted with a guard, and the case of the motor is provided with ventilating holes, so that there is no fear of the windings becoming overheated. The lampholder fan is supplied to run on any standard voltage, either direct or alternating current.

WIRING WORK IN GLASGOW.

One of the most energetic and pushing firms of electrical contractors in Glasgow is that of Messrs. Allan Arthur & Ure. This firm have not only done a large amount of country mansion lighting, where complete private plants have had to be supplied, but they have been very successful in securing large wiring contracts in and around Glasgow, where the competition is generally supposed to be so much keener. They are at present busied with the wiring of the New Mitchell Library, Glasgow, which, exclusive of fittings, will run up to about £3,000, and the Northern Insurance Co.'s Buildings, Glasgow, which will come to something over £2,000. In a private house job, the work includes a telephone system (32 instruments) for communication between rooms, and an electrically driven vacuum cleaner. A considerable amount of business in electric heating is also being developed. The increasing number of enquiries to hand is the surest indication of the coming trade revival.

CONTRACTS WORTH WATCHING:—

Below we present a list of building contracts which have recently been placed or for which tenders are invited. We have no means of ascertaining whether electricity will be used at all; but it is evident that in the majority of cases electricity will be used either for lighting or for power, or for both. Where names of firms are mentioned they are those of the builders or contractors who have the work in hand, and it will repay electricians to keep in touch with these jobs.

Abertillery.—Major H. A. Moore, 35, Stow Hill, Newport, Mon. Erection of Drill Hall for Territorial Force Association.

Ashford (Kent).—G. E. Wallis & Son, Maidstone. Construction of Drill Hall.

Bolton.—Potts & Hemmings, architects, 141, Bradshawgate. Extension to Spinners' Hall.

Bradford.—H. E. Priestly, architect, Bertram-road, Massingham, Bradford. Vicarage.

Chatham.—A secondary school, costing £8,500, for the Kent Education Committee.

Dartford.—J. W. Ellingham, Dartford. Public Baths.

Edinburgh.—The City Architect. A new school is to be built at McLeod-street, at a cost of about £20,000.

Gillingham (Kent).—Electric Lighting for the Town Council to cost £1,900.

Hull.—Wellsted, Dossor & Wallsted, City-square, and A. Easton, 7, Land of Green Ginger, joint architects. Territorial Forces Barracks.

Londonderry.—City Architect, Foyle-street, Londonderry Re-building of Guildhall.

Liverpool.—Workhouse to be extended for the Board of Guardians, to cost £7,000.

Newquay.—Proposal to erect Pavilion by Town Council.

New Sarum.—W. J. Goodwin, engineer. Municipal Offices, Salisbury. Alterations of Municipal Buildings.

Southchurch.—C. Wall & Sons, Grays, Essex. Construction of a railway station.

Watford.—Home for Children to cost £2,000, for the Board of Guardians.

Wood Green.—Mr. H. Burgess, 62, New Broad-street, E.C. Erection of Public Baths.

York.—C. Martin, York. Mission Hall.

INSTITUTE OF MINING ELECTRICAL ENGINEERS.

As a result of efforts made in Whitehaven and neighbourhood, a Cumberland branch of the Institute of Mining Electrical Engineers has been formed. The following have been elected as officers for the year: President, Mr. T. P. Martin, Workington; vice president, Mr. Robert Blair, Whitehaven; secretary and treasurer, Mr. J. Glynn-Williams; branch council, Messrs. Neville G. Barraclough (Workington), W. H. Borlase (Threlkeld), W. Leck (inspector of mines), A. C. Scoular (Workington), R. Steel (Whitehaven Collieries), A. Thom, jun. (Moresby Collieries), and S. Turner (William Pit, Whitehaven); auditor, Mr. Darley, Frizington. Monthly meetings for the discussion of papers will be held.

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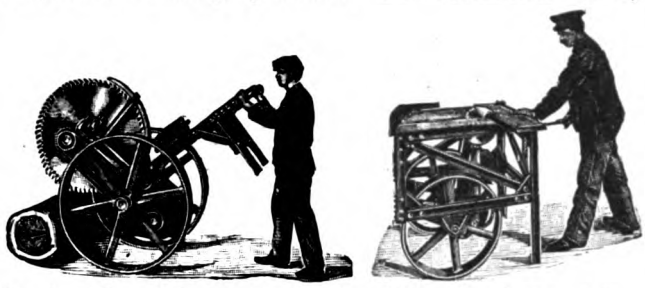
PORTABLE ELECTRIC SAWS.

We illustrate two different types of the portable electric saws introduced by Messrs. Feld Bros. & Co., Ltd. The motors and starters are affixed to the strung frames of the machines, a flexible cord being utilised to connect the motor with the main. Type A is a circular saw machine, used for sawing planks, etc. It works very regularly, and gives a perfectly clean cut. The motor is a ⅔ h.p. and takes 240 volts. Type C is a very strongly built machine, designed for cutting up lumber. This machine is usually



fitted with a 6 h.p. motor taking 240 volts, but a 5 h.p. motor can be substituted and the voltage raised to from 400 to 500 volts. A type B is built, much on the same lines as Type C, for cutting up logs, beams, sleepers, etc. These portable electric saws have been found very useful in large government and other work-yards, by dock and railway companies, and by mining engineers.

TRADE NOTES.

Messrs. Siemens Bros., Dynamo Works, Ltd., point out that a misprint occurred in our announcement of their additional telephone number. This is 8387 Central.

Messrs. H. Barder & Co., Johannesburg, Transvaal, have placed an order for a complete plant, consisting of two 130 h.p. 3-phase motors, and two 140-k.v.a. single-phase oil-cooled transformers, with switch panel, with the Union Electric Co., Ltd., London, S.E.

Messrs. Joseph Kaye & Sons, Ltd., Leeds, have received further orders from the British Navy for 3,918 oil cans, and 6,963 seamless spouts, for H. M. "Dreadnoughts."

OSRAM STREET LAMPS AT ACTON.

We understand that the Acton Urban District Council is now experimenting with metal filament lanterns for street lighting. Several experimental posts have been erected, and each lantern is provided with three 100 c.p. Osram lamps, backed with a suitable reflector. Doubtless the Council has observed the successful results obtained with Osram lamps at Croydon, Hammersmith, and other places, and is anxious to give the local ratepayers the benefit of the economies which this class of illumination has been shown to effect. There is no disguising the fact that the many experiments already carried out in various parts of the country have gone a long way towards establishing, on the score of reduced maintenance cost and increased illumination, the marked superiority of the metal filament lamp for all forms of street lighting.

CATALOGUES AND PRICE LISTS.

From Messrs. Jens Orten-Böving & Co., we receive a new price list of the Zodel-Voith Patent Flexible Insulating Couplings, referred to elsewhere in this issue.

Mr. Percy Pitman sends an illustrated leaflet on his impulse water wheels.

Messrs. Bruce Peebles & Co., Ltd., Edinburgh, have a new pamphlet, No. 13a, dealing with their standard alternating current generators. These machines are manufactured in the usual types and for voltages of 200-6,600 v., outputs being given, over a total of nine pages, for standard sizes suitable for three ranges of voltages both in 50 and 25 cycle machines. The list is very complete and should prove of service to users of this type of electrical plant.

The latest Osram Price List, issued by the General Electric Co., giving revised particulars of wattages and candle-power of Osram lamps, which can now be supplied as detailed. On page 4 we find also particulars and prices of 600 and 1,000 c.p. lamps.

VULCANITE

TURNED & MOULDED GOODS TO PATTERN.
RODS, SHEETS, AND TUBES.
F. CARSON & EVANS.
3A Fenchurch Buildings
LONDON, E.C.

EBONITE

NOTICE.

Contract and Miscellaneous Advertisements should reach this Office by Mid-day on Wednesday. For rates apply to the Manager, 149, Fleet Street, London, E.C.

CONTRACTS.

BOROUGH OF TORQUAY

The Electric Lighting Committee of the Torquay Town Council are prepared to receive TENDERS for the supply of 2,000 to 3,000 tons of COAL, about 300 tons of which to be Smokeless Through Steam Coal and the remainder to be Coal suitable for use with Mechanical Stokers of the Underfeed Type.

Specifications and Form of Tender may be obtained from the undersigned.

Tenders, endorsed "Tenders for Coal," must reach the undersigned not later than noon Monday, March 14th, 1910.

The lowest or any Tender will not necessarily be accepted.

FREDK. S. HEX,
Town Clerk.

Town Hall, Torquay,
March 2nd, 1910.

CORPORATION OF GLASGOW.

ELECTRICITY DEPARTMENT.

The Corporation invite TENDERS for the supply of

1. MAIN CABLES.
2. ELECTRICITY METERS.
3. ARC LAMP CARBONS.

for a period of twelve months from May 31.

Copies of the Specifications and Forms of Tender may be obtained on application to Mr. W. W. Lackie, Engineer, 75, Waterloo-street, Glasgow, on making a deposit of £2 for each Specification. The amount deposited will be returned on receipt of a *bona-fide* tender.

Sealed offers, marked "Electricity Department, Tender for .....", must be addressed to and lodged with the Town Clerk on or before Tuesday, March 29.

The Corporation do not bind themselves to accept the lowest or any offer.

A. W. MYLES,
Town Clerk.

City-chambers, Glasgow,
March 11, 1910.

METROPOLITAN BOROUGH OF ST. MARYLEBONE.

CONTRACTS.

The Council of the Metropolitan Borough of St. Marylebone invite Tenders for the undermentioned Works and Materials for one year, commencing 1st April, 1910:—

WORKS DEPARTMENT.

Street Watering (North District).
Horses, Harness and Drivers for Night Washing and Sweeping Machines.
Carting Rubbish and One-Horse Carts.

WORKS AND ELECTRICITY DEPARTMENTS.

Pitch.
Refined Bitumen (sample to be submitted).

Tenders must be made upon and strictly in accordance with printed forms, which, together with further particulars, may be obtained on application at the Town Hall, Marylebone Lane, Oxford Street, W. Tenders must be sealed and clearly endorsed on the envelope, "Tender for ——" (not more than one Tender to be in one envelope), and delivered to the undersigned by or before 12 o'clock noon on Monday, the 14th March, 1910.

Satisfactory security (if required) is to be given for the performance of the contracts.

The Council will not be bound to accept the lowest or any Tender.

JAMES WILSON,
Town Clerk.

Town Hall, St. Marylebone, W.
1st March, 1910.

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MINE PUMPS.

A difficulty of a rather unusual kind was successfully overcome at the Ward Mine, Virginia City, Nevada, thanks to electricity. The shaft is 3,480 ft. deep, and water was tapped which flowed abundantly at a temperature of 175° F. A temporary plant, consisting of a pressed air driven sinker pumps at the bottom of the shaft lifted the water to a centrifugal pump on the 2,330 ft. level. This in turn delivered to a vertical triplex pump on the 2,100 ft. level. The sinker pumps were supplied with compressed air from two 100 h.p. compound air compressors driven by 100 h.p. Westinghouse motors placed on the surface. A three stage centrifugal pump on the intermediate level was connected by belts to a 50 h.p. Westinghouse induction motor, while a 100 h.p. type "C" Westinghouse induction motor drove a 6¾ × 8 in. triplex pump at the uppermost pumping level.

This output was in due course replaced by the installation of a permanent pumping plant located in a pumping station 80 ft. long, 24 ft. wide and 20 ft. high, connected with the shaft 3,100 ft. below the surface, where the temperature is 110° F., and necessitates daily shifts of 12 hours. The permanent pumping equipment consists of a special slow speed, 800 h.p. Westinghouse type "H F" induction motor direct connected to an express type, duplex, double-acting pump, operated at 195 r.p.m.

The valves are of an automatic type, arranged in nests of 13 each, presenting a valve area of 104 sq. in., which makes necessary very slight movement of the valves, and is conducive to a high speed and a minimum of wear. The valves and other visible parts are of bronze, and the pump has a capacity of delivering 1,600 gal. per min. against a total head of 1,550 ft.

The plant is equipped with a three-stage electrically-driven air compressor for charging the air receivers, besides a vacuum pump and an automatic oiling system. For convenience of erection and repair, the pump station will be fitted with a 15-ton travelling crane; in fact, it is intended to include in this plant everything that will insure reliability and ease of operation.

The over-all dimensions of each pump are 27 ft. 3¾ in. in length, 17 ft. in width, and 14 ft. 2 in. in height. The motor is 13 ft. in diameter, and the steel crank shaft, forged from one piece, is 13¾ in. in diameter and 14 ft. 4½ in. long. These pumps are supplied by either one of the two centrifugals located in the pump at the bottom of the shaft, and operated by special 75 h.p. Westinghouse motors on a vertical shaft.

The water is discharged through a 16-in. steel column with welded steel flanges. The thickness of this pipe varies from ¼-in. at the tunnel level to 9-16 in. at the bottom. The column is supported by means of heavy weight iron clamps 6 in. in length, which in turn rest upon the wall and end plates. To resist the pressure of 675 lbs. to the sq. in., male and female flanges are used and each fitted with a lead-filled copper gasket.

The current is conveyed by means of a load covered, steel armoured cable. The cost of the whole equipment was about £25,000.

TRAMWAY RAIL IMPROVEMENTS.

Mr. John Dobbie, public works contractor, Leith, and his son, Mr. Arthur Dobbie, are responsible for two noteworthy improvements in tramway and other rails.

The first improvement is connected with bonding anchors, which they have lightened, yet in such a way as to maintain strength. The principal part of the new anchor is a steel bar, which may or may not be provided with auxiliary wings, webs, or trusses. By means of holes drilled in the flanges or bed plates, connection is made between these and the bar. In a modification the bar has a detachable trussed member, and the connection with the rail is formed by means of a plate. Or a slot or strap may be used.

The bar is formed cylindrical at the ends, and screwed for the reception of a nut, the shear members being placed upwards towards the centre. The ordinary tie rods are not dispensed with, but serve to further maintain the position of the bar, to which they may be coupled in any suitable manner. Longitudinal bars may be employed for giving greater rigidity to the anchor. They are laid over the anchor bars and embedded in the concrete.

CONTRACTS—continued.

GLOUCESTERSHIRE COUNTY COUNCIL.

EXTENSIONS TO SHIRE HALL, GLOUCESTER.

The Committee of the Gloucestershire County Council are prepared to receive TENDERS for the ELECTRIC LIGHTING OF THE EXTENSIONS TO THE SHIRE HALL, GLOUCESTER.

General Conditions, Specification, Plans, etc., may be seen and Forms of Tender obtained at the Office of the Consulting Surveyor in the Shire Hall.

Sealed Tenders, endorsed "Electric Lighting," must be addressed to me and delivered not later than the 2nd day of April, 1910.

The Council do not bind themselves to accept the lowest or any Tender.

EDWD. T. GARDOM,
Clerk to the Council.

Shire Hall, Gloucester.

GRIMSBY CORPORATION ELECTRICITY DEPARTMENT.

STREET LIGHTING.

The Corporation are prepared to receive tenders for the supply of:—300 Cast Iron Lamp Posts to Specification No. 79; Swan necks and Fittings to Specification No. 80; Supply of 300 d.p. Fuse Boxes to Specification No. 81.

Specifications and forms of tender can be obtained from the undersigned. Tenders by March 21st, 1910.

W. A. VIGNOLES, M.I.E.E.,
Borough Electrical Engineer.

Electricity Works, Grimsby.

PATENTS.

S. SOKAL, Chartered Patent Agent,
AND
Specialist for German Patents and Patent Litigation.
55, CHANCERY LANE, LONDON, W.C.

THE PROPRIETOR of BRITISH PATENT No. 5258 of 1906, relating to "Improvements in or relating to Wireless Telegraphy," desires to enter into arrangements, by way of license or otherwise, on reasonable terms, for the purpose of developing and practically working the same in this country. —Enquiries should be addressed to W. P. THOMPSON & CO., Chartered Patent Agents, 285, High Holborn, London, W.C.

THE PROPRIETOR of LETTERS PATENT No. 5332, of 1907, relating to "Wireless Telegraph or Signalling Systems," desires to dispose of the Patent, or to grant Licences to interested parties on reasonable terms, with a view to the adequate working of the Patent in this country.—Enquiries to be addressed to Cruikshank & Fairweather, Ltd., International Patent Agency, 65-66, Chancery-lane, London, W.C.

PLANT FOR SALE.

Advertisements under this heading: Twenty-four words, 1s. per insertion; three insertions for 2s. 6d.; or each additional line of eight words. 4d.

HORIZONTAL HIGH PRESS CONDENSING ENGINE for sale by Woodhouse & Mitchell, capable of developing 20 to 30 h.p., first rate order. Selling as more power is wanted. —For particulars apply Box O, c/o THE ELECTRICAL ENGINEER, 149, Fleet Street, E.C.

FOR SALE, ELECTRIC LIGHTING PLANT, consisting of shunt-wound Dynamo, belt-driven, and National Gas Engine; also Switchboards, &c.; output 30 amps. at 100 volts. —Address, W. H., c/o THE ELECTRICAL ENGINEER, 149, Fleet-street.

DYNAMO, 220 to 240 volts, 110 amps., spare armature, in good order.—Address, C. B., c/o THE ELECTRICAL ENGINEER, 149, Fleet-street.

CROMPTON SHUNT DYNAMO, 65 volt, 54 amp., in first-class condition.—W. S., c/o THE ELECTRICAL ENGINEER, 149, Fleet-street.

ELECTRIC POWER DYNAMOS, MOTORS, CRANES, and HOISTS; several FOR SALE.—Address, S. H. P., c/o THE ELECTRICAL ENGINEER, 149, Fleet-street.

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Economical Transmission

is a problem which rests very much with the **Ball Bearings.**

Our **Ball Bearings** are the best obtainable and are made of the finest Diamond Cast Tool Steel.

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Telegrams: "Fisherdom, B'ham."

The invention differs from others with the same purpose, mainly in that the rails do not rest on the bar, and that the bar is bedded in the concrete at a level low enough to allow a greater weight of material on it. This anchor can be bent or arched so as to come under cable conduits.

The second invention refers to the construction of the roadway lying between or beside tram lines. This improvement, called an "interlocking" block, is intended by the inventors to counteract the effects of the heavy motor traffic so injurious to the roads. This block is quite the first of its kind, and as such should command the market. The objects aimed at are greater durability and a non-slipping surface, and also to secure economy in cost and upkeep by making the block interchangeable and reversible. The block is made of any suitable metal, but preferably of cast iron. On the top and bottom surfaces are chilled metal studs, or they may be bars or rails, and of any suitable shape. They are spaced at intervals and either undercut or dovetailed. The spaces are filled up with non-slipping material.

The blocks interlock with each other and each has two similar faces, enabling them to be reversed. A bar or bars passed through the hollow parts serves to reinforce the blocks and render them rigid and even of surface. The blocks can be used alternately with the ordinary hard paving stone, if greater cheapness is desired, and they can be made to break bond with the paving by means of a wider alternating paving block. They are especially valuable for horse traffic, as so small a portion of the metal surface is presented to the iron shoe.

WESTON-SUPER-MARE ELECTRIC RAILWAY.

As the result of an inquiry held by the Light Railway Commissioners, it has been decided to construct an electric railway, forming a branch line extending from the Weston-super-Mare, Clevedon, and Portishead Light Railway at a point approximately opposite the Waterworks, in a southerly direction, across certain pasture land into the Locking-road, proceeding along the latter thoroughfare for a short distance, and then connecting with the existing line of the Weston-super-Mare Tramways Co.

PLANT WANTED.

PLATINUM UTENSILS, SCRAP, LAMP TOPS.—Best prices given by DERBY AND CO., LTD., 44, Clerkenwell Road, London, E.C. N.B.—Platinum Sold.

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TO LET.

TO ENGINEERS, ARCHITECTS, AND OTHERS, WESTMINSTER.

Exceptionally light and spacious OFFICES, near Victoria-street, Houses of Parliament, and District Railway station, consisting of 16 rooms on two floors, with private staircases, and having a total floor space of about 6,300 ft. super. Rent very moderate.—Particulars, plan, and order to view of Messrs. Trollope, 5, Victoria-street, Westminster.

WANTED COPY of THE ELECTRICAL ENGINEER, Sept. 3rd, 1909. Box W.D., c/o. THE ELECTRICAL ENGINEER, 149, Fleet Street, E.C.

APPOINTMENTS.

SHIFT ENGINEER WANTED. Previous experience in D.C. and A.C. Power Stations, and Technical and Workshop Training desirable. Salary 35/-, rising to 45/- per week. Applications, stating age and experience, with copies of testimonials to be delivered to S. J. WATSON, Electricity Works, Bury, not later than Friday, the 18th inst.

SITUATIONS WANTED.

DRAUGHTSMAN, 28, Bavarian, speaking French, some English, experienced with switchboards, low and high tension, installation, electrical apparatus, general engineering, requires situation in England. Highest references.—KOLB, 24, Avenue Carnot, Paris.

THE ELECTRICAL ENGINEER REPRINTS.

New Series No. 1.

JUST PUBLISHED.

"LIGHTNING CONDUCTORS,"

By ALFRED HAHDS, F.R.Met.S.

Author of "Scientific Protection," "A Guide to the proper Application of Lightning Conductors," "Lightning and the Churches," etc.

PRICE THREEPENCE.

Post free, Threepence Half-penny.

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ELECTRIC LIGHTING.

The Company has always encouraged the development of Electricity, and the well-known "Phœnix Fire Office" Rules for Electrical Installations are in use throughout the world. Copies will be supplied free on application to the Head Office.

G. H. RYAN, General Manager.

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NEW ZEALAND POWER STATION.

Mr. Alexander Wyllie, M.I.E.E., who went out to Auckland, New Zealand, some time ago, to take up the duties of Engineer and Manager of the Municipal Electricity Department, sends as a copy of his report to the chairman and members of the Electricity Committee, together with plans of the proposed new power station. We give below in full the report, which was adopted.

The present electricity works, situated at the Destructor, in Freeman's Bay, were begun in 1906 in accordance with a report presented by Mr. Goodman early in that year. The Council had previously considered various proposals, but finally decided to adopt Mr. Goodman's recommendation to start with a small installation at a minimum capital outlay, in order first to test the actual extent of the demand before launching on a larger scheme. The proposal put forward was for the expenditure of £20,800. The Council therefore applied for a loan of £25,000, the whole of which was spent on the first contracts, the excess amount over the estimate being chiefly accounted for by additional lengths of main not included by Mr. Goodman, who only allowed for a very restricted area of supply.

The applications that came in not only from the streets in which the mains were being laid, but also from many other parts of the city, made it evident to the Council, even during the erection of the works, that inadequate provision was being made. It was, therefore, decided in the latter part of 1907 to raise a further loan of £50,000 for immediate extensions of the plant and mains.

On my arrival in December, 1907, I therefore proceeded with such necessary extensions as were required to meet the immediate demand of the future. These additions consisted of :—

1 New boiler.
1 New generating set.
Enlargement of the switchboard.
5 additional feeder cables.
A large extension of the distributing network, service meters and cables.

These extensions have been carried out in accordance with the detailed estimate presented when the last loan was applied for, and have absorbed, approximately £27,000 of the amount then sanctioned. Of the balance, £20,000 is reserved to meet expenses in acquiring the new site.

The Council further realised the necessity of making adequate provision to meet the obligations imposed by their license to supply electricity throughout the whole of the city ; and, further, they realised that it was absolutely essential to reorganise the power station on a much larger scale.

The destructor site had been chosen in order to get assistance from the steam furnished by the destructor boiler. This boiler is small, and the demand soon outran its capacity. For three months after the opening of the power station the destructor furnished the whole of the steam required, but since that date the proportion furnished by the destructor has become smaller and smaller as the demand has increased. This was the only advantage of the site.

The disadvantages are as follows :—

(1) The capacity of the engine-room is exceedingly limited, and will only hold very small plant.
(2) The capacity of the chimney is only big enough for present needs, and quite inadequate for future steaming demands.
(3) There is no water available for condensing purposes, and this loss alone far more than outweighs the advantage from the small amount of destructor steam.
(4) The site is a considerable distance both from the waterfront and the railway, so that the cost of carting coal is very heavy. The storage room for coal is very small.

It was impossible to remodel the existing station on the present site with these disadvantages. The council, therefore, determined to obtain a site of ample area near the waterfront, and possessing the advantages that were absent in Drake-street.

After much deliberation the land near Railway Wharf leased from the Auckland Harbour Board to the Farmers' Freezing Co., was decided on as the best in every respect. In addition, it possesses the most important advantage of being absolutely central for the principal portion of the supply. This site has since been acquired under the Public Works Act, and is now the property of the City Council.

In accordance with the instructions of the committee, I have prepared an estimate of the cost of erecting and equipping the new power station, and extending the supply to all the principal portions of the city and suburbs. In preparing this estimate I have made a most careful estimate of the probable demand in the city of Auckland during the next four years, based on our actual experience up to the present time. I have, at the same time, made a careful comparison with the demand and the station capacity of other towns in New Zealand and throughout the United Kingdom, and my estimates are in all respects of a moderate character and in no way over-sanguine.

I first submit a statement of the estimate, followed by a comparison with other towns in New Zealand and Great Britain, and shall then add a complete description of the proposed new station and the extension of the supply, and finally an estimate of the future income and expenditure.

ESTIMATED COST OF PROPOSED POWER STATION.

Buildings and Sites : Sites for generating and sub-stations, £30,000 (£20,000 is also reserved out of the last loan for this purpose) ; clearing site, etc., £1,000 ; stations, buildings, including piling, raft and foundations for machinery, £31,000 ; sheds for stores, etc., £400 ; offices, test rooms, etc., £900 ; total, £63,300.

Boiler House : six boilers with feed pumps, etc., £14,775 ; feed tank, pipes, etc., £725 ; coal conveyor and steel work, £4,500 ; gantry crane, £1,350 ; chimney, £1,700 ; flues, £1,650 ; economiser, £1,000 ; motors, gearings, etc., £400 ; total, £26,100.

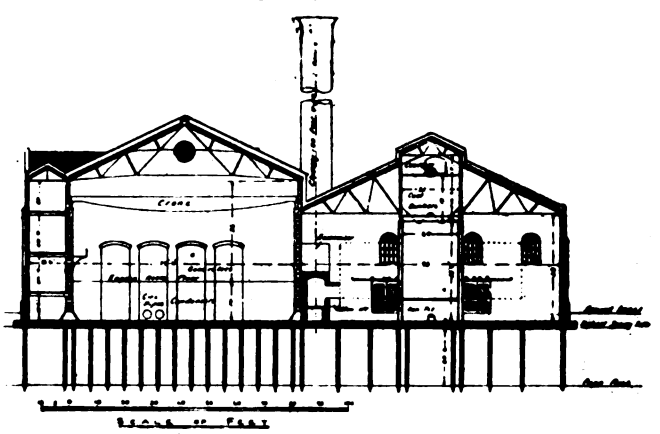

FIG 1 —SECTION THROUGH POWER STATION.

Engine Room : 4 D.C. generators, 3,000 kw., with condensers, £32,200 ; 2 A.C. generators, 1,000 kw., with condensers, £11,300 ; balancers, boosters and auxiliary plant, £4,250 ; switchboard and connections, £4,000 ; steam pipes, circulating pumps and pipes, £4,600 ; oil separators, etc., £850 ; overhead travelling crane, £1,600 ; total, £58,800.

Sub-stations : Equipment of two sub-stations, with transformers and converters, £10,000. Mains : 12 new feeders and additional distributors, £42,000 ; service mains and meters, £4,000 ; total £46,000. Tools, instruments, etc., £800 ; cost of floating loan and contingencies, £10,000. This makes a grand total of £215,000.

This estimate is expected to cover the whole of the capital expenditure during the next five years from the present time. As the undertaking develops with time, periodic extensions of the plant and mains will become necessary, and the ultimate capacity of the plant will eventually be greater than that provided for by the present estimate. The station on the new site, however, will be so designed as to admit of the largest extensions that may be required. The estimate given above will raise the total capital of the undertaking to £290,000. The new capital will only be expended as the growth of the undertaking warrants extensions.

The above figures leave out of account any credits that may be obtained by the transfer of the existing buildings or the sale of the existing plant. It is not proposed to transfer the present generators to the new station. The boilers, battery, and booster will be transferred, and all

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the existing supply mains will be connected to the new station. The cost of the existing buildings, generators and connections, which cannot be transferred, was approximately £15,700, and the possible credits on this plant will be about £4,500.

COMPARATIVE FIGURES FROM NEW ZEALAND AND ENGLAND.

Wellington: Capital expenditure, March 31, 1909, £223,494; capacity of plant, 3,450 kw.; capital outlay per kw., £65; number of customers, 4,136; units sold to private customers, 2,886,444.

Dunedin: Capital expenditure, March 31, 1909, £217,000; capacity of plant, 2,000 kw.; capital outlay per kw., £108; number of customers, 444; units sold to private customers, 2,691,989.

The above figures for Dunedin are for the second year of operation, and the plant is being doubled at the present time. Auckland in a few years will surpass both the above undertakings.

The following figures refer to a few typical English towns of varied character, in which the demand for electric power is not greater than it ultimately will be in Auckland.

Town.	Population.	Capacity in kilowatts.	Expenditure on Electricity works.	Number of Customers.	Units sold to private Customers.
Bolton ..	182,000	7,400	£326,000	2,380	6,493,911
Brighton ..	130,000	7,200	774,000	4,500	6,112,500
Coventry ..	87,000	3,900	219,000	1,020	4,822,114
Halifax ..	106,000	4,750	252,000	1,720	1,619,192
Oldham ..	137,000	5,230	284,000	932	1,382,648
Portsmouth ..	208,000	4,326	314,000	4,220	3,294,050
Sunderland ..	146,000	9,593	403,000	1,235	6,810,494

Plant in New Zealand costs on an average about 30% more than in England.

DESCRIPTION OF PROPOSED STATION.

The proposed station will be situated on the northern portion of the site previously referred to, and now occupied by Messrs. J. J. Craig, Ltd., John Burns & Co., Logan Bros., and the Premier Joinery Co. The southern portion of the site occupied by the Waitemata Timber Co. and Mr. David Goldie, are reserved for future extensions.

The depth of the rock is very uniform over the site, being everywhere about 25 ft. from the existing surface, which consists of made ground, but well consolidated; nevertheless, it will be necessary to drive ferro-concrete piles to carry the weight of the power station. The number of piles will be about 600, and these will carry a concrete raft 2 ft. 6 in. thick, on which the building and the foundations of the machinery will stand.

The boiler house will be 112 ft. long and 93 ft. wide, and the height will be 38 ft. from the raft to the tie-rods. It will be big enough to hold 12 large boilers, forming two rows of six on each side. It is proposed to instal only four boilers to begin with, and two more later, thus completing one side. The boilers will be of the water tube type, fitted with mechanical stokers and superheaters. An economiser with about 480 tubes will be erected over the main flue at the back of the boilers, which will be capable of extension.

The chimney will be of steel, 10 ft. in diameter and 150 ft. high, and provision is made for the erection of an induced draft fan near the base of the chimney if this should ultimately be needed, but the cost of such a fan is not included in the estimate. A second chimney will be added for the second row of boilers.

On the north side of the boiler house, next to the water, will be erected a gantry crane with a 70 ft. jib and a 1 ton grab standing on a carriage 10 ft. high. This will lift coal from the holds of vessels lying at the wharf and deliver it straight into a hopper in front of the boiler house, where it will be automatically weighed and picked up by a bucket conveyer capable of handling 40 tons an hour. This conveyer will travel the whole length of the centre of the boiler house close to the roof, and will deliver the coal into steel bunkers over the boilers, whence it will be fed into the hoppers of the automatic stokers. The bunkers will be 100 ft. long, 21 ft. wide, and 14 ft. deep, and will have a total capacity of about 750 tons. Outside coal bunkers will be added later as required. The conveyer will then pass into the ash pit under the central gangway of the boiler house, where it will pick up the ashes and deliver them into a hopper outside the boiler house.

The engine room will be parallel with the boiler house, and the same length, but 80 ft. wide. The height will be 50 ft. from the raft to the tie-rods. Its first equipment will be four steam-driven, direct-current, low-pressure generators, two of 500 kw. capacity, and two having a capacity of 1,000 kw. The engine room and boiler house will be equipped with all the necessary testing instruments for insuring the economic working of the machinery.

Each set will be capable of carrying an overload of 20% for one hour. These four sets will supply continuous current at approximately 460 volts straight to the consumers. This is the system of supply already in use, and is the simplest, cheapest, safest, and best for a limited range. By this system the heavy cost of transforming machinery is saved, and the loss in efficiency due to transformation is avoided. This most important saving is rendered possible by the very central position of the site chosen.

The area that will be embraced by this supply will have a radius of about a mile and three-quarters from the power station, and will include Parnell, Khyber Pass, Newton-road, Ponsonby-road and St. Mary's-road. In order to reach further and supply large power consumers not in the vicinity of the power station, a high tension three-phase alternating supply at 6,000 volts will be required, and provision is made in the loan for two turbine-driven alternators arranged longitudinally on the western side of the engine room. There will still be room in the engine room for two more generators of large capacity.

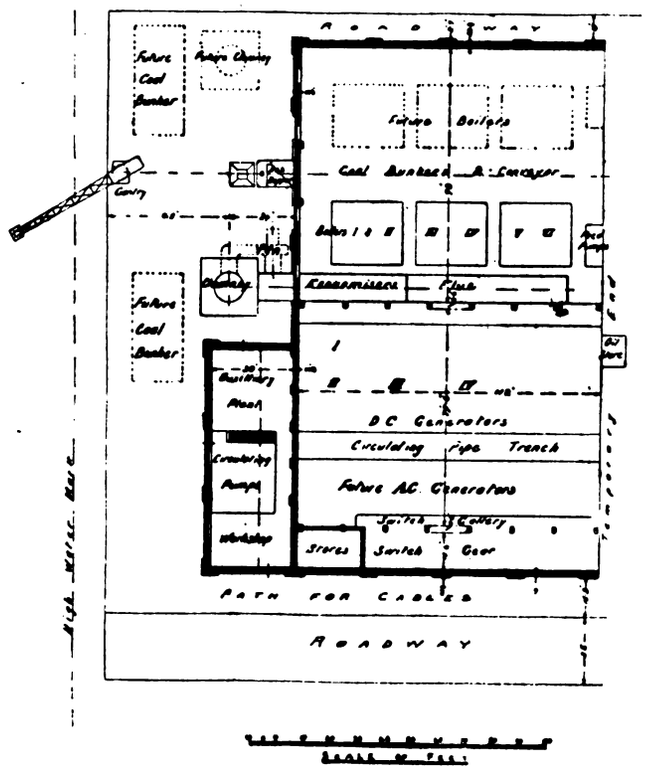

FIG 2.—PLAN OF PROPOSED POWER STATION.

The engine room will be equipped with a 15-ton overhead, electrically-driven travelling crane, which will be carried on steel stanchions and girders.

Below the engine room floor will be a basement which will contain condensing plant for the above machinery. Each 1,000 kw. or larger set will have a separate condenser, and the 500 kw. sets a common condenser between two. In the basement will also be carried the circulating pipes for the condensing water. The intake and outlet pipes will each be 2 ft. 6 in. in diameter.

On the west of the engine room, and communicating directly with it will be situated the switch house, which will be 13 ft. 6 in. wide, and the same length as the engine room. In this will be mounted the switch gallery and the whole of the switch gear. Connecting cables from the dynamos to the switchboard will be carried in the basement.

On the north side of the engine room will be situated a room 80 ft. long and 30 ft. wide, which will contain in the basement two large electrically-driven centrifugal pumps to furnish condensing water from the harbour. It will also contain a workshop, store room, auxiliary plant, such as boosters, and on the top floor a battery room and lavatory for the men.

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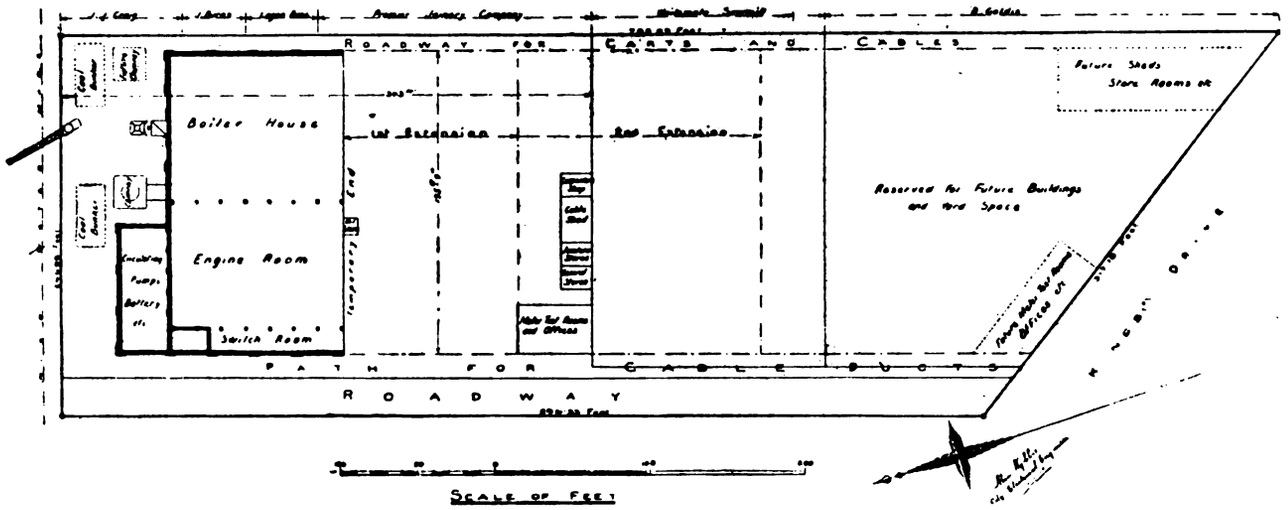

FIG. 3.—AUCKLAND CITY, N.Z., ELECTRICITY WORKS.
GROUND PLAN OF SITE OF PROPOSED POWER STATION, SHOWING FUTURE EXTENSIONS.

The buildings will be constructed of fire-proof materials throughout. Steel stanchions will take the principal weights, and will be filled in with brickwork.

The item for buildings in the estimates includes, besides the actual buildings, a large number of minor fittings in the buildings.

On the south side of the land occupied by the Premier Joinery Co. will be erected a row of temporary iron sheds that can afterwards be removed. These will be 75 ft. long and 20 ft. wide, and will contain timber and trough shed, carpenter's shop, cable shed, and a shed for jointers' stores and general stores. Facing the present roadway will be the meter and test rooms and offices. These will have a frontage of 48 ft. and a depth of 31 ft., and will contain the meter testing room, a meter store room, an instrument room, a drawing office and general offices. These rooms will be arranged in two floors.

The outgoing feeders from the switchboard will be laid along a footpath made on a portion of the present roadway. Twenty-four earthen ducts will be laid solid in a bed of concrete from the switchboard to Beach-road, with suitable man-holes at intervals, through which feeder cables can be drawn as required. Special ducts will be laid for drawing in high tension cables later on. These high tension cables will be laid to sub-stations on sites determined by the future growth of the demand. The sub-stations will contain transforming and converting machinery for supplying low-pressure current to the consumers. It is not proposed to instal the high tension plant until it is actually required.

The feeding points on the distributing circuits will be as at present, with the addition of others as the demand grows, and the low tension distributing network will be divided into several sections, so as to confine any troubles that may arise on the mains to as small an area as possible.

The estimate includes for laying distributing mains with feeder connections in 20 leading streets.

ESTIMATE OF INCOME AND EXPENDITURE FOR FIRST FOUR YEARS. FIRST YEAR ENDED MARCH 31, 1909.

Total capital expenditure at end of year	£48,358
Number of customers	196
Units sold	225,053
Income	£3,451
Expenditure	£3,269
Interest and sinking fund (on £25,000)	£829
Loss on year's working	£647
Total loss since starting, including loss of first few weeks	£873

(This loss was less than the estimate for the first year.)

ESTIMATE OF SECOND YEAR, ENDING MARCH 31, 1910, BASED ON OUTPUT TO CHRISTMAS, 1909.

Total capital expended at end of year	£55,000
Number of customers	400
Units sold	482,000
Income	£7,150
Expenditure	£4,150
Interest and sinking fund (on £75,000 less bank interest)	£2,800
Profit on year's working	£200
Total loss since starting	£673

ESTIMATE OF THIRD YEAR, ENDING MARCH 31, 1911.

Total capital expended at end of year	£110,000
Number of customers	620
Units sold	725,000
Income	£10,650
Expenditure	£5,400
Interest and sinking fund (on £75,000 plus portion of new loan)	£4,500
Profit on year's working	£750
Total profit since starting	£127

ESTIMATE OF FOURTH YEAR, ENDING MARCH 31, 1912.

Total capital expended at end of year	£190,000
Number of customers	900
Units sold	1,250,000
Income	£17,000
Expenditure	£6,500
Interest and sinking fund	£9,500
Profit on year's working	£1,000
Total profit since starting	£1,127

The above estimates are by no means excessive. The Dunedin Electricity Works in its *second* year sold to private consumers more units than I have estimated for our fourth year.

To meet the demand of the fourth year it will be absolutely necessary to have the new station equipped and working, and this is only possible by beginning now. We shall be able to work more efficiently and cheaper with the new plant than at present, and from the fourth year onwards the financial results will show ample balances on the right side.

It will thus be seen that the undertaking will be quite self-supporting and wholly independent of the rates.

An immediate start with the works is also of the utmost importance, in order to avoid expenditure ultimately useless on extending the present station.

ADVERTISING AND ITS SERVICE.

Properly directed advertising reduces the cost of distribution of goods by providing the salesmen with a greater number of selling opportunities in a given territory and in a given time. It performs the preliminary but necessary work of informing and educating the prospective user as to the nature, possibilities and profitableness of improved machinery, thereby hastening its adoption. Greater sales, brought about through advertising, usually make possible cheaper production, thereby benefiting the community as a whole, while competitive advertising, which seems to be the especial bugaboo of socialistic writers, is also a benefit insomuch as it stimulates to improvements in the design of apparatus, and advertising is necessary in order that such improvements may meet with a prompt and adequate reward. A secondary benefit is derived from the fact that a consistent policy of advertising lessens the capital risk when new enterprises are undertaken and insures permanency to a business. In other words, advertising does not become an added burden on the consumer.—New York *Evening Post.*

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Electrical Progress at Home & Abroad.

A Review by our Special Correspondents.

TYNESIDE.

NEWCASTLE-ON-TYNE.

In view of the keen competition between gas and electricity, it is interesting to note a recent instance of the supercessation of gas by electric lighting which has taken place in one of the public halls of Newcastle. The main lighting of the White City has recently been accomplished by means of high pressure gas lamps of high candle power, electricity being only for decorative lighting. As the result of tests, however, it has been shown that electric lighting by means of metal filament lamps offers a cheap and more efficient means of illumination, with the result that Messrs. Robson & Coleman, electric contractors, of Haymarket-lane, Newcastle-on-Tyne, have been instructed to instal about 400 metal filament lamps. A feature of this work, apart from the victory over gas lighting of the most modern type, is the speed at which the conversion is being effected, as the whole work has to be carried through within six working days. In order to effect this, Messrs. Robson & Coleman had a staff of twelve men actually engaged upon the work within three hours of the placing of the order, and it is anticipated that the work will be completed well under the schedule time.

Colliery Village Lighting.

An interesting piece of work which has just been completed in this area for the parish council of Sherburn, County Durham, is an example of an overhead public lighting system for small communities carried out in a very high class engineering style, and it is probable that there is not another system in this country which is being carried out with the same precision as regard safety of construction as the one which is now being completed by Messrs. Sydney Stobart & Co., of this city. This scheme of overhead street lighting which is being constructed according to the requirements of the Newcastle-upon-Tyne Electric Supply Co. extends over a distance of 2 miles, there being 60 lights, each consisting of a 50 c.p. Osram lamp. The wrought iron brackets, which have been specially designed by the firm for street lighting work, are of especially stout, but ornamental, description, and in order to enable the lamp to stand heavy vibration due to wind pressure, the brackets are stayed to the poles both on the side, top, and bottom, this rigidity giving in practice complete immunity from the fracture of the filament due to vibration; 30 ft. wood poles are used, 7 in. at the top and 9 in. at the butt, each pole having an ornamental finial 2 in. long, giving the pole a very graceful appearance. The conducting circuit consists of 7–16 wire, there being two positive leads and one return, so that should there be any break in a wire or fall of the pole, only the alternate lamps will be extinguished. The wires are carried on white porcelain knob insulators held by ¾ in. swan neck bolts passing through the pole, while the insulated wire running down the pole is of 600 meghom insulation. Each lamp is contained in a well-glass, water-tight fitting, and the work has given, when finished, complete satisfaction, and provides an excellent argument against the alleged unsightly appearance of overhead transmission for public lighting. Similar schemes are being carried out by the same firm of contractors at Lumley, Penshaw, Usworth, and Shadforth.

Electric Vacuum Cleaners.

An interesting demonstration has just been held by Messrs. Potter, Thomas & Co., of St. Nicholas-buildings, Newcastle-upon-Tyne, the local agents of Messrs. Drake & Gorham, Ltd., in order to show the advantages of a new portable electric vacuum cleaner which they are introducing. The demonstration consisted of, firstly, cleaning an ordinary carpet on which a plentiful supply of miscellaneous dirt and dust had been placed, which was accomplished satisfactorily. The second and more severe test consisted of removing a mixture of soot and salt from a strip of carpet, the mixture having been previously well rubbed into the fabric. This was done without any perceptible stain being left on the material; and as the result of this demonstration, it is announced that a local firm has bought a supply of portable cleaners, which are easily handled, and capable of being attached to an ordinary lighting fixture, for the purpose of hiring them out at a daily charge for the use of households in which spring cleaning and other special cleansing operations are being conducted. The demonstration was watched with interest by the engineer to the Lighting Department of the local supply company, among other gentlemen present.

THE MIDLANDS.

BIRMINGHAM.

Notices are being served in the Midlands, as elsewhere, upon firms having machinery for the generation, transformation, distribution, and use of electricity, calling attention to the new regulations under the Factory and Workshops Acts, affecting the users of such machinery. While these regulations came into force on July 1 last year, there was an exception as regards such parts of electrical stations as were constructed before July 1, 1908, in respect of which they came into force on January 1 of this year. There appears to be some difficulty in securing an accurate list of the places affected by the new regulations, but as far as the enquiries of His Majesty's inspectors in this district have gone it seems probable that about 1,000 establishments will come under inspection specially for this purpose. Beyond the serving of notice of the requirements of the regulations for the protection of persons employed upon or about the electrical plant, practically nothing has been done. There is reason to believe, however, that most of the electrical apparatus in use in this district will be found to comply with the factory inspector's requirements, or, at all events, that such recommendations as may be made to the users will be carried out with little difficulty or friction.

Converts to Central Station Supply.

Among the important firms which have recently decided to take their supply of electricity from the Birmingham Corporation mains is that of Samuel Heath & Sons, Ltd., of Leopold-street, general brassfounders, etc. Until recently, this firm generated its own current for lighting, but the works are now supplied with alternating current by the Corporation for both power and lighting. The installation, so far, consists of one 120 kw. transformer, with tappings for power and lighting, 5,000 v. three-phase, 25 cycle. The secondary windings of this transformer are 440 v. for power and 110 v. for the lighting of 1,800 32 c.p. lamps. The whole of the works were changed over by the firm's own electrician from continuous current to alternating current in one week end, and the work involved no outside expenditure in labour. Several motors are employed driving spinning lathes used for the purpose of bedstead manufacture. The whole of the installation has proved so satisfactory and economical, that the firm has now placed orders for several more motors to supersede their present steam engines. Messrs. F. A. Power & Son, of Saltley, wire manufacturers, are also arranging for a power and lighting supply from the Corporation.

Early Days of Light.

The reminiscences of early electrical developments in Birmingham, given by Mr. Whitehouse recently at the dinner of the Birmingham Electric Club, have excited a great deal of interest in the city, and have been supplemented by interesting contributions from the recollections of other veterans. For instance, Mr. Timothy Morris, who was personally connected with the Aston Lower Grounds installation, then the largest in the world, mentions that

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he remembers it being put in by Messrs. Macabe & Sutton, and a football match being played on the meadow by the light of 10 Jablochkoff lights. It was probably not long after this incident spoken of by Mr. Morris, that Buffalo Bill visited the Lower Grounds and gave night performances by electric light. The present writer well remembers how the thrill of the exciting episodes enacted by scouts and Indians was enhanced by the fiftul and seemingly precarious nature of the illumination, as well as by the strong contrasts of light and shadow caused by its incompleteness. Mr. Morris, however, goes further back, calling to mind an electric arc light worked by primary batteries in the Chapel of Aston Hall, at the time when Queen Victoria, in 1858, opened the Park and Hall to the public. Five years later, an arc light, with a Serins lamp, was seen on the roof of Messrs. Elkington's establishment in New-hall-street. This was before the days of the dynamo machine, the current being produced by 60 Bunsen batteries, 12 in. high, and having a capacity of about 16 amps. and about 110 v. Mr. Morris also remembers how three days after the lecture on the telephone to the British Association at Plymouth, a pair of telephones were successfully made entirely in Birmingham. Another piece of local electrical history, of which mention is often made, is the part played by Birmingham in the making of the first Atlantic cable, the steel armour wire being made at Messrs. Horsfall's Works, Hay Mills, and the rope portion by Messrs. John & Edwin Wright.

Tramway Matters.

The promotion by the Corporation of Birmingham and the British Electric Traction Co. of schemes of tramway development, from which the newly added part of Birmingham, Quinton, hopes to benefit, has revived the project of tramway communication between the city and Harborne. The latter healthy and growing suburb, though it has been for some years included in the city, still has to be content with an infrequent and slow railway service or the horse-drawn omnibus for its communication with the civic centre. The original scheme of municipal electric tramways included Harborne, but the Hagley-road, upon which it was then proposed to lay the tram lines passes through the purely residential and select district of Edgbaston, and the influence of Lord Calthorpe and other property owners secured the rejection of the Bill on the poll. Warned by this experience, the City Council excluded this part of the scheme when the Bill was brought up in the following year. During the last few years, however, owing to the rise of working class suburbs in the Bearwood district lying off the Hagley-road, it has been found both desirable and profitable to reach these places by a somewhat circuitous tram route which serves districts lying near to Hagley-road, without trenching upon that sacred preserve.

It is evidently thought by the Harborne people that the claims of Quinton will now form a powerful make-weight for their own, and they are, therefore, advocating for tramway communication by the Holloway Head route, which is already in use for the Ladywood route as far as the Five Ways. This gets over the objections to an approach by Broad-street, and it is suggested that the tramway should be continued through the Harborne-road to Harborne and Quinton. A committee has been formed to prepare a memorial to the City Council in favour of the scheme.

Wireless for Territorials.

The Company of the Southern Command Wireless Telegraph Co. of the Royal Engineers, having its headquarters in Birmingham at the Great Brook-street Barracks, is expecting to take an important part in the next August manœuvres. The Company will be encamped on Salisbury Plain at Windmill-hill, near Ludgers' Hall, where there will be concentrated several thousands of Birmingham Territorials. The Commander of the Company ((Captain H. B. Matthews) states that the Company, which is entirely a Birmingham unit, now has its strength up to the full authorised establishment. The majority of its members are skilled engineers, many of them being past or present apprentices to the great electrical and other engineering firms of the district. The Company's wireless gear is at last in order, and Colonel Lister, who is in command of the whole Birmingham Electrical Corps, visited the War Office last week, and was informed that the orders for engines, wagons, and posts have now been placed. Some parts of the gear, however, may not be obtainable for some time to come from the War Office, but Colonel Lister is going to have them made at his own works (Verity's, Ltd.), so that the unit may hope to do some wireless telegraphy this year. The Company held its annual supper at the *White Ho se Ho'el*, Birmingham, on Saturday evening, Captain Matthews being in the chair.

LANCASHIRE.

MANCHESTER.

It is expected that very shortly a great improvement will take place in the cotton trade, which controls activity in many other trades here. In about a week the mills will be working whole time again. There is, therefore, a very good prospect of some important orders being given in the course of the next few months, for conversions of steam-driven mills. The conversion of the Brunswick Mill, of the Bannerman Mill Co., has proved a notable success, and in itself is a pretty powerful "counterblast to Bradford." This mill, which is an old one, was formerly driven by two old engines, the combined power of which was 1,600 h.p. Driving was through a number of spur and bevel gears, upright shafts and rope drives. These have now almost entirely been displaced. It is noteworthy that current is taken from the Manchester Corporation H.T. mains, a special sub-station having been put down in one of the old engine houses. The drive is by three-phase motors at 400 volts 50 cycles running off the secondaries of the transformers in the sub-station. There are some 37 motors in all, of various sizes, the total full load capacity being about 1,600 h.p. All the hoists are motor driven. A 45 h.p. motor drives the bale-breaking machines and blowing room, the line shafting there having been speeded up to 480 r.p.m. The card-room, which contains 112 cords and 16 preparing machines, is driven by a 150 h.p. motor, which, on account of the dusty atmosphere, is enclosed in a sheet iron case, with air ducts for ventilating from the outside air. The 64 machines in the frame-room are all run off a 130 h.p. motor. The driving of the spinning machinery presented special difficulty, and necessitated two steel motor towers being built, one at each end of the mill. On each of the five floors carrying spinning machines, there are four pairs of mules and 10 ring frames; two pair of mules are driven by one 75 b.h.p. motor direct coupled to the line shaft. There are two motors per floor in each tower, the starting gear being with its motor, but provision has been made by emergency push buttons placed in each spinning room to stop the motors from the room in case of necessity. The lighting is also done from a special three-phase transformer supplying about 1,000 220 volt carbon lamps.

What the Owners Say.

From the results so far obtained, the owners of the mill have made a very definite statement, to which considerable publicity has been given in the textile papers, to the effect that from the same machinery there are now obtaining, since the conversion, a larger production than in the old steam-drive days. They find the quality of their yarn has also improved, due to the more even running of the machinery. It should be noted that this firm has always been noted for the high quality of its products, so that this testimony carries much weight. The British Thomson-Houston Co. have been responsible for the installation, under the general supervision of Mr. S. L. Pearce, the company's chief engineer. As usual, the conversion was effected without stoppage of work.

The Commercial Side of Electrical Engineering.

At the last meeting of the Local Students' Section, Institute of Electrical Engineers, Mr. J. I. Law Brooks read a very interesting paper on this subject, in which he considered the internal and external organisation of the large electrical firm, as regards its commercial efficiency. The head office, he said, should always be at the works, and system was absolutely necessary to success. Salesmen should invariably be trained engineers, and preferably men who had passed through the firm's own shops. The selling

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of machines required much more tact and ingenuity than the designing of them, though ultimately everything depended on the designer to produce a sound article at a competitive price. Retailability should be the first point in any design; it proceeded efficiency. He dealt at length with the keen competition, and pointed out the need for joint action. An organisation was wanted to impress the general public and parliament with the vast commercial interests represented by the industry, and which would support the representations of existing societies by bringing the public voice to bear on them. He thought restrictive legislation largely responsible for the bad state of the electrical industry, and that legislators ignored electrical interests. He also considered the questions of representation abroad by agents or branches in favour of the latter. Mr. A. G. Seaman, M.I.E.E., who was chairman, thought manufacturers must combine to improve conditions, but the industry was not yet sufficiently organised for this, and in his opinion shareholders were not sufficiently energetic in seeing that they got a good return and, consequently, there was not that impelling force behind the industry which one found in other industries. The first requirement of a system was simplicity, and, moreover, it should be adapted to the changing needs of business. A designer should keep in close touch with outside prog.ess, so that his designs might always be up-to-date.

Fostering the Commercial Spirit.

An excellent discussion followed—an antimated discussion such as no ordinary technical paper could have produced—and those members who allowed apathy to keep them away missed a most useful meeting. It was suggested by one speaker that more of such papers would be beneficial to members. Indeed, as a means of giving a sense of commercial proportion to the "young idea" at college or in the shops (accounting for the majority of recruits to the Students' Section), two or three commercial papers or discussions per session would do much to create that first requisite of a thriving industry—a spirit of commercialism—which is at present so lamentably absent among electrical engineers, thanks largely to present-day technical training, which, so far from fostering it, affects to disdain it altogether, and does much to destroy it, to the lasting hurt of the industry. No doubt the Manchester Students' Section will be found, as usual, in the van of progress, giving a fairer share next session to the consideration of matters directly affecting the time basis of all engineering work—the "making" or saving of money.

SCOTLAND.

GLASGOW.

Two further extensions of the Glasgow tramways should be opened on Sunday next, the one half-a-mile and the other a mile long. The Corporation are inclined to fight shy of lengthy tramway extensions into areas outside the city boundary, for the decentralising tendency on population, resulting from the cheap and rapid locomotion provided by tramway services to suburban districts, has grown to such an extent that it is having a detrimental effect on city rates. It is found that an increasing number of people are taking advantage of the cheap services provided by the city without contributing their due share to the upkeep of the same. The net result of all this is that at public functions the oratory increasingly takes the form of lengthy references to those who, getting full advantage of civic activity, relegate to others the burden of civic responsibility, and the hope is expressed that the neighbouring burghs, of Govan and Partick particularly, may ere long consent to be annexed to Glasgow with a view to all concerned sharing in the economies which would thus doubtless be effected. The local branch of the Institute of Civil Engineers held their annual dinner the other night under the chairmanship of Mr. Robert Robertson, of Messrs. Strain & Robertson, Glasgow, and what has just been said is practically a summary of the two principal speeches, the one by Sir George Beatson and the other by Lord Provost McInnes Shaw, of Glasgow. Only the movement was not traced to its real origin in the cheapness and efficiency of the Glasgow electric tramways.

Partick Electricity Supply.

The Partick Electricity Supply Undertaking is just eight years old; in the interval it has grown from a plant capacity of 400 kw. to six times this amount. The units generated have increased in like proportion, and the growth of the concern was continuous until the year 1908–9, when the introduction of the metal filament lamp, together with trade depression, gave electrical undertakings all over the country a temporary set-back. The trade depression is rectifying itself, and the metal filament lamp is now adding to revenue and output instead of being the hindrance to growth that it was 18 months ago. The first extension of the plant took place in 1904, and a year later further extensions were decided. In 1907, upon the advice of the Burgh Electrical Engineer, Mr. W. Sillery, the Council decided to alter the existing condensing plant and to instal a new surface condenser and two compound automatic balancers. The stores and general offices were also remodelled to suit requirements. In the spring of 1909 the question of further increasing the capacity of the plant was considered. The connections to the mains in December, 1908, were 251 motors, equal to 2,881 h.p., 240 kw. of street lighting, including 301 arcs, private lighting 1,092 kw., or 2,186 kw. of possible demand over the plant installed. Extensions were, therefore, decided upon, and have just been completed as follows:—1,000 kw. generator direct coupled to a high speed engine, the main contractors being Messrs. The Lancashire Dynamo Co., with Messrs. Belliss & Morcom as sub-contractors for the engine; surface condensing plant, water cooling tower by Balcke & Co.; Deoiling plant by Paterson Engineering Co.; Stirling water tube boiler with chain grate stoker 25,000 lbs. of steam per hour; Weir feed pump and Venturi water meter, 4,000 gal. per hour capacity; switchboards by Eckstein Heap & Co., etc. The entire scheme of alterations and extensions to plant and mains has been prepared by Mr. Sillery and erected under his personal supervision. These extensions amount to a total of £21,328. Provost Logan presided at the formal opening of the extension on Monday, March 3, Mrs. Jackson, wife of Ex-Bailie Jackson, convener of the Electricity Committee, starting up the new engine. Mrs. Jackson was thereafter presented with a silver tea service by the Glasgow representatives of the Lancashire Dynamo Co. Mr. Willoughny C. Warden (Belliss & Morcom) proposed, and R. Baillie, Esq. (Stirling Boiler Co.) seconded, a vote of thanks to the Provost and the Convener of the Electricity Committee. The works were then inspected by the company, who afterwards adjourned for luncheon.—The Partick Electricity Department have a considerable motor load, and evidence of trade revival in the district is shown by the fact that during the last two months their output has been increased to the extent of 50,000 units. A quotation of ½d. per unit for 2,000,000 units failed to secure the power load of the firm concerned the other day, but negotiations are in progress in one case for a demand of 845 h.p. or 210,000 units per annum, which it is anticipated will be secured, and some of the larger shipbuilding firms are also expected to increase their power demand in the immediate future. The Burgh of Partick boasts the largest electric oven in the kingdom. It is erected in the kitchen of the Burgh Halls, and has been working successfully for nearly two years. It was invented and designed by Mr. Sillery, the Burgh Electrical Engineer, and made at the works by his own staff.

Telegraph Cables.

The Town Council of Dundee had last week under consideration a letter from the local Chamber of Commerce asking their co-operation in approaching Aberdeen and other Chambers of Commerce in Scotland to take part in a movement having for its object the extension of underground telegraph cables extended to Scotland. The intention is to secure an interview with the Postmaster-General this month. The Council agreed to lend its help, and a subcommittee was appointed to attend at the forthcoming interview if it was thought necessary that the Council should be represented.

Leith Electricity Department.

The Electricity Committee of Leith are contemplating a considerable extension to their works, and a preliminary step was taken last week, when a deputation from the Electricity Committee visited the new extension to the Partick Electricity Works.

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GERMANY.

BERLIN.

According to the Berlin Borsencourier, the Telefunken Co. will start on April 1st, 1910, at the School of Navigation at Hamburg, a course of instruction in wireless telegraphy for officers and men employed in the German mercantile marine. It is hoped that the result of this instruction will be to diminish the cost of working wireless installations on merchant vessels, cargo-steamers, especially as no telegraphist will be wanted, the crew doing the work as part of their ordinary duties, or perhaps a small extra remuneration might be awarded, far less than the high salary of a person borne on the books merely as a telegraphist. In round numbers the following is the number of merchant vessels fitted with wireless apparatus and sailing under the flags of the countries named: Germany, 50; England, 100; United States, 250. The reception by wireless telegraphists of messages not intended for them has sometimes resulted in considerable commercial profit to the interceptors. Unfortunately, German law only makes it illegal for receivers in public telegraph offices to disclose the nature of the messages passing through their hands, and an agitation is in progress in Berlin to extend the law to persons possessing private wireless installations.

A Postal Underground Railway.

It has long been intended in Berlin to have an underground postal railway, and according to the *Morgenpost*, the Siemens Schuckert Werke are trying a test line on their premises at Nounendamm. This line is a quarter of a mile long and is double with a gauge of 16 in. It is worked by a 220 volt rotary current. The model locomotive is 5 ft. long, and reaches a speed of 25 m.p.h., with four trucks, each carried on a single axle and about the same size as the locomotive. Each truck carries a post bag of the largest size. This size of locomotive and trucks will suffice for the real line, of which, however, the exact course is not yet settled. It will, however, probably extend from the letter office in the Spandauer Strasse to the head office, now in course of erection in the Französische Strasse, and thence to the office at the Potsdam railway station. The line is to run through tunnels only 6 ft. 8 in. wide and 2 ft. 8 in. high, as no train crew is required. There will, nevertheless, be a deep cutting in the "six foot" so that access to the tunnels can be had for inspection, repairs and rectification of breakdowns.

Calcium Carbide as a Drying Substance.

In electric static work metallic sodium is chiefly used for drying and acts well at first, but once it is covered with a layer of caustic soda it is practically worthless. Wulf, of Falkenburg, has discovered that sodium can be advantageously replaced by calcium carbide, as the lime formed during the absorption of water vapour scales off, so that a fresh surface is always exposed. A sufficient quantity of carbide will last several weeks.

Company Notices.

The Siemens Schuckert firm are now erecting a new power station for the Berlin overhead and underground railways, especially for the West end lines, and the new line to be started in 1912. The station will be between Fürstenbrunn and Spandau, and is to provide a 10,000 volt 40-phase current, to be converted into a 780 volt continuous current at the sub-stations. Three turbines of 4,000 kw. each are to be installed.

The Felten & Guilleaume Lahmeyer A. G., of Frankfort, have just supplied a rolling mill for the manufacture of 100 ton armour plates at Terni. The rolls are 125 cm. in diameter and 450 cm. long. They are driven by two direct current motors of a combined power of 15,000 horses, when making 90 revolutions a minute. The dynamos feeding them are driven by a 2,600 h.p. turbine. The flywheel of the mill weighs 50 tons.

At Riesa, an electrically worked inclined plane has been installed for carrying up charges for the Martin steel furnaces and bringing down the empty wagons. The inclined system has the advantage over vertical lifts that it works without interruption. There is no stoppage of the wagons. The lifting is done by a magnetic crane, worked by a shunt motor developing 17 h.p. at 730 revolutions a minute. Three wagons are carried at a time up the endless chain constituting the inclined plane.

We have to signalise the approaching completion of yet another electric rolling mill, which presents several points of interest. It is in course of erection by the Austrian Siemens Schuckert at Wilkowitz in Moravia, for rolling armour plates of 80 tons. The engines supplying the power are driven by waste blast furnace gas, and the power of 1,500 h.p. produces a rotary current 50-phase and 5,250 volt current, while two 2,000 kw. turbo aggregates are kept in reserve. The current is taken from the blast furnaces to the rolling mill, a distance exceeding a mile and a half, by an underground cable.

A new electric railway project has been quietly arranged between the Milan Siemens Schuckert Co. and M. Alessi, the Roman contractor, and nothing more remains than to get the permission of the Italian Government for making a line which will supply a shorter route between the important cities of Milan and Munich than has hitherto been afforded by either the Brenner or the Gothard line. The new line is to have the normal gauge and the steepest bank will not exceed 2·7 in 100, and there will be no curves with a radius of less than a quarter of a mile. It is hoped that the State will contribute 8,500 lire per kilometer towards the cost of construction (say £650 per mile), the payment to be made for 50 years. The railway is started on Italian territory from Tirano, the present terminus of the Veltliner line. At Bormio at the foot of the Stelvio, there will be a tunnel 5½ miles long under the Swiss boundary. After a short distance in Switzerland, the line will pass to Malo in the upper Etsch valley, where it will be met by a railway which the Austrian Government has decided to make, with the same gauge from Landeck. The total cost is put at about £800,000. The shortening of the distance between Milan and Munich, already mentioned, will be fully a hundred miles, and will be much more when Austria and Bavaria have carried out their intention of making a direct line between Landeck and Munich, *via* Imst. and Partenkirchen. The tunnel under the Swiss frontier will be at the summit level of line, nearly 5,000 ft. above sea level.

UNITED STATES.

NEW YORK.

Lockport, on the Niagara frontier, is laying claim to the title of The Electric City. In proportion to its population more electric power is used there than in any other city in the world. The supply of cheap power is literally inexhaustible, and if Lockport goes on developing at its present rate, 10 years hence it is likely to be the wonder city of the world from the electrical point of view. There is scarcely a house or a store in the city which does not get its light, heat and domestic power from this source. Factory after factory has sold or scrapped its steam or gas plant and installed electric motors, and so economical has this source of power proved that the output of manufactured goods at materially reduced prices has doubled, trebled, and in some instances quadrupled, and the industrial expansion of the city has been phenomenal. Lockport, indeed, constitutes one of the most remarkable object lessons in the advantages of electricity as a motive power that this country has ever exhibited, and though there are at the present moment some thousands of acres of land in the near vicinity of the transformer stations, and in districts intersected by two railroads, it is safe to say that 10 years hence, and perhaps much sooner, practically all this area will be covered by electrically driven factories.

Electricity versus Steam.

Brief reference may be made to two or three prominent instances in which electric power has influenced industrial development in this Electric City. The Traders Paper Mills, one of the largest plants controlled by the United Boxboard Company, have been operating their immense plant by electric power for over a year and find it to be very economical. They have dismantled their mammoth steam engines, and now use 2,500 electrical h.p., and since adopting this method of operation have increased their output 25%. The Susquehanna Smelting Company, which was formerly located in Pennsylvania, but after an investigation of other

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cities finally decided to locate their industry in Lockport for the reason that in no other place could they obtain such favourable conditions on account of the large amount and low cost of electric power. This firm manufactures Ferro Silicon, and is the only industry of its kind in the United States. They use upwards of 300 electrical h.p. and operate their plant 24 hours a day, 365 days in the year. They have leased additional buildings and have plans under consideration for the extension of their business. In Lockport also is another industry which is the only one of its kind in the United States, namely, the United Indurated Fibre Company, of New York. They manufacture several hundred articles of fibreware which is made from woodpulp, pressed into moulds, baked in ovens, oiled and finished to a high polish and made practically waterproof, hundreds of thousands of tubs, pails, cuspidors, trays, closet seats, tanks and similar articles are manufactured at this plant every year, giving employment to upwards of 300 men the entire year and the use of their product for insulation of third rail and other electrical devices has met with such a great success that the demand has greatly increased and the plans of the company call for extensive additions to their plant during the present year. This immense plant is now controlled by the John Manville Company, of New York, the largest dealers in electrical supplies in the world, and who operate a large number of industries throughout the United States, and one of the chief reasons of the proposed enlargement of the Lockport plant is on account of the availability of cheap power.

The Cure for Electrolysis.

Reference has already been made in these notes to the great interest aroused here by the paper which was read at a meeting in London of the Institute of Electrical Engineers in September last, giving an account of the electrolytic survey of the city of Manchester, which was carried out by Mr. J. G. Cunliffe and Mr. M. G. Cunliffe. On this subject there is an extremely interesting article in the current issue of the *Electrical World*, from the pen of Mr. William Del Mar, and also a long editorial. Mr. Del Mar concludes that the net result of the new ideas on electrolysis is that corrosion can be completely eliminated in the following ways only: (1) Keeping all cable sheaths, pipes, etc., outside the danger zone, which is generally impracticable, and (2) reducing the area of the danger zone so that it will contain no pipes, cable sheaths, etc. This can be done in one way only, and that is by keeping down the drop in the grounded rails to a very low amount. "Fortunately the drop in the grounded rails," he adds, "may be kept down without using an excessive amount of copper. This may be accomplished by means of insulated negative feeders tapped into the rails at intervals, as is done in the New York subways. The drop in these cables may be of any magnitude without affecting the electrolytic conditions and they may be tapped in at such frequent intervals that the drop in the grounded rails is insignificant. This system is in extensive use in England. Much of the trouble with high-resistance returns is, however, due to improper maintenance of rail bonding. The writer has observed differences of potentials of 42 volts between abutting rails of a 550 volt trolley system in Greater New York. Another result of the new ideas is that the propriety of connecting pipes and cable sheaths to the rails or bus cannot be determined by potential readings only, but should be the subject of careful investigations."

Electrical Anaesthesia.

Dr. M. M. Johnson and Dr. L. Rabinovitch have brought to a successful issue at the St. Francis Hospital, in Hartford, Connecticut, a very remarkable operation, in which electrical anaesthesia played an important part. The patient had been very severely frostbitten and the amputation of four toes became necessary. Electrodes were strapped to the patient's legs near the knees, and when the current was turned on the legs were numbed below the knees just as if they had been cocainized. Dr. Rabinovitch's plan consists of sending an interrupted current of electricity through the affected part of the human body to be operated upon. No other part is affected by the fluid. A current at 54 volts was used in this instance, reduced by means of a commutator to one-tenth of that amount. The interruptions of the current were estimated at 20,000 a minute. The secret of the use of the device is in correctly applying the electrode to the nerve that controls the affected part. Dr. Johnson said there were no bad after-effects, and the patient suffered no pain. He declared that the feat marked an epoch in anaesthetic surgery and that other forms of anaesthesia were likely to be entirely supplanted by Dr. Rabinovitch's process.

Rheostats for Remote Control.

The General Electric Company is now putting on the market a new type of remote control for large generator field rheostats, for which important advantages are claimed. The rheostat arm is rigidly fastened to a wheel with a toothed rim. Pawls fastened to the common core of two magnets, engage the toothed rim of the wheel, and move it clock-wise or counter clock-wise. To cut resistance into the field, it is only necessary to close a double pole switch to the left, thus energising the left-hand solenoid and causing the left-hand pawl to engage the rim of the wheel, moving it in a clock-wise direction. When the solenoid core has reached its extreme point of travel, the solenoid circuit is automatically opened by a small switch, allowing the pawl to be returned to the position midway between the solenoids by a spring, and permitting the switch to again close starting anew the cycle of operations just decribed. This cycle of operation is repeated over and over again until the double pole switch is opened. To cut out resistance the double pole switch is closed to the right, causing the same cycle of operations as described above, with the exception that the right-hand solenoid is energised and the arm is driven counter clock-wise. Each end of the switch dial is provided with a limit switch, which is automatically operated by the switch arm to open the circuit of the solenoid when the resistance is entirely cut in or out, protecting the apparatus in case the solenoid is left energised when the arm has reached its extreme point of travel. The device is dead-beat, as there are no high-speed revolving parts which, due to their inertia, continue to cut in resistance after the controlling circuit has been opened. As compared with motor-operated rheostats, there are claimed for this device the advantages of less cost, closer regulation of resistance, minimum attention, less space, and light weight. It can be made self-contained, repairs are much simpler and can be more quickly made, and the cost of maintenance less.

A Personal Note.

Electricians in the Old World as well as in the New will feel a more than passing interest in an announcement which appears in this week's issue of the *Electrical World*. It is to the effect that Mr. J. M. Wakeman, for 11 years vice-president of the McGraw Publishing Company and general manager of that journal, resigned these offices at the recent annual meeting of the company. While not in serious ill-health, Mr. Wakeman feels it desirable to be relieved from business cares in order to recover his former physical condition, and his future plans include a visit of a year or more to Europe for a complete rest. After a successful connection of some years with the *American Machinist* and *Locomotive Engineering*, Mr. Wakeman joined the McGraw Publishing Company at its formation in 1899, having been one of its incorporators. As the chief assistant in the management of the company he has been a strong factor in the success which it has achieved, and as general manager of the *Electrical World* he has guided its business career along the broadest lines and with rare ability. The departure of Mr. Wakeman will be a source of the keenest regret to his associates, and without doubt also to the host of warm friends he has made in the electrical field. Mr. Wakeman will not retire immediately, but will continue for several months as a director of the company and in active work. Mr. Hugh M. Wilson, who will occupy the office of vice-president of the McGraw Publishing Company, made vacant by the retirement of Mr. J. M. Wakeman, has passed the greater part of an active business life of 23 years since graduation in 1887 from Illinois College, in technical journalism. As publisher of the *Railway Age* and the *Electrical Railway Review* he gained an enviable reputation as an enterprising, successful and constructive manager of newspaper properties. He sold his interest in these publications early in 1908, and later became vice-president of the Barney & Smith Car Company, which office he has just resigned to take up his present work.

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Cheaper than Convict Labour.

It appears that as a sequel to investigations following on the recent fire which destroyed the power plant of the Illinois State penitentiary at Joliet, it has been decided to purchase electricity for light and power from the Sanitary District of Chicago. The contract calls for current at 1 cent per kw. hour, and the chief engineer of the penitentiary says that this is 50% less than the rate at which they were able to manufacture electrical power even with convict labour. It is also claimed that purchasing this power will save the State an expenditure of rebuilding the plant of at least $100,000, and in addition thereto save $6,000 annually. The Sanitary District will supply 6,600 volt, 60-cycle, 3-phase current from its hydroelectric plant between Lockport and Joliet, to the penal institution, where it will be stepped down to the required voltage for lighting and power purposes.

Telephone Merger Abandoned.

"In deference to public opinion"—that is the delicate way in which the matter is put—the Mackay Companies are going to sell their holdings in the American Telephone & Telegraph Company, which in turn controls the Western Union. With this announcement disappears the talked-of "billion dollar" merger and the Postal Telegraph-Cabl Company, if the promise be carried out, becomes a keene competitor of the Western Union. When the American Telephone & Telegraph Company bought George J. Gould's stock in the Western Union, carrying practically control, it was pointed out that the Mackay Companies held approximately 82,000 shares of the former's stock. This was interpreted by many as a tacit merger of the three great companies, which would mean death to competition. A statement issued in New York by Mr. C. C. Adams, vice-president of the Postal Telegraph-Cable Company, says: "The Mackay Companies will sell its entire holdings of stock in the American Telephone & Telegraph Company, that step being in deference to public opinion, which views with suspicion the large holding of stock in a company which has recently purchased the control of the Western Union Telegraph Company. Moreover, that stock was acquired by the Mackay Companies with a view to bringing about economies in the construction and maintenance of joint pole lines over long stretches of country, where the business was not sufficient to justify either company constructing an independent pole line by itself. Many such arrangements were made, each company doing one-half of the pole line, but having nothing to do with the business of the other company. Since, however, the American Telephone & Telegraph Company has acquired control of the Western Union Telegraph Company, the time has come for the Mackay Companies to sell its holdings of stock in the American Telephone & Telegraph Company, and that will be done. The Postal telegraph system will continue to be free and independent, prepared to maintain the competition which it has furnished for 25 years."

Some Big Enterprises.

Some important electrical developments are announced in the Chicago *Electrical Review*. A large company to develop power sites in central Washington has been organised by Mr. Robert E. Strahorn, builder of the North Coast Railway, and associates. It is the Columbia River Reclamation Company, with headquarters in Spokane. The company has filed a request for a right-of-way across State lands, near Priest Rapids, Ida., for a width of 1,000 ft. and running about 10 miles near the river.—Excavation for the power-house which is to be erected on the Savannah River near Augusta, Ga., are now being made. A railroad has been built from Modoc, S.C., to the dam site in order to facilitate the work of excavation. The Ambursen Hydraulic Construction Company, of New York city, has the contract for building both dam and power-house. The work represents an investment of $3,000,000, and according to the terms of the contract, power must be delivered to Augusta within three years.—An option has been secured on a large tract in the State of North Carolina whereon it is understood that a million-dollar textile manufacturing plant, to be electrically driven, will be erected soon by New York and Boston capital. W. Jordan Massee, president of the Central Georgia Power Company, is a stockholder in the new enterprise, which will cost about $650,000. The electrical development on the Ocmulgee river is progressing rapidly, and 20,000 h.p. of electric energy will soon be available. The proposed cotton mill is said to be the first industrial enterprise to follow the harnessing of the Ocmulgee river.

Current Items.

It is announced from Skowhegan, Maine, that plans are being made by the Kennebec Development Company for the development of the water-power of Kennebec River by which it is estimated that about 90,000 h.p. can be developed at a cost of about $9,000,000, work on which will begin in the spring. The plans call for the construction of three large dams, the first of which will be located at Indian Pond, a short distance below Moosehead Lake's outlet, where the two outlets come together. Electricity generated at the plant will be transmitted throughout the State, and 30,000 h.p. has been already contracted for.

The Pacific Light & Power Company, of Los Angeles, which was recently re-incorporated with a capital stock of $40,000,000, proposes to enlarge several of its plants to meet the increasing demands for electrical service. The first step taken by the company will be the doubling of the output of the plant at Redondo, at a cost of $1,750,000. The present equipment of the plant includes three units of 7,500 h.p. each, and it is proposed to install three additional 7,500 h.p. units. The company also proposes to develop more power on the Kern River, and to run new lines and build new plants in the mountains.

Plans have been completed by the La Crosse (Wisconsin) Water Company for the construction of a large dam at the mouth of Rock Creek on the east fork of the Black River, which will provide for the storage of 6,007,067,600 cubic ft. of water which will be utilised by means of a 97 ft. head, and will develop 30,000 h.p. This will be the third of a series constructed by the company which operates the Hatfield water power. On completion of the dam a second power-house with an output of 14,000 h.p. will be erected.

Residents of Niagara-on-the-Lake, who were unsuccessful in their attempts to have the International Railway Company extend its line from Queenstown northward, have organised an independent company to build a line from Queenstown to Niagara-on-the-Lake.

The flaming arc lamp is growing in popularity with merchants' associations and similar bodies that are developing plans for making brilliant the business sections of some of the smaller cities. The Excello Arc Lamp Company, which has recently closed a contract for the business centre of Newark, N.J., reports that many inquiries have been received from other places and that it is likely a number of similar installations will be made.

Chicago Subway Plans.

Mr. B. J. Arnold, chairman of the Board of Supervising Engineers, Chicago Traction, has been requested by the Mayor of Chicago to undertake the work of constructing a system of subways for that city. Mr. Arnold will organize an engineering force and prepare plans for the work. He is quoted as saying that in a general way the plans will include provisions for the through routing of trains between different sides of the city and the elimination of loops so far as practicable in the business district. The city will have money enough to build eight or nine miles of subway from its accumulations from the street railway company's dividends, and the street car companies themselves are bound to contribute $5,000,000. This will give a fund of $9,500,000, and it is believed this is sufficient to start the actual work on the subway. It is the plan to build these eight or nine miles in the city's heart with this fund, making it a sort of hub for the lines to be built later. This hub is to be so arranged that it will permit of additions extending out towards the city's rim as the city increases.

BILLS IN PARLIAMENT.

Standing Orders of the Houses of Parliament were found to have been complied with by the Examiners of Standing Orders Proofs in the case of the following Bills: Baker-street and Waterloo Railway, Charing-cross, Euston, and Hampstead Railway, Great Central Railway, London Electric Railway, Amalgamation Metropolitan District Railway, North-East London Railway, Metropolitan Railway, and Duke of York's School (Chapel) Bill.

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Business Notes and News.

LIGHTING AND GENERAL—Home.

BISHOP AUCKLAND.—The Guardians propose lighting their infirmary with electricity, at an estimated cost of £155.

BARKING.—Owing to the growth of the electricity department, the Council have instructed the electrical engineer to prepare alternative plans for extending the present works and for removing them to a larger site on the river side. Tenders are to be invited for the sinking of a well to supply (a) the electricity works only, (b) the electricity works and public baths and washhouses, a storage tank being required in the latter case.

BATH.—Opposition is being offered to the city scheme for the extension of their electricity supply area. Among the opponents are the Midland and London and South-Western Railway Cos. (merely, however, in order to secure themselves against interference with their permanent ways, except at road crossings), and the local gas company.

BELFAST.—The Harbour Commissioners are about to put up 22 arc lamps on high tubular masts.

CAMBERLEY.—The Urban District Council have decided not to proceed with their application for a Provisional Order under the Electric Lighting Acts.

DARLINGTON.—After experimenting with various arc flame lamps, two different types are to be put up at Imperial-corner and Skinnergate at a cost of between £400 and £500.

DUNDEE.—It has been decided to effect an insurance of £40,000 on the new electricity station at Stannergate, and £10,000 on the sub-stations.

GILLINGHAM.—The Local Government Board have sanctioned loans of £1,450 and £450 for electric lighting purposes, and will shortly hold an inquiry into a application for powers to borrow £3,000 for purchase of a Diesel oil engine.

GLOUCESTER.—A considerable demand for electricity for power purposes is arising, and it has been decided by the Town Council to allow special terms according to the nature of the contract entered upon.

HASLEMERE.—The agreement for lighting Haslemere by the local electricity company has been signed by the Parish Council.

HEREFORD.—The Town Council will apply to the Local Government Board for permission to borrow £3,000, half to be spent on new electric mains, and half on new services.

HOLLINGBOURNE.—The Rural District Council have given permission to the Corporation of Maidstone to supply Turkey Mills, within Hollingbourne, with electricity.

LEITH.—There is a proposal to extend electric lighting at the Docks, the Town Council supplying the Dock Commissioners with the extra current required.

LIVERPOOL.—Ten arc lamps are to be placed in Harman and Myrtle-streets, at a cost of £250, and an estimated expenditure on upkeep of £49 per annum.

LONDON: POPLAR.—It has been decided that the charge for current for public lighting, as from April 1 next, be £13 per kw. per annum, and a further ½d. per unit for all current supplied.

LONDON: ST. MARYLEBONE.—Mr. Seabrooke, the Council's electrical engineer, reported that the electrical installation at the baths required overhauling, as in its present condition it might prove dangerous to bathers. He stated that it should be re-wired, lead covered cable to be used in damp places, and the lighting could be re-arranged. The total cost of the work, including metal filament for the present carbon lamps, would be £400, and they recommended that the work should be done. They had also ordered some alterations to the steam piping connected with the boilers, which would cost £90. The Council finally decided to advertise for tenders.

MIDDLESBORO'.—A movement is on foot for the lighting of the market by electricity.

NORWOOD GREEN.—Schemes are being considered for the lighting of Norwood Green and Coley by electricity. One idea is to take current from the mains running near-by, which would mean only an extension. If 43 lamps were put in the cost would be £176 6s. for first cost and from £80 to £92 for maintenance. An alternative plan is to go in for an electricity undertaking such as that existing at Grassington, and already described in the columns of THE ELECTRICAL ENGINEER.

OLDHAM.—A proposal is on foot for the Municipality to take over the telephone service.

PENMAENMAUR.—Two electric lanterns, containing each three 100 c.p. electric lamps, have been erected on the promenade by the Town Council, the electricity being obtained from Messrs. Darbishires' power station at their mills. The Town Council are preparing a scheme for the lighting of the whole promenade, when Messrs. Darbishire will quote a price for the supply of current.

REDDITCH.—It is proposed by the Council's Electricity Department either to purchase a new switchboard, or to have the present switchboard overhauled and brought up to the requirements of the Home Office. Extensions of cables are to be made along Feckenham-road.

SALFORD.—From April 1 users of electricity for power purposes will be allowed to use current for lighting purposes at the power rate up to 10% of their power consumption. This is a reduction by 5%.

SHEFFIELD.—A new boiler feed pump, to deal with 10,000 gallons per hour, has been put in the Corporation's electricity works at Neepsend, at a cost of £190.

STOCKPORT.—This year the electricity department are not contributing their usual £2,000 in relief of rates, the profits being expended on necessary extensions.

SWANSEA.—Lighting mains are to be extended in Carlton-terrace at an outlay of £100.

TAVISTOCK.—Messrs. Rudge & Co., of this town, have applied to the Council for consent to their applying for a Provisional Order under the Electric Lighting Act. The matter has been deferred, as it is possible the Council may decide to apply for the Order. Meanwhile a consulting electrical engineer is to be called in.

TEMPLEMORE, IRELAND.—The proposal of the Town Council to obtain a Provisional Order for Electric Lighting is still in abeyance. The preliminary steps have been taken, a scheme obtained from Messrs. Wilkins & Barden, electrical engineers, and estimates from different firms placing the cost respectively at £3,500 and £2,200. Should the local military authorities enter into an undertaking to take current for a period, the scheme will go through.

TURTON.—In view of adopting electric lighting, the District Council are negotiating with the Lancashire Electric Power Co.

WEDNESBURY.—A Local Government Board inquiry has been held into the application for permission to borrow £2,095 for purposes of the Town Council's electricity undertaking.

WOKINGHAM.—The Town Council have decided to oppose the Reading Electric Supply Bill.

LIGHTING AND GENERAL—Overseas.

BLUE MOUNTAINS, NEW SOUTH WALES.—The Shire Council have entered into a contract with a Sydney electrical firm for the lighting of the Blue Mountains. About 13 townships from Glenbrook to Mount Victoria, with the exception of Katoomba, will participate in the service. The cost per lamp will be £4 10s. Apart from supplying 300 street lamps of 200 c.p. each, they will supply power for pumping water and other purposes. Electricity for private consumption will also be supplied. The rate to be charged is 6d. per unit, but it is understood that when the consumption has attained a certain quantity, the price will be reduced to 4½d. per unit. Negotiations are pending between other councils and the contractors for extending the range of operations.

BOULDER CITY, WESTERN AUSTRALIA.—The municipality purpose spending £8,000 on an extension of the electric lighting plant.

BRUSSELS.—The High Technical School authorities at Drontheim invite tenders for the supply of three electric lifts. Tenders will be opened on March 12.

CALCUTTA.—The Corporation are contemplating lighting some of the principal streets by electricity.

CHARLTON, VICTORIA.—A local electricity company, with a capital of £3,000, is being formed here.

ROSARIO, ARGENTINE.—The Municipality have ordered 300 arc lamps from Germany.

SIMLA.—The Municipality have obtained a license for the generation and supply of electricity, for lighting and power purposes. The current is to be generated by hydraulic power, and the scheme is well on its way.

TRACTION—Home.

DARLINGTON.—The Electricity Committee are reducing the charge for current to the tramways from 1⅛d. to 1d. per unit.

EDINBURGH.—The Town Council have decided to construct an electric tramway between Ardmillan-terrace and the new markets at Gorgie. This will probably be worked by the local tramway company on a basis of 7% on the capital expenditure.

MAWDDWY.—The Board of Trade have recently confirmed the undermentioned Order made by the Light Railway Commissioners: Mawddwy Railway (Light Railway) Order, 1910, authorising the Mawddwy Railway Co. to construct a light railway on the site of the disused Mawddwy Railway, and for other purposes.

TORQUAY.—Work is being pushed forward with the tramway to Paignton, but the line cannot now be opened for Easter as expected, and is not likely to be ready until the end of the summer.

WESTON-SUPER-MARE.—The local tramway company are about to carry out considerable extensions.

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TRACTION—Overseas.

GEELONG, VICTORIA.—As a result of a poll of the ratepayers, the provisional agreement with the Melbourne Electric Supply Co. for the construction of electric tramways is likely to be ratified.

ROME.—The opposition of the Italian War Office against the proposal to form an electric railway between Verona and Riva is to be withdrawn, it is stated, provided the railway company erect a fort at the Austrian frontier. The war ministry at first demanded that £80,000 should be spent on the fort, but they have now come down to £60,000, with the result that their terms have been accepted and that the railway will be made forthwith. The fort is already in process of erection. The line will be 80 miles long, and will join the electric railway connecting Mori, Arco, and Fiva at the last-named place. A branch six miles long will connect the new line with the Milan Venice main line, by joining Lazise to Peschiera.

SANTA FE, ARGENTINE.—The Municipality propose calling for tenders for the electrification of the tramways.

CONTRACTS OPEN.

HOME.

BOOTLE.—Corporation invite tenders for (1) automatic reversible traction booster, (2) circulating pump and electric motor, (3) automatic reverse current breakers and traction feeder breakers, (4) shunt regulating resistances and switches, (5) rewinding 75 kw. generator armatures. Particulars from Borough Electrical Engineer. March 19.

CHICHESTER.—West Sussex County Asylum Committee invite tenders for electric lighting supplies for 12 months. Specification No. 27. Particulars from Mr. J. R. Newman, Clerk and Steward, at the Asylum. March 22.

EAST HAM.—Corporation invite tenders for engineers' sundries for electric lighting and tramways department. Particulars from Town Clerk. March 12.

GLASGOW.—Corporation Electricity Department invite tenders for (1) main cables, (2) electric meters, (3) arc lamp carbons. Specifications from the electrical engineers. March 29. *Further particulars, see page* 303.

GLOUCESTER.—County Council invite tenders for the electric lighting of the extension of the Shire Hall. Particulars from the Consulting Surveyor, Shire Hall, Gloucester. April 2.

GRIMSBY.—Corporation Electricity Department invite tenders for the supply of (1) 300 cast iron lamp posts, specification No. 79; (2) swan necks and fittings, specification No. 80; (3) 300 d.p. fuse boxes, specification No. 81. Particulars from Mr. W. A. Vignoles, Borough Electrical Engineer. March 21.

LONDON.—County Council invite tenders for wiring and fittings for electric lighting of the Camden-street Central School. Persons desiring to submit tenders may inspect the drawings and obtain the specification, form of tender, and other particulars, on application to the Chief Engineer of the Council, Mr. Maurice Fitzmaurice, C.M.G., at the County Hall, Spring Gardens, S.W., upon payment to the cashier of the Council the sum of one pound (£1). This amount will, after the Council or its committee shall have come to a decision upon the tenders received, but not before, be returned to the tenderer, provided he shall have sent in a *bona-fide* tender and not have withdrawn the same, but in no case will the fee be returned unless a *bona-fide* tender is submitted. Full particulars of the work may be obtained on application at the County Hall before the payment of the fee for the specification, etc. Each tender is to be delivered at the County Hall, in a sealed cover addressed to the Clerk of the London County Council, Spring Gardens, S.W., and marked "Tender for Electrical Installation at the Camden-street Central School." No tender received after 11 a.m. on Wednesday, March 23, 1910, will be considered.

LONDON, ST. MARYLEBONE.—The Borough Council invite tenders for (1) pitch, (2) refined bitumen (sample to be submitted), for the year commencing April 1, 1910. Particulars from the Town Clerk. Tenders by March 14.

LONDON (FOR DURBAN).—Corporation of Durban, Natal, Electric Tramways, require 300 tons of steel girder rails, fish plates, bolts and nuts, f.o.b., London. Particulars (deposit £2 2s.) from Messrs. Webster, Steel & Co., agents, 5 East India-avenue, Leadenhall-street, E.C. Tenders by March 14.

SUNDERLAND.—Electric Tramways Department invite tenders for the following stores for one year: paint and oil, general electrical and car supplies, ironmongery, wrought iron and steel, timber overhead line materials. Particulars from Mr. A. R. Dayson, Tramways Manager. March 31.

WIGAN.—Corporation Electric Light Department invite tenders for the supply of (1) cables, (2) carbons, (3) electric accessories, (4) ironmongery, (5) engine room stores. Particulars from the Borough Electrical Engineer. March 21.

WIGAN.—Corporation Tramways Department invite tenders for (1) timber, (2) overhead line material, (3) glass, (4) paint, (5) varnish, (6) train car accessories, (7) ironmongery. Particulars from the Tramways Engineer. March 21.

OVERSEAS.

BUCHAREST, ROUMANIA.—The Roumanian State Railways Administration invite tenders for the supply of 4,900 metres of cable and insulated wire. Tenders, which will be opened on March 15, should be addressed to the "Direction Générale des Chemins de Fer Roumains," Bucharest. It is understood that the competition is limited to firms who may be invited to tender.

MADRID.—A Royal Decrees inviting tenders for the construction of strategic railways (1) from Jarandilla to Plasencia; tenders will be received up to August 26: (2) from Valdepeñas to Alcaraz; tenders will be received up to October 26: (3) from Burgos to Ontaneda; tenders will be received up to December 26: (4) from Burgos to Calatayud *via* Soria; tenders will be received up to February 22, 1911. The railways are to have a single track, with rails weighing not less than 30 kilogs. per metre. Means must be provided for the transport of artillery. Projects may be submitted providing for electric traction. While these contracts are open to Spanish firms only, it is probable that some of the material required will have to be purchased out of Spain.

THE HAGUE, HOLLAND.—Tenders are invited by the Dutch Ministry of Finance for the installation of an electric light and power plant in the new building of the Royal Mint at Utrecht. Tenders, which will be opened at 11 a.m. on March 21, should be addressed to the "Ministerie van Financien, Rijks Munt, Oude Gracht," Utrecht. Plans and specifications relating to the above may be examined at the offices of "Heer Van der Hegge Zijnen, Electrotechnisch Adviesbureau en Laboratorium," Utrecht, or purchased on payment of five gulden (8s. 4d.), together with postage, at the same address.

TENDERS ACCEPTED.

ERITH.—The Urban District Council have accepted the tender of Messrs. Siemens Bros., Ltd., for a double bus high-tension three-phase switchboard, at £1,083.

LONDON.—County Council have received tenders for the supply and erection of two static transformers at tramway sub-stations. British Electric Transformer Co., Ltd., Hayes, Middlesex, £429 10s. (accepted); Spagnoletti, Ltd., Shepherd's Bush, W., £430; Dick, Kerr & Co., Ltd., Abchurch-yard, E.C., £450 10s.; British Thomson-Houston Co., Ltd., Rugby, £452; Johnson & Phillips, Ltd., Old Charlton, Kent, £472 10s.; British Westinghouse Electric and Manufacturing Co., Ltd., Manchester, £476 (less 2½% discount); Electric Construction Co., Ltd., Wolverhampton, £480. Also for the supply of plough lead cable for electric cars, India Rubber, Gutta Percha and Telegraph Works Co., Ltd., Cannon-street, E.C., £147 5s. 3d. (accepted); St. Helen's Cable and Rubber Co., Ltd., Warrington, £150; Callender's Cable and Construction Co., Ltd., Victoria Embankment, S.W., £155 5s. 10d.; Johnson & Phillips, Ltd., Charlton, Kent, £155 5s. 10d.; Johnson & Phillips, alternative tender, £159 2s. 4d.; British Insulated and Helsby Cables Co., Ltd., Helsby, £155 5s. 10d.; British Insulated and Helsby Cables Co., Ltd., Helsby, alternative tender, £159 5s. 10d.; W. T. Henley's Telegraph Works Co., Ltd., Blomfield-street, E.C., £155 5s. 11d.; W. T. Henley's Telegraph Works Co., Ltd., Blomfield-street, E.C., alternative tender, £159 2s. 5d.; W. T. Henley's Telegraph Works Co., Ltd., Blomfield-street, E.C., alternative tender, £163 6s. 6d.; Siemens Bros. & Co., Ltd., Westminster, S.W., £155 5s. 11d.; Craigpark Electric Cable Co., Ltd., Glasgow, £163 6s. 7d.; W. T. Glover & Co., Ltd., Manchester, £190 (less 2½% discount). For roadwork and plate-laying in connection with the construction of tramways (a) from Streatham to Tooting Junction, and (b) in Wimbledon-road: Kirk & Randall, Woolwich, £35,797 (accepted); Dick, Kerr & Co., Ltd., £36,729. The tenders of the following firms for electric supplies to the London County Asylums for periods of seven months, twelvemonths and three years, have been accepted: The General Electrical Co., Ltd.; The British Electrical and Manufacturing Co., Ltd.; Veritys, Ltd.; Siemens Bros. & Co., Ltd.; Siemens Bros., Dynamo Works, Ltd.; Saxonia Electrical Wire Co., Ltd.; Cox-Walkers, Ltd.; Baxter & Counter; Pryke & Palmer; British Thomson-Houston Co., Ltd.; The Edison & Swan U.E.L. Co., Ltd.

TOTNES.—Board of Guardians have accepted Mr. A. S. Distin's tender of £9 7s. 6d. for the replacing of 160 carbon lamps in the new infirmary with 49 Osram and 9 carbon lamps.

COMPANIES' MEETINGS AND REPORTS

BROMPTON AND KENSINGTON ELECTRICITY SUPPLY.

The directors of the Brompton and Kensington Electricity Supply Co., Ltd., have declared a dividend of 11% per annum on the Ordinary shares for the half-year to December 31, making 10% for the year, transferring £6,000 to reserve and setting aside £3,592 for depreciation, carrying £8,533 forward.

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TELEGRAPH CONSTRUCTION AND MAINTENANCE CO.

At the 46th ordinary general meeting held at the offices, Old Broad-st., Sir James Pender, who presided, stated that the result of the year's work was very gratifying, especially when it was remembered that all the important contracts which the company had carried out had been obtained not only by tendering successfully against other British manufacturing companies, but that they had also had to meet the competition of the great Continental cable makers, who were so much helped and supported by their Governments. He proposed the adoption of the report. Mr. Colin F. Campbell seconded the motion, which was carried.

MERSEY RAILWAY CO.

The report for the half-year ended December 31 states that the total receipts have been £54,363, as compared with £52,193 for the corresponding period of 1908. The working expenses, exclusive of the charges for pumping, ventilation, and lifts, have been £30,286, equal to 55·71%, as against £33,593, equal to 64.36%. These charges for pumping, ventilation, and hydraulic lifts for the past half-year amounted to £3,504, equal to 6·44%, as compared with £4,105, or at the rate of 78·7%. The company are applying to Parliament for an extension for five years of the period during which the payment of interest on certain of the Debenture stocks is contingent on the available net revenue of the company, and the holders of each of these stocks are entitled to appoint a representative on the board and for other purposes.

LONDON STREET TRAMWAYS CO.

At the ordinary general meeting, Mr. George Ennis presided, and said that that was practically the last meeting of the company, as they were soon coming to the end of their lease and their existence. He moved the adoption of the report. Mr. J. Barber Glenn, a director, seconded the motion. He said that in July or August next the shareholders would receive their final dividend under the annuity, and then all the money in hand and to be derived from the London County Council, from sinking funds and investments would also be distributed among the shareholders. The total would depend upon the price they got in July next for their Consols and Metropolitan stock. He expected that the final return would be about 6s. to 7s. per share. The report was adopted, and a dividend of 2s. 6d. per share was declared.

WINCHESTER ELECTRIC LIGHT AND POWER CO.

The directors' report for 1909 states that the progress which the Company is making continues to be satisfactory; the equivalent of 2,012 8 c.p. lamps have been added during the year, making the total connection at the end of the year 58,653 8 c.p. lamps. Including the balance of £278 18s. 4d. brought forward from last year's account, the statement shows a net profit of £7,199 4s. 11d.; which, after payment of debenture interest, £2,050, leaves a balance of £5,149 4s. 11d. available for distribution. An interim dividend for the half-year, at the rate of 5% per annum, amounting to £1,104 17s. 6d., was paid in September last, and the directors now recommend that a dividend of 7% per annum be declared for the half-year, which will absorb £1,546 16s. 6d., making 6% for the year; that £1,000 be placed to depreciation fund account, and that £1,200 be placed to reserve fund account, leaving a balance of £297 10s. 11d. to be carried to the next account. The works and mains are in good working order. Notice of the intention of the Corporation of Winchester to exercise their powers of compulsory purchase of the undertaking at the expiration of twelve calendar months from January 20, 1910, has been received.

LLANDUDNO AND COLWYN BAY ELECTRIC RAILWAYS.

At the fourth ordinary general meeting, Mr. A. W. Tait, the chairman, stated that the profit for the period was £4,436, which, with the addition of the amount brought forward and the damages received for delay in the delivery of rolling stock (amounting to £432), made a total of £5,185, and after deducting £1,994 law costs, depreciation, and expenses of loan, out of the £3,191 remaining the directors recommended a dividend at the rate of 3% for the year on the issued capital of the company, carrying forward £209. The traffic receipts were £14,372, against £12,067 last year, showing an increase of £2,204. He thought that was fairly satisfactory, in view of the fact that part of the line was only open a few months; that the weather upon which a holiday resort like Llandudno was much dependent, was very bad; and that the additional rolling stock was very much delayed. The traffic expenses had increased owing to 60,000 more car miles having been run. The extension to Old Colwyn was still under consideration, but the directors had been unable to arrive at a satisfactory agreement with the Urban District Council with regard to the cost of road widening. The action by the Llandudno Council for cost of current was settled by a compromise. The report was adopted.

HOVE ELECTRIC LIGHTING CO., LTD.

The eighteenth annual report, for the year ended December 31, 1909, states that the gross revenue shows an increase of £510 1s., while the costs have decreased by £8 1s. 8d., the net result of the year's working being a profit of £13,981 8s. 6d., compared with £13,463 5s. 10d. in the preceding year. To the net profit brought forward into the revenue account, £13,981 8s. 6d., there has to be added the balance brought forward from the preceding year, £291 18s. 5d., making a total of £14,273 6s. 11d. The half-yearly Preference dividends, due on March 1 and September 1 last, have been paid, together with an interim dividend on the ordinary shares, at the rate of 8% per annum, in October last. After deducting these amounts, together with the accrued debenture interest, and provision for income tax, there remains an available surplus of £8,413 1s. 1d. The directors propose to place £1,500 to the renewals and depreciation account, and £2,500 to the sinking fund; to set aside a sum of £588 10s. 9d. for the accrued preference dividend to December 31 last, and to declare a final dividend on the ordinary shares, payable on April 15 next, at the rate of 9% per annum, making 8½% for the year. This will leave a balance of £363 9s. 10d. to be carried forward, after providing for the extra remuneration to the directors. The renewals and depreciation account, with the above addition, will now stand at £22,604 5s. The sinking fund account, with the above addition of £2,500 and £1,272 10s. 3d. received by way of dividends on investments, will now amount to £34,845 6s. 2d. The machinery, buildings and mains of the company have been kept in good repair. The expenditure during the year on capital account has amounted to £1,941 7s. 8d., the greater portion of which has been incurred in extensions of mains and in additional meters.

SOUTH LONDON ELECTRICAL SUPPLY CORPORATION.

The report for the year ended December 31, 1909, states that the gross receipts for the year have been £39,075 17s. 11d., while expenditure has been £18,245 16s. 6d., leaving a profit balance of £20,830 1s. 5d. Adding to this the amount brought forward from last year, £1,770 0s. 5d., there is a total amount available of £22,600 1s. 10d. After providing for depreciation on plant and machinery, etc., debenture and other interest accrued, £8,474 19s. 8d., there remains to be carried to the general balance sheet the sum of £14,125 2s. 2d. Out of this the Board recommend the payment of a dividend at the rate of 5% per annum on the Ordinary shares, amounting to £13,000, carrying forward a balance of £1,125 2s. 2d. At the end of 1909 there were connected to the Company's mains the equivalent of 210,394 8 c.p. (or 35 watts) lamps, showing a net increase for the year of 22,468 upon last year's figures. Applications were also in hand for a further 5,000 lamps not then connected to the circuit. During the year under review the plant, machinery, and mains have been maintained out of revenue in a high state of efficiency. Notwithstanding the extended use of the new metallic filament lamps, which consume considerably less current than the old carbon lamps, the gross revenue for the year is in excess of that of the previous year by £2,061. The units sold, which amount to 3,705,208, show an increase of 522, 388 or 16·5% in excess of the previous year, the total costs per unit sold being 1·18d. as against 1·34d. in 1908, a reduction of nearly 12%. The ratio of total costs to revenue is 46·7%.

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COMPANIES REGISTERED.

APPLEBY CRANE & TRANSPORTER CO.—£150,000, in £1 shares (100,000 preferred ordinary and 50,000 ordinary). Business: Makers of electric and hydraulic cranes, hoists, lifts and all kinds of lighting and conveying machinery, etc. Private company. First directors (not less than seven nor more than 11) are to be appointed by the signatories. Office, 58, Victoria-street, S.W.

J. B. MARR & CO., LTD.—£1,000, in £1 shares. Business: Merchants and agents for British and foreign manufacturers, electricians, electrical engineers, etc. Private company. Office, 53, Victoria-street, Westminster.

SLAG POWER.—£20,000 (£1). Generators of power by heat, light, steam, electricity, or otherwise. Minimum cash subscription, seven shares. 638, Salisbury House, London-wall, E.C. (107,722).

UNITED ELECTRIC THEATRES.—£60,000, in 10s. shares. Business: That indicated by the title. Minimum cash subscription, 10% of the shares offered to the public. The first directors are Hon. H. A. Stanhope, J. Hughes, A. S. Raworth and one other to be appointed by the signatories. Qualification, £100. Remuneration, £100 each per annum (Chairman £200), and 5% of the net profits divisable. Registered office, Walter House, 422, Strand, W.C.

YORKSHIRE BOILER CO.—Capital, £5,000, in £1 shares (500 preferred, 1,000 ordinary and 3,500 deferred). Objects: To take over the business of a mechanical, heating, ventilating and general engineer carried on by W. Casmey, together with patents granted for inventions relating to improvements in boilers, fuel combustion indicators and water-circulators, etc. Private company. The first directors (to number not less than three nor more than five) are: W. Casmey (managing director), J. F. W. Peckett and H. W. Mason. Qualification, £100.

REVIEWS.

"India Rubber and Gutta Percha." Translated from the French of P. Seeligmann, G. Lanry Torrilhon, and H. Falconnet, by J. G. McIntosh; 2nd edition, revised and enlarged. London: Scott, Greenwood & Son. Price 12s. 6d. net.

This second edition of a very comprehensive book comes at an opportune moment, when rubber planting and manufacturing ventures loom so large in the public eye. The subject of indiarubber and gutta-percha is dealt with here thoroughly from the botanical, mechanical, chemical and electrical aspects, the text being elucidated by numerous illustrations and valuable tables. It is, however, unnecessary to review this second edition at any length, though we may say that it appears to have been carefully revised, and still remains the most reliable comprehensive text-book on the subject with which it deals.

"Direct and Alternating Current Testing." By F. Bedell, Ph.D., and C. A. Pierce, Ph.D. London: Constable & Co. Price 8s. net.

Dr. Bedell, who is Professor of Applied Electricity in Cornell University, and his colleague in writing this book have, not unnaturally, kept the needs of university students in their minds, which accounts for the rather scholastic text-book ordering of the matter. However, the authors deal for the most part with questions cropping up in actual practice. The subject is dealt with in the form of experiments. Types of machines are described, the characteristics of special machines are given, together with methods of testing, diagrams, curves and formulæ being used where necessary. The seven chapters deal respectively with direct current generators, direct current motors, synchronous alternators, single-phase currents, transformers, polyphase currents and phase chargers, potential regulations, etc. It will undoubtedly be found useful by teachers, students, and by electrical engineers in general practice.

PUBLICATIONS.

Transactions of the Faraday Society, Vol. V., Part 3, contains much interesting matter. Dr. Gand discusses "Electroanalytical Determination of Lead as Peroxide," Mr. A. Jacques, "The Influence of Dissolved Gases on the Electrode Potential in the System of Silver-Silver Acetate," Dr. Rudolf Taussing describes "Large Electric Furnaces," and "Technical Alkali Chloride Electrolysis," and Dr. Eugene Haanel has a paper on "Investigation of an Electric Shaft Furnace" at Domnarfoet, in Sweden.

Transactions of the North-East Coast Institution of Engineers and Shipbuilders, Vol. XXVI., Part 1, contains four excellent papers on different topics relating to shipbuilding, but nothing of direct concern to electricians.

Proceedings of the Royal Society of Edinburgh, Vol. XXX., Part 3, contains a valuable paper by John Gibson, Ph.D., and G. E. Gibson, B.Sc., on "An Electrically Controlled Thermostat and other Apparatus for the Accurate Determination of the Electrolytic Conductivity of Highly Conducting Solutions," and another by John M'Whan, M.A., on "Observations on some Spark-Gap Phenomena."

DIARY.

SATURDAY, MARCH 12.

ROYAL INSTITUTION OF GREAT BRITAIN (Albemarle-street, London, W.).—At 3 p.m., "Waves and the Electro-magnetic Theory of Light," by Professor Sir J. J. Thomson, D.Sc., F.R.S. (Lecture V.).

MONDAY, MARCH 14.

INSTITUTION OF MECHANICAL ENGINEERS (Graduates' Association).—At 8 p.m., paper by Mr. G. V. V. Hutchinson, Graduate, on "Locomotive Valve Motions."

JUNIOR INSTITUTION OF ENGINEERS.—At 7.30 p.m., meeting at the Royal United Service Institution, Whitehall; paper on "The Transmission of Power by Belts," by Mr. Reg. F. Krall, Assoc.M.Inst.C.E.

TUESDAY, MARCH 15.

INSTITUTION OF ELECTRICAL ENGINEERS (Manchester Students' Section).—At the Municipal School of Technology, at 7.30 p.m., "A Modern Telephone Exchange," by Mr. J. P. Garner and Mr. R. L. Bell, B.Sc.Tech.

WEDNESDAY, MARCH 16.

INSTITUTION OF ELECTRICAL ENGINEERS (Leeds Section).—At the University of Sheffield, at 7.15 p.m., "Electrical Machinery for Iron and Steel Works," by Mr. E. E. Saunders.

INSTITUTION OF ELECTRICAL ENGINEERS (Students' Section).—Meeting at 92, Victoria-street, S.W., at 7.45 p.m.; paper by R. C. Plowman, "Isolated Electrical Plants."

INSTITUTION OF ELECTRICAL ENGINEERS (Yorkshire Section).—At the Department of Applied Science, the University, Sheffield, at 7.15 p.m., "Rating and Testing of Motors for Intermittent Working," by Dr. R. Pahl.

THURSDAY, MARCH 17.

INSTITUTION OF ELECTRICAL ENGINEERS.—At the Institution of Civil Engineers, Great George-street, Westminster, S.W., at 8 p.m., adjourned discussion on Mr. Miles Walker's papers on "Short Circuiting of Large Electric Generators and the Resulting Forces on Armature Windings"; and "The Design of Turbo Field Magnets for A.C. Generators, with Special Reference to Large Units at High Speeds."

INSTITUTION OF NAVAL ARCHITECTS.—At the Royal Society of Arts, Adelphi, W.C., at 7.30 p.m., "Motor Lifeboats for the Royal National Lifeboat Institution," by Mr. J. R. Burnett, and "The Substitution of the Electric Motor for Marine Propulsion," by Mr. W. P. Durtnall.

FRIDAY, MARCH 18.

NORTHAMPTON INSTITUTE ENGINEERING SOCIETY.—At the Institute, "Oxidation of Atmospheric Nitrogen in the Electric Arc," by Mr. S. Field.

SATURDAY, MARCH 19.

ROYAL INSTITUTION OF GREAT BRITAIN.—Albemarle-street, at 3 p.m., "Electric Waves and the Electromagnetic Theory of Light" (Lecture VI.), by Professor Sir J. J. Thomson, F.R.S.

NORTHAMPTON INSTITUTE ENGINEERING SOCIETY.—Visit to the National Physics Laboratory.

JUNIOR INSTITUTION OF ENGINEERS.—At 3 p.m., visit to the New Engineering Laboratory, workshops, etc., of Finsbury Technical College, Leonard-street, City-road.

FACTORIES AND WORKSHOPS.

ELECTRICITY REGULATIONS.

The Chief Inspector of Factories forwards us a copy of a memorandum by H.M. Electrical Inspector of Factories (Form 928), dealing with the Regulations made by the Secretary of State in December, 1908, for the generation, transformation, distribution and use of electrical energy in premises under the Factory Acts. The memorandum is intended to assist occupiers and others in complying with the Regulations by explaining in detail what precautions are required in the case of various types of installations, and in what circumstances exemption may be claimed. The price is 3d., by post, 4d.

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P. & O. BATTI WALLAHS.

FIFTH ANNUAL DINNER.

All the elements of genial sociality were evidenced at the fifth annual dinner of the P. & O. Batti-Wallah's Society at the Holborn Restaurant, London, on Saturday evening. The interesting occasion brought together a large company of members and friends, and a number of ladies graced the proceedings by their presence. The Past President, Mr. L. M. Waterhouse, presided in characteristically happy fashion, and among others present were Mrs. Waterhouse, Mr. C. L. Lichtenberg (President), Mr. F. B. Joseph, Mr. T. Drewry (Chief Engineer of the P. & O. S.N. Co.), Mr. Elmhirst (Chief Electrical Engineer of the P. & O. S.N. Co.), Mr. Newton Russell (Electrical Engineer, Shoreditch), etc. After a *recherche* repast the gathering settled down to harmony and conviviality. Several appropriate toasts were interspersed in the delightful musical programme, the speeches being commendably brief and to the point. Proposing "Success to the P. & O. S.N. Co., Ltd.," the Chairman remarked on recent electrical developments in connection with the company's services. He had heard that the Marconi system was being rapidly fitted on the new boats. Electric fans were now largely used in the bigger boats for ventilation and connection with the refrigerators. He hoped that shortly the committee would be able to arrange, with the co-operation of the company, for another visit to one of the latest ocean greyhounds. The "Batti-Wallahs," he continued, took a great deal of pride in their Society. At the first dinner at which he had the pleasure of occupying the chair they had about 37 members. Thanks in a large measure to their energetic hon. secretary, Mr. J. F. Avila, the membership roll now totalled 163, and they hoped very shortly to double that number.

First responding, Mr. T. Drewry, one of the earliest P. & O. "Batti-Wallahs," remarked on the high position which the P. & O. occupied in the way of safety and comfort to passengers, and attention to the thousand and one details which they met in ocean travel. That had been brought about very largely by the members of that Society. Every new ship came out with more electrical appliances, the latest thing he had seen in this direction being a patent electrical steering gear. He was bound to say from the way in which the model worked that it was as near perfection as they could possibly get it.

Mr. Elmhirst, whose name was also associated with the sentiment, expressed the opinion that in course of time ships would be fitted entirely with electrically driven pumps. The "Batti-Wallah" was always a glutton for work: the more he had of it the better he liked it, and the more he liked those who gave it to him. Although they had more gear in the ships the trouble experienced was proportionately less than in the old days. They were getting better gear altogether, and he thought that was accounted for by the fact that so many old seagoing men had given their attention to the requirements of ships, and were turning out infinitely better gear than was provided for them 20 or 25 years ago.

Mr. Newton Russell, in the regretted absence of Mr. W. Slade Olver, proposed, in felicitous terms, "The President and Officers," and Mr. Lichtenberg, who responded, noted the continued success of the Society.

Other toasts included those of "The Ladies," introduced by Mr. F. B. Joseph and acknowledged in a charming little speech by Mrs. Waterhouse, and "The Visitors," submitted by Mr. R. G. Simpson, and replied to by Mr. Price.

The honours of the musical portion of the programme were shared by Miss Annie Bartle, Miss Mary Strangeways, Mr. James Davis, Mr. Walter Walters, Mr. Will Bentley, and Mr. Joseph, the last-named by special request giving a fine rendering of "The Batti-Wallah." Mr. Harry H. Heap was at the piano. The function proved a brilliant success, and Mr. Avila, hon. sec., and Mr. R. J. Elmhirst, assistant hon. sec., are to be congratulated on the admirable arrangements.

MUNICIPAL TRAMWAYS' ASSOCIATION.—The Tramways Committee of the Bradford Corporation have invited the Association to hold their annual conference at Bradford next September.

PERSONAL.

During the consideration of the Electricity Bill, Mr. Frank Rawson, C.M.G., Agent and Manager of the Calcutta Electric Supply Corporation, will join the Viceroy's Council as "additional expert-member."

On retiring from the London managership of the Western Electric Co., Ltd., Mr. J. E. Kingsbury, who had held the post with conspicuous success for the past 27 years, was presented with a solid silver rose-bowl and cigar-case by the staff.

Mr. C. S. Anderson, M.I.M.E.E., electrician on the staff of the Shibbottle Colliery, Northumberland, has passed the Under-Manager's Examination held at Newcastle.

Mr. E. Greenhalgh, who has been in the London district for the Hart Accumulator Co., Ltd., takes up the position of Works Manager at W. O. Rooper & Co., Stafford, from Monday next.

Mr. Reginald Keble Morcom, M.I.E.E., a member of the firm of Belliss & Morcom, is a candidate for the Birmingham City Council to fill a seat rendered vacant by the elevation of a councillor to the Aldermanship.

Mr. James Swinburne has retired from the firm of Swinburne, O'Gorman & Baillie. He, and the firm, continue their respective practices at 82, Victoria-street, Westminster.

Mr. Daniel Cowan, Mechanical Superintendent of the Croydon Electricity Works, has been granted an increase of salary, by yearly increments of £10, to £230.

Mr. W. E. Chappell has vacated his position as District Engineer in the Birmingham area of Messrs. The British Westinghouse Electrical & Manufacturing Co., Ltd., to take up (as from March 1) the position of Chief Electrical Engineer to Messrs. The Staveley Coal & Iron Co., Ltd., Chesterfield.

FINANCIAL NOTES.

Messrs. Brain & Brain, of Reading, announce the offer of £900 5% first mortgage debentures of £100 each secured upon the Goring and Streatley Electric Light and Power Undertaking. The debentures will be sold free of brokerage and stamp duty. The price of issue is £92%. The debentures constitute a first charge upon the company's undertaking, and are repayable on March 25, 1929.

The directors of the Silverton Tramway Co., Ltd., have declared an interim dividend of 1s. and a bonus of 1s. per share.

The transfer books and register of members of the Bournemouth and Poole Electricity Supply Co., Ltd., will be closed from the 9th to the 17th inst. inclusive.

For the past year the net profits of the Direct Spanish Telegraph Co. amounted to £13,708, in contrast with £13,086 for the preceding twelve months. The usual dividend of 4% on the Ordinary shares is to be repeated, and £5,000 is again to be allocated to the reserve fund; but the balance carried to the contingencies fund is reduced from £2,501 to £58. The traffic receipts show an increase of £1,087, and the working expenses one of £402, as compared with 1908, despite the fact that revenue was charged with £3,215 as the cost of repairing the Bilbao cable upon two occasions.

Brisbane Electric Tramways Investment Co., Ltd.: Receipts for month of February (by cable)—1910, £15,750; 1909, £13,766; increase, £1,984. Aggregate for two months, 1910, £32,840; 1909, £29,126; increase, £3,714.

ELECTRICAL ENGINEERS TERRITORIALS (London Division).—Orders for week ending 19th inst.: Monday, March 14, "A" Company, Recruits' Infantry Drill, 6 to 7 p.m.; Technical Drill, 7 to 9.30 p.m.; Tuesday, March 15, "B" Company, Technical Drill, 7 to 9.30 p.m.; Wednesday, March 16, Gymnasium, 6.30 to 9.30 p.m.; Thursday, March 17, "C" Company, Technical Drill, 7 to 9.30 p.m.; Friday, March 18, "D" Company, Recruits' Infantry Drill, 6 to 7 p.m.; Technical Drill, 7 to 9.30 p.m.; Saturday, March 19, "D" Company, Week-end Run at Coalhouse Fort: Parade at Fenchurch-street Station, 3.10 p.m.: Dress—Service dress with putties, great coat and haversack to be worn. (Signed) P. H. Campbell, Capt. R.E., Adjutant.

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PATENTS.

Electrical Resistances.

1998.—1909. M. Brull, Paris. A difficulty with electrical starting rheostats of which the elements have a high resistance at normal temperatures, but rapidly decrease in resistance as the temperature rises, so that they act automatically when brought into circuit, is that when one has been operative it requires an appreciable time to resume its normal temperature and resistance. Although, therefore, an element which has become hot may remain in circuit without appreciable loss, if the installation requires frequent startings, it is desirable that it should be cut out by short circuiting it when the starting has been accomplished, so that it may be cool enough for the next starting operation. Automatic devices for this are known, but are inefficient, since the element may not have cooled sufficiently before it is to be used again. This improvement consists of automatic devices for superseding the element which has been in circuit by another when the next starting operation is performed, and also a safety device to prevent the closing of the circuit of a hot resistance. Fig. 1 represents the arrangement for superseding a hot resistance, and Fig. 2 the safety device. In Fig. 1 a bi-polar switch 18 closes the circuit comprising the motor 19 and starting resistance 20. It also controls automatically or mechanically

Fig. 1.

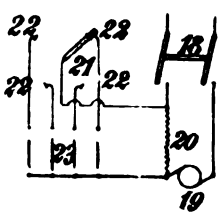
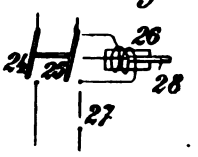


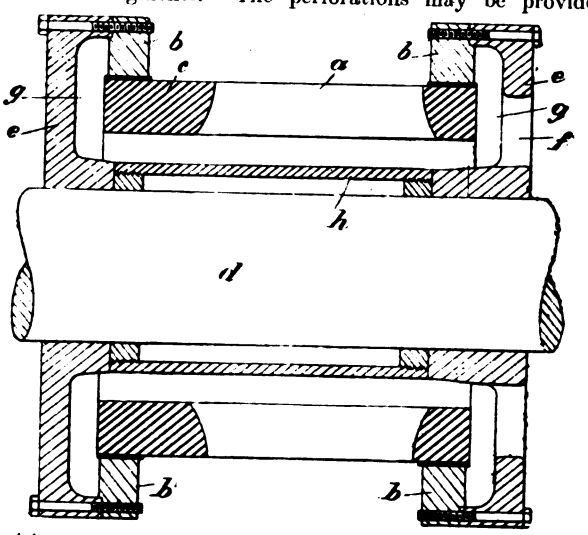
Fig. 2.



the lever 21 of a distributing switch having four contacts 22, in such a manner that whenever switch 18 is opened, switch 21 is advanced through a quarter of a circle. The lever 21 is electrically connected with one terminal of the resistance 20, while the contacts are connected with one terminal of the automatic resistances 23 respectively, the other terminals of the latter being connected together and to the other terminal of the resistance 20. Every time the circuit is opened, therefore, a cold resistance is substituted for that which has just been used. Fig. 2 is a safety device preventing the closing of the circuit of a hot resistance. A bi-polar switch is so arranged that its left-hand pole 24 closes before the right hand pole 25 closes. The effect is to send the current into the high resistance winding of the magnet 26. If the automatic resistance 27 is cold, the magnet 26 is not sufficiently energised to attract its armature 28 : if the element 27 is hot, the armature is attracted and prevents the closing of the pole 25 of the interrupter and, therefore, the closing of the circuit.

Current Collecting Devices for Dynamo Electric Machines.

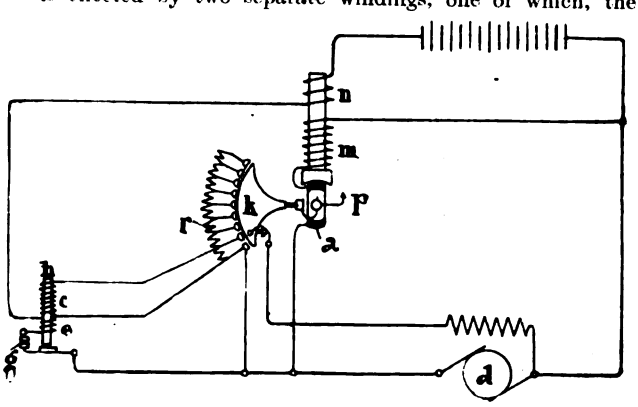
15421.—1909. The British Thomson-Houston Co., Ltd., London. In constructing commutators for dynamo electric machines, and particularly for large machines or those running at a high speed, it has hitherto been considered advisable to support the commutator so that it is free to expand in an axial direction. To this end it has been proposed to support the shrink rings which hold the segments of the commutator together by means of discs which are made so thin between their hubs and peripheries that they are flexible and permit of the expansion of the segments in an axial direction. It has also been proposed, in order to cool commutators of the type in which the segments are provided with dovetailed bases clamped between grooved discs to omit the insulation between the segments except at the ends, and to leave an annular space between the inner edges of the segments and the shaft into which air can pass through apertures formed in the discs or in the shaft. The object of the present improvement is to obviate the necessity of allowing for expansion in commutators of the type in which shrink rings are used to hold the segments in place, and the invention consists in so constructing the commutator that the segments are thoroughly cooled by air drawn or forced in to the underside from one or both ends, and caused to pass out radially between the bars which have spaces left between them to allow of this. The accompanying drawing illustrates a sectional view of a commutator so constructed. The commutator segments *a* are secured together in the usual manner by means of shrink rings *b*. Instead, however, of securing insulation between the segments throughout their length, as is usual, the insulation, except at directly under and in close proximity to the shrink rings, as clearly shown at *c*, thus having narrow slots between the bars through which air can pass. In order to permit of more passing air between the bars, they may be undercut at the points where there is no insulation or tapered towards their inner edges. The end shrink rings *b* and commutator segments *a* are supported concentric with the shaft *d* by means of discs *e*, sufficiently thick to prevent appreciable expansion in an axial direction. These discs are perforated as shown at *f*, so as to permit of the entrance of air to the annular space *g* between the shaft *d* and the inner edges of the commutator segments. The perforations may be provided



with vanes which force the air into the annular space, or the air may be supplied by a separate fan or from a supply under pressure. The discs *e* may be held in position relatively to each other by means of a spacing tube *h* surrounding the shaft. With a commutator so constructed there is no necessity to provide means for allowing for the axial expansion, as the cooling is very efficient, and practically no expansion takes place. The cool air issuing from between the segments in the neighbourhood of the brushes improves commutation and almost entirely eliminates sparking.

Control of Dynamo Electric Machinery in Electric Lighting Installations Worked with Accumulators.

16631.—Aktiengesellschaft Brown, Boveri, et. Cie, Baden. This is an improved method of regulating electric lighting installations worked automatically by means of dynamo electric machinery and accumulators in which the speed of the dynamo may vary within wide limits, and more particularly those in which at a certain pressure the dynamo circuit is closed with an increasing speed or opened with a decreasing speed, and in which action of the dynamo current switch is dependent on an electric regulator or rheostat used for regulating the voltage or pressure and the current intensity. In carrying the invention into effect according to the form illustrated, a Deprez-d'Arsonval coil *a* is used for adjusting the field excitation of the dynamo *d*, which coil is on the one hand subjected to the influence of a mechanical force *p*, and on the other hand to the influence of a magnetic system, the magnetisation of which is effected by two separate windings, one of which, the



winding *m*, is connected in shunt with the dynamo, while the dynamo series current flows through the other coil *n*. The coil adjusts under the influence of these two forces acting in opposite directions directly or indirectly the contact device *k* of the dynamo shunt resistance *r* at any number of revolutions and under any condition as to charge of the battery for such a period until the electrical forces balance the mechanical force. The electro-magnet *h* makes and breaks the dynamo main circuit, and is provided with two separate windings, one of which, the winding *c*, is fed with a partial current of the excitation, whilst the dynamo series current flows through the other winding *e*.

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Should the speed of the dynamo *d* so rise that a voltage is reached which is sufficient for moving the rheostat or regulator out of its initial position by turning the coil *a* in a clockwise direction, then the circuit of the winding *c* of the electro-magnet *h* is cut in at the very commencement by the movement of the rolling sector *k* over the resistance steps. By this means the armature of the electro-magnet *h* is attracted and the dynamo circuit is closed at *g*. Should the charging current, which then flows through the installation, cause a sufficient decrease in the dynamo pressure, owing to the internal drop of pressure in the dynamo, or if no rigid drive be provided, in consequence of a decrease of the speed the electrical forces acting on the regulator decrease in strength to such an extent that the regulator returns into its initial position, thus cutting out the circuit of the winding *c*. This would effect an interruption of the charging current, and an uninterrupted succession of cutting in and cutting out of the dynamo lasting over a considerable period might ensue. The charging current flowing through the winding *e* however holds the switch *h* in the closed position for such a period until that current has approximately reached the zero value, which happens if the number of revolutions of the dynamo has been sufficiently reduced by the drive. This process has the advantage, as compared with others in which the cutting in and cutting out of the charging current is effected by an automatic switch which has to be specially adjusted, that it is not necessary especially to adjust or synchronise two forces, that of the switch and that of the regulator or rheostat, relatively to each other, and in which always greater or less differences occur. A simple adjustment of the regulator or rheostat is sufficient for effecting the cutting in and cutting out of the charging current at the right moment. This method carried out is especially suitable for electric train illuminating systems and for electric installations driven by windmills requiring no real or special adjustment.

Electrical Energy Distribution.

27859.—1908. A. E. TANNER, London. In a system for distributing electrical energy by continuous current, the cable is provided with conducting sheets which are connected to the main conductor and to one another in succession through external resistances so that the conductance through each cylindrical layer of dielectric is such that the stress on the inner surface of each cylindrical layer will be equalised.

Braking Electric Cars.

905.—1909. A. IMBREY, Halifax. This appliance for braking electric tramcars automatically upon the failure of current or the occurrence of an overload of current, consists of an overload and no voltage release switch which automatically opens the trolley circuit and short circuits the motors to apply the brake.

Electric Signs.

1132.—1909. H. JENNER, Manor Park. The object is to connect incandescent lamps in series, parallel or series-parallel, which can be automatically controlled so that a sequence of coloured lamps can be changed as desired. The lights of the whole sign are switched on in one colour. The first lamp of the sign is then changed to another colour, and this substitution goes on lamp by lamp through the whole sign. When the last lamp is changed in colour, the first lamp is again changed, and so on through the whole sign.

Electric Switches.

1662.—1909. E. J. SELBY, Wednesbury. The arrangement of the quick make and break switch enables the same springs to be used to give the quick make and break action in a manner operating each side of a dead centre. The coupler to the contacts has movable conducting extensions which operate on the breaking in such a manner that without them the double action by the springs could not take place.

Alternating Current Electric Machines.

1705.—1909. ALLGEMEINE ELEKTRICITATS GESELLSCHAFT, Berlin. This is a method for the excitation and regulation of alternating current commutator machines excited by the rotor either directly or inductively and arranged as series, constant potential or compound excited machines, which consists in distributing the total working potential upon the externally energised stator and rotor working windings, having regard to the ratios of the effective ampere turns for each working condition in such a manner that the potential between the exciter brushes arranged at right angles to the working brushes becomes a minimum.

Electric Arc Electrodes.

2027.—1909. BRITISH THOMSON-HOUSTON CO., LTD., London. The electrodes are composed of two or more metallic oxides, one of which is titanium oxide. The constituents are melted together into a homogeneous mass, allowed to solidify, and then finally powdered. The powder is filled into a tube and formed into electrodes without a binding material.

Electrical Insulating Material.

2127.—1909. BRITISH THOMSON-HOUSTON CO., LTD., London. The new insulating material is formed by mixing silica with an excess of calcium hydrate. The mixture is pressed into shape and treated with dry steam under pressure. The material is then exposed to the action of a reagent capable of combining with the calcium hydrate to form a stable compound.

Electric Mercury Switches.

15854.—1909. SIEMENS BROS. & CO., Westminster. This is an improvement in electric switches operated by a vehicle passing along a railway, and consists in connecting the supplementary reservoir with the main reservoir through a passage controlled by a valve which allows mercury to flow from the supplementary into the main reservoir, but not in the reverse direction.

Current Collector for Vehicles.

26347.—1909. W. KOHLER, Bremen. The current collector is for use with vehicles that run without a track, and is adapted for wires arranged vertically one above the other, and having contact rollers pressed against the wires from the outside. The upper contact consists of two rollers, one behind the other, and made to turn about a vertical axis. The inventor provides a further improvement in the propulsion of this class of vehicle (26348—1909). In order to increase the extent of the free travel, the pulley which carries the conductor cable is connected with a second pulley upon which a rope is wound under tension of a spring, when the cable is unwound, and *vice versa*.

Current Collectors.

26807.—1909. W. KOHLER, Bremen. In order to allow the connecting cable in overhead conductor systems to be quickly lengthened or shortened for the purpose of enabling the vehicle to have free movement so as to prevent collision, a spring member in the form of a loop consisting of two pivoted arms, the free ends of which are connected with the current collector and the cable, and with a central spring is provided.

Exchange of Current Collectors.

26808.—1909. W. KOHLER, Bremen. The portion of the conducting cable carried on the vehicle extends through a guide pipe and terminates in the socket which is to receive the plug connected with the portion of the cable attached to the current collector. The guide pipe is pivoted on the roof of the vehicle above the driver, and is held in the working position by a lever which ends in a handle above the driver. By pulling the handle the driver can lower the guide pipe so that the plug and socket come within his reach, and thus facilitates the necessary exchange of current collectors when two vehicles meet.

Carbon Holders in Magneto Ignition Apparatus.

27103.—1909. R. BOSCH, Stuttgart. This is an improved method of fixing carbon holders, and consists in placing the insulating substance in the metal support of the carbon holder, while the substance is in a plastic condition, and fixing it in position by subsequent vulcanisation.

Electric Lighting of Vehicles.

27937.—1909. H. GROB, Zurich. This is a controlling apparatus for electrically lighting vehicles, and is set in operation by a centrifugal governor which, when running at a given speed, shifts an eccentric sleeve along its axis, and thus repels in each of its two extreme positions one of the arms of a two-armed lever, and, consequently, reverses the switch contacts. The eccentric sleeve need only release an arrestment of the switching lever, the remaining portion of the switching out motion is effected automatically.

Dynamos.

29376.—1909. The secondary member of this alternating current induction motor is provided with a polyphase winding, the terminals of which are connected to an independent polyphase exciter machine. The independent machine receives energy from or supplies energy to the secondary winding as desired.

Overhead Traction Conductors.

28024.—1909. SIEMENS BROS., London. The supporting cable is tensioned to rotatable brackets, and the overhead conductor is connected to the supporting cable, rigidly or without substantial play at its middle points between any two posts.

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TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns per week.			Increase or decrease.		Miles of track open.		Accounts for past year.						Cost per car mile.
	Ending	1909-10.	1908-9.	Week.	Current year.	1909.	1908.	Ending	Total receipts.	Passengers carried.	Car miles run.	Receipts per Passenger.	Car mile.	Mile of track.	
		£	£	£	£				£						
Aberdeen Corporation	Mar. 2	1,244	1,196	+ 47	— 828	27½	27½	May 31	71,930	17,517,304	1,566,119	·98	11·02	4,940,	5·93
Ayr Corporation	Sept. 18	671	562	+ 108	—	8	8	—	—	—	—	—	—	—	—
Baker Street and Waterloo Ry.	Nov.	8,141	6,070	+2,071	—	4·25	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	Feb. 27	984	1,011	— 27	+ 33	24·003	13·52	—	—	—	—	—	—	—	—
Birmingham Corporation	Feb. 26	6,692	6,151	+ 541	—	56·792	58·52	—	—	—	—	—	—	—	—
Blackburn Corporation	Oct. 6	1,100	1,293	— 173	— 1,036	24·53	28·3	—	—	—	—	—	—	—	—
Blackpool Corporation	Aug. 26	2,152	2,050	+ 102	+ 782	—	—	—	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams	„ 8	2,304	2,309	— 24	—	—	—	—	—	—	—	—	—	—	—
Bolton Corporation	Oct. 10	2,416	2,337	+ 79	— 259	42	42	Mar. 31	117,799	25,492,902	2,492,147	1·1	11·84	2,804	6·50
Bournemouth Corporation	July 21	1,681	1,723	— 42	— 23	29½	29½	„ 31	86,225	13,991,328	1,766,068	1·47	11·71	2,912	7·22
Bradford Corporation	Feb. 26	4,646	4,246	+ 400	+ 9,376	98	54·81	„ 31	235,258	47,839,569	5,331,007	1·17	10·59	2,378	—
Brighton Corporation	Feb. 27	740	609	+ 131	+ 2,297	9·5	—	—	—	—	—	—	—	—	—
Bristol Tramway Company	Mar. 4	5,307	4,332	+ 975	—	57	51½	Dec. 31	265,362	46,652,389	5,756,842	—	—	—	—
Burnley Corporation	Mar. 5	1,231	1,037	+ 194	—	19½	19½	Mar. 31	64,261	12,355,958	1,202,330	1·23	12·83	5,971	7·92
Burton Corporation	Mar. 6	247	228	+ 19	— 38	6½	6½	„ 31	14,918	3,221,595	430,913	1·04	8·30	1,460	5·85
Cardiff Corporation	April 3	2,000	1,957	+ 43	—	—	—	„ 31	109,979	25,058,146	2,497,169	—	10·57	—	—
Carlisle Tramways Company	June 19	170	175	— 5	— 89	—	—	—	—	—	—	—	—	—	—
Central London Railway	Mar. 5	5,666	5,633	+ 33	— 559	6·32	6·32	Dec. 31	350,150	41,898,373	1,456,781	2·01	5·769	55,404	30·27a
Charing X, Euston, & Hamp. Ry.	Nov.	6,822	6,092	+ 730	—	7·75	—	—	—	—	—	—	—	—	—
City and South London Railway	Mar. 6	3,391	3,609	— 218	— 635	7·26	7·26	—	—	—	—	—	—	—	—
Colchester Corporation	July 14	200	219	— 39	—	8	—	Mar. 31	10,983	2,308,721	349,539	1·09	7·74	1,477	6·56
Cork E. T. and L. Company	Mar. 3	414	354	+ 60	+ 99	9·89	9·89	Dec. 31	24,044	5,737,478	896,945	—	6·43	—	4·43
Croydon Corporation	Feb. 18	1,494	1,192	+ 302	+ 8,242	11½	—	Mar. 31	74,132	16,277,418	1,884,137	1·06	9·56	3,703	7·109
Darwen Corporation	Oct. 1	239	256	— 17	— 201	7·23	7·23	„ 31	13,899	2,557,654	245,584	1·30	13·68	1,922	9·40
Dover Corporation	Sept. 18	230	252	— 22	— 395	7	—	„ 31	11,593	2,697,672	316,754	·98	8·78	—	—
Dublin and Lucan Electric Ry.	Mar. 4	109	93	+ 16	— 65	7	7	—	—	—	—	—	—	—	—
Dublin U.T.	Mar. 4	4,937	4,284	+ 653	+ 1,418	54½	54½	—	—	—	—	—	—	—	—
Dundee City Tramways	Oct. 6	1,332	1,305	— 27	— 569	—	26½	May 15	60,573	16,367,911	1,281,552	·875	1·9	2,371	7·46
East Ham Corporation	Mar. 5	992	746	+ 246	+ 5,628	15	15	Mar. 31	47,430	15,355,703	1,091,586	·73	10·26	—	6·96
Glasgow Corporation	Feb. 26	16,778	16,288	+ 490	— 6,092	189	185	May 31	907,494	226,948,290	20,766,722	·96	10·49	5,080	5·89
Gloucester Corporation	Oct. 6	395	425	— 30	+ 535	15	—	—	—	—	—	—	—	—	—
G.N., Piccadilly and Brompton	Nov.	13,429	9,354	+ 4,075	—	9·25	—	—	—	—	—	—	—	—	—
Halifax Corporation	—	—	—	—	—	52·574	37	Mar. 31	81,872	20,378,672	1,786,390	11·40	11·13	1,528	8·40
Huddersfield Corporation	Dec. 4	1,613	1,357	+ 256	+ 2,663	28	28½	„ 31	84,704	16,200,020	1,960,329	1·29	10·37	2,421	5·10
Hull Corporation	Mar. 5	2,699	2,323	+ 376	+ 7,015	29	26	„ 31	128,722	30,964,254	3,022,844	1·	10·22	—	6·04
Ilford Corporation	Feb. 12	451	391	+ 60	+ 1,969	10	10½	„ 31	25,328	6,385,466	634,446	·87	9·58	2,066	6·42
Ilkeston Corporation	Mar. 2	124	113	+ 11	+ 239	4	4	„ 31	7,214	1,968,850	198,415	9·1	7·9	1,803	7·04
Kirkcaldy Corporation	Sept. 5	259	266	— 7	—	7½	7½	May 15	14,993	4,874,199	459,066	·711	7·838	1,856	5·26
Lancashire United Tramways	Mar. 2	1,198	1,081	+ 117	+ 90	39	39	Dec. 31	68,904	12,554,593	2,244,344	—	—	—	—
Leeds Corporation	Sept. 18	6,896	6,624	+ 272	+ 3,662	108	96½	Mar. 31	340,368	75,784,083	7,694,989	1·06	10·62	3,527	5·51
Leicester Corporation	Sept. 11	2,162	2,130	+ 32	—	—	—	—	—	—	—	—	—	—	—
Liverpool Corporation	Nov. 6	10,803	10,687	+ 116	— 1,977	109	104	Dec. 31	572,822	124,043,239	12,231,799	1·108	11·24	5,508	7·94
Liverpool Overhead Railway	Feb 27	1,235	1,265	— 30	— 289	6·65	2·40	June 30	79,004	11,171,515	1,106,386	—	—	—	—
London County Council	Feb. 19	38,431	32,846	+ 5,585	+ 119924	129½	122½	Mar. 31	1,274,660	279,166,461	25,591,028	1·08	11·74	—	6·79
Lowestoft Corporation	Dec. 11	155	150	+ 5	+ 30	3½	—	Sept. 30	11,399	2,645,206	370,320	1·03	7·36	2,279	6·12
Maidstone Corporation	Feb. 26	132	116	+ 16	—	7·4	—	—	—	—	—	—	—	—	—
Manchester Corporation	Sept. 11	15,631	15,297	+ 334	— 2,871	183	181	—	—	—	—	—	—	—	—
Metropolitan District Railway	Mar. 5	10,962	9,439	+ 1,523	+ 9,073	24	24	—	—	—	—	—	—	—	—
Metropolitan Railway	Mar. 6	16,065	15,258	+ 807	+ 5,056	24½	24½	June 30	680,357	99,846,735	—	1·46	—	—	—
Nelson Corporation	Oct. 16	151	131	+ 20	+ 7	2¾	2¾	Mar. 31	7,362	2,060,712	204,740	·85	8·63	1,907	—
Newcastle-on-Tyne Corporation	Feb. 26	3,589	3,726	+ 137	— 1,459	60¼	59¼	„ 31	211,085	46,203,164	4,411,745	1·10	11·48	3,504	6·36
Newport (Mon.) Corporation	Oct. 9	663	638	+ 25	— 311	14½	14½	„ 31	35,531	8,174,003	798,029	1·04	9·89	2,450	7·21
Oldham Corporation	Jan. 24	1,778	1,516	+ 262	— 386	—	—	—	—	—	—	—	—	—	—
Portsmouth Corporation	Oct. 10	2,046	1,809	+ 237	—	28½	28½	Mar. 31	97,741	21,247,048	2,309,439	1·10	10·15	—	4·95
Reading Corporation	Mar. 3	548	472	+ 76	+ 122	13½	13½	„ 31	32,769	7,933,572	915,481	—	8·93	—	—
Rochdale Corporation	Dec. 26	1,240	1,126	+ 114	+ 746	20·9	20·93	„ 31	56,558	10,196,148	1,252,925	1·32	10·83	2,693	6·47
Rotherham Corporation	Feb. 4	555	587	— 32	—	—	—	—	—	—	—	—	—	—	—
Salford Corporation	Sept. 27	4,096	4,662	— 66	— 3,326	78	74½	Mar. 31	244,065	45,771,611	5,486,150	1·25	10·67	3,185	—
Scarborough Tramways Co.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Sheffield Corporation	Feb. 27	5,687	4,946	+ 741	+ 7,004	39⅝	37	Mar. 25	289,745	17,568,686	7,065,380	·896	9·842	4,225	5·04
Southampton Corporation	Feb. 23	945	841	+ 104	+ 359	18	18	„ 25	52,647	10,121,887	1,157,451	1·25	11·33	—	7·20
Southend-on-Sea Corporation	Aug 21	995	557	+ 438	+ 1,483	—	—	—	—	—	—	—	—	—	—
Stockport Corporation	—	—	—	—	—	25	25	Mar. 31	52,004	9,155,172	1,335,911	1·34	9·342	1,830	4·75
Sunderland Corporation	Jan. 27	1,310	1,336	— 26	— 7,984	—	—	—	—	—	—	—	—	—	—
Swindon Corporation	Dec. 11	126	114	+ 12	—	—	—	—	—	—	—	—	—	—	—
Torquay Tramways	Aug. 26	630	647	— 30	—	8·41	—	Dec. 31	15,065	2,880,420	353,297	1·40	1·023	—	—
Wallasey U.D.C.	Mar. 5	814	735	+ 79	+ 908	12·68	12·45	Mar. 31	43,823	8,331,038	891,540	1·2	11·79	3,453	7·72
Warrington Corporation	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
West Ham Corporation	Feb. 24	2,234	2,055	+ 179	+ 7,495	27	14·7	Mar. 31	122,881	35,502,836	2,556,854	·789	10·95	4,417	6·79
Wolverhampton Corporation	Nov. 3	841	823	+ 18	— 206	21½	—	„ 31	44,432	9,440,369	975,714	—	10·929	2,190	6·509

a Train Miles. h Half-year's figures.

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NOTES.

INTERMITTENT WORKING MOTORS.

Rating and testing methods adopted in connection with intermittent working motors, Dr. Robert Pohl contended in his address before the Yorkshire Local Section of the Institution of Electrical Engineers, are not scientific, and he pleaded for the framing by the Institution of definite rules on the rating and testing of electrical machinery. He argued that owing to the fact that it was practically impossible to test machines intended for intermittent working under actual working conditions, a conventional test, generally a short run to test the temperature rise, was adopted. But there are two drawbacks to this. In the first place, a purchaser is not likely to be aware of the relationship between the conventional test and the particular working conditions for which the machine is required, with the result that he may take one too large and expensive, or one of insufficient capacity. Secondly, a manufacturer is apt to be led to favour designs and methods of construction which improve the performance during the specified test, but which do not necessarily persist under working conditions. Having discussed load factor, temperature rise under working conditions, temperature rise after a short-time run, the connection between the temperature rise under working conditions, and that after a short full-load run, and given various formulæ, he came to the conclusion that it is the time constant that is the chief disturbing element. A 10 h.p. motor running at 900 r.p.m. and ¼-load factor had a time constant $T = 1{\cdot}35$, while a 100 h.p. running at 400 r.p.m., gave $T = 3$; even larger variations for the same range of output being found in practice. Dr. Pohl holds that this leads not only to uncertainty on the part of purchasers, but to errors in design, because the tendency is to depend for rating purposes on the heat-storing qualities of a machine. This means that a heavy iron body rather than a light steel frame will be adopted, the weight of other inactive parts also being increased to undesirable extent, the cooling properties being neglected. Now in actual practice the final temperature does not depend on the weight, but on the cooling properties. While, said the lecturer, a ventilated motor is capable of giving a larger output than a totally enclosed one, yet ventilated and enclosed crane motors are often listed as giving equal outputs. So that these short-time tests are both deceptive and conducive to designing on wrong principles.

IDEAL TEST.

Dr. Pohl said that the test adopted should give direct and reliable information on the temperature rise of the machine under working conditions. It must take the load factor duly into account which in every instance is to be specified. The factors which determine the temperature rise during the test should be identical with those on which it depends under working conditions, *i.e.*, the heat dissipating qualities, and the method adopted must thus indirectly lead to the cooling surface, and not the weight being considered the basis of rating. Finally, the test conditions imposed should be capable of being easily complied with by the ordinary testing plant and arrangements of the manufacturer. He suggested test specification should run as follows: "The temperature rise of machines for intermittent working shall be found by subjecting them to a prolonged test consisting of successive periods of running and of rest. The running time to be 10 minutes, the standing time adjusted in accordance with the specified load factor; the duration of the test to be sufficient for the mean temperature to attain a practically constant value. The last run to be of five minutes' duration, immediately after which the temperature is to be measured."

INVENTION AND STANDARDISATION.

At the Birmingham Institution of Electrical Engineers' discussion on Mr. Orsettich's paper dealing with the "Standardisation of Electrical Machines," reported in another column, Mr. A. E. Anderson gave expression to the fear that any attempt to secure uniformity would discourage invention. The notion was rather scoffed at, and justly so, for the countries *par excellence* of standardisation—Germany and America—are just the ones which are most remarkable for the fertility of inventive genius. We do not find that in those countries there is any reluctance on the part of manufacturers to try new things; and to take them up if they are good, scrapping patterns if necessary. Inventors, indeed, are encouraged by the firms in whose employ they are, as the patent lists abundantly testify.

ELECTRICITY IN DOCK EQUIPMENT.

Mr. George H. Baxter, of the Clyde Navigation Trust, in an account of the Glasgow Harbour equipment, gives some striking facts about the steady advance of electricity as a motive power for dock appliances. At the Queen's Dock the coal and other cranes, turntables, capstans, etc., are worked by steam or hydraulic power. At the Prince's Dock there is a combination of hydraulic power and electricity; while at the more modern Rothesay Dock, at Clydebank, all is worked by electricity. Here there are two electric coal hoists capable of raising loads of 32 tons (including weight of cradles) to heights of 50 and 60 feet respectively, tipping, emptying, lowering and running the empty wagons off at a high level inclined railway. An actual test has given the following result: 30 wagons containing 253 tons of coal shipped in 31 minutes 57 seconds. Had the wagons contained 20 tons each, the record would have worked at between 1,000 and 1,100 tons per hour. In connection with these hoists are electric tipping turntables, worked by motors, fitted with automatic safety stops. Electricity is also used for working capstans and moving trains of wagons. Mr. Baxter points out that electricity is a means of saving time and prevents waste of coal and other merchandise during handling.

RAND MINE EQUIPMENT.

We learn that Mr. George Nathan, presiding at the annual general meeting of the West Rand Consolidated Mines at Johannesburg, and then at Rand Collieries Co., spoke in eulogistic terms of the services rendered by electricity. At the gold mines 100 additional stamps are being laid down, and these will be worked by electricity, as well as the whole of the existing stamps, and the compressor and winding engines in the new west shaft. This, together with certain mechanical improvements, will, Mr. Nathan asserts, more than double the average daily duty of the plant. As regards the collieries, the installation of permanent electrical pumps and winding engines are being pushed forward as fast as possible, and in the course of three or four months there will be a very considerable expediting of the hoisting arrangements. This is the news from only two groups of mines, but electrification is going on rapidly all over the field.

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RAILWAY ECONOMIES.

Evidence steadily accumulates as to the great boon that electricity must in the long run prove to railway undertakings. London company reports have been most encouraging, and the Mersey results quite convincing. Prior to electrification that undertaking was altogether in a bad way, and there were not wanting critics who shrugged their shoulders when the British Westinghouse Co. agreed, as part of the electrification scheme, to guarantee interest on the new first perpetual debenture stock and on the redeemable first 4½% debenture stock. But, as soon as the electrification was complete, matters began to mend, and the number of people carried has lept from under eight-and-a-half millions in 1903 to just under fourteen-and-a-half millions in 1909. Even more satisfactory are the concrete results. Three years ago the total receipts were £100,919, and the working expenses £72,785; last year the amounts were respectively £107,591 and £68,261. Notwithstanding this, we find some of the financial papers crying out for the need for caution as regards conversion.

DRIVING OF TEXTILE FACTORIES.

Professor Charnock has once more succeeded in arousing a nice little controversy in Yorkshire and Lancashire. Lecturing before the Bradford Textile Society, he declared: "We seemed in this matter to remain pretty nearly where we were for lack of evidence as to its results. Millowners and managers were not prepared to take mere statements. They must have proof, and, unfortunately, he could not find much proof of any of the claims put forward in its favour." Taken to task in the local press, he qualified his statement as follows: "As a matter of fact, I had previously demonstrated the advantages of electrical transmission under certain circumstances, as agreed upon at the very first. The statement in question was intended to apply to the claim of an increase in the production of from 5 to 10%, accompanied at the same time by an improvement in quality equal in value to an additional 2½%, and of this claim I am not aware that any proof has yet been forthcoming." Thereupon Mr. Thomas Roles, Bradford city electrical engineer, promptly took up the challenge. He pointed out that the Acme Spinning Co., whose mill at Pendlebury was the first to adopt the electric drive in this country, and other pioneers, were somewhat loth to give publicity to results obtained after their expenditure of time and money. Others, however, are following on in this path, and information is now rather more easily obtained.

EXAMPLES.

Mr. Roles quotes several cogent examples. For instance, the Brunswick Mill of the Bannerman Mills Co., Ltd., Bradford-road, Manchester, of which Mr. C. W. Macara, the well-known president of the English Federation of Master Cotton Spinners' Associations and of the International Federation of Master Cotton Spinners' and Manufacturers' Associations, is managing director, was originally driven by two steam engines, one being a two-crank beam engine and the other a single-crank horizontal engine, the combined horse-power being 1,600 i.h.p. After exhaustive investigations had been made, it was decided to place the continuity of the running of the mill in the hands of an outside source of power, and the whole of the mill is now driven by electricity supplied from the mains of the Manchester Corporation electricity department. Then Mr. D. Pearson (of Pearson & Co., cotton spinners), in giving evidence before a Local Government Board inquiry into an application for a loan to extend the electricity works at Bury, said his firm were users of electricity for motor power. They had experience of gas, steam, and electricity, and they were in favour of electricity. They contemplated putting in two more motors. It had proved very successful so far. His firm were cotton spinners, and they had five motors, totalling 140 h.p. Their experience was that with electric driving there were fewer breakages and more production. The driving was steadier, and he thought as the cost was reduced there would be many more users among cotton manufacturers in Bury. His firm had 140 h.p. steam, 140 h.p. electricity, and 70 h.p. gas. Next, Mr. W. B. Woodhouse recalls to us that from tests made at Messrs. Thomas Rhodes, Ltd., Mersey Mills, at Hollingworth, they state "they are entirely satisfied with the results of the electrical driving," and that "the regularity of turning, which was the particular point aimed at, is all that could be desired." Further, "the production of yarn on the spindles driven electrically has been increased by about 6%, and the yarn produced is of a very superior quality." Incidentally, the adoption of electrical driving has permitted, owing to the changes which have been possible, a considerable increase in the machinery in the mill and an increase "of over 26% in production has been secured."

PROGRESS OF FACTORY ELECTRIFICATION.

One example came under Mr. Role's personal observation. This was a mill in which at the present time a small number of fly frames are being driven by an electric motor supplied with current from the Bradford Corporation's mains. Previously the drive was obtained from a beam engine. He has been definitely informed by a responsible official of the firm in question that as much yarn is now being obtained from the spindle at 2,000 r.p.m. as was previously obtained when the same were running at 2,180 r.p.m. He had not, however, received permission to state the name of the firm in question. Clearly, as he states: "The fact that during the past five years electrical driving to the extent of 50,000 b.h.p. in alternating current induction motors alone has been installed in the United Kingdom, of which 20,000 b.h.p. are driven by current supplied from outside sources, gives some idea of the headway which is being made by the new system."

RATING OF UNDERGROUND CABLES.

Mr. H. Richardson, borough electrical engineer, of Dundee, has raised an important point for his Committee and the Town Council. He has asked that early steps should be taken to place the Electricity Department on the same basis as others in the matter of rating underground works. The gas works receives 75% reduction on their pipes, while the underground works of the Electricity Department, costing some £100,000, only receive a rebate of 25%. It is understood that a clause remedying this injustice is to be tacked on to the Provisional Order which is now being promoted by the Corporation. But the whole question of taxation and rating requires thorough revision. Some months ago we pointed out how unfairly the instructions issued by the Inland Revenue regulating assessment for income-tax bore on electrical enterprises—lighting, power and traction.

SHIP PROPULSION.

At the Institution of Naval Architects, Mr. W. P. Durtnall once more returned to that subject which he has made peculiarly his own—the electrical propulsion of ships. It is a big topic, upon which there is always much to be said. Certainly Mr. Durtnall's information on big units will be new. He treats of equipments varying from 830 shaft h.p., with combined reciprocating engines exhausting into high-speed exhaust turbines, driving non-synchronous three-phase generators, to similar electrical lay-outs suitable for high-speed war and other vessels, with four shafts each driven by 11,700 h.p. motors, will be news to the generality. But Mr. Durtnall has chapter and verse for all that he advances in this special direction of high power, safe equipment, and his paper, which we hope to publish next week, should prove stimulating reading, opening up, as it does, such vast possibilities.

GIBRALTAR UNDER WATER SIGNALS.

The new signalling system with bells under the straits is now in operation. It corresponds to a long-felt want on the part of large mail and freight steamers passing between Spain and Africa. It is expected that the bells will contribute greatly to the safety of vessels passing in foggy weather through the straits.

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LARGE UNITS AT HIGH SPEEDS.

By MILES WALKER, M.I.E.E.

Two carefully prepared papers on "Short-circuiting of large electric generators and the resulting forces on armature windings," and "The design of turbo field magnets for alternate-current generators, with special reference to large units at high speeds," were read by Mr. Miles Walker, M.I.E.E., before the Institution of Electrical Engineers, London, on the 10th inst. The first paper dealt with the currents which flow when large electric generators are short-circuited. Oscillograph records were given showing the current which flows when a 5,500 kw. generator is short-circuited at its terminals. The forces operating on armature windings were approximately calculated, and the methods adopted by various designers to support armature windings were illustrated. The phenomena accompanying the short-circuiting of direct-current generators and rotary converters were also considered, and oscillograms given showing the current on short circuit and the voltage rise across the circuit breaker. In the second paper the author re-opened the controversy between the salient pole type of field magnet and the cylindrical type. Reasons were given why the latter type is better suited for obtaining the greatest possible output from a given diameter. The methods adopted by various makers of supporting the windings were described, and the possible limits of output considered. The chief conclusions of the author were dealt with in the last issue of THE ELECTRICAL ENGINEER.

DISCUSSION.

Mr. W. A. Chamer: I am more than usually interested in Mr. Miles Walker's observations, because I have a 3,000 kw. alternator designed by him. Although we had the misfortune to have one or two short circuits, and have been rather alarmed, and the noise and dust, which comes from the alternator, making one think it is smoking, we have never had a breakdown. I think that speaks volumes, particularly when I tell you I believe it is the first two-pole alternator of 3,000 kw. capacity running at 1,500 r.p.m. There are plenty of instances of four-pole machines, but I have never been able to find another two-pole machine of that size. As Mr. Miles Walker says, the strains on two-pole machines are very much greater. The strains in our case seem to have been remarkable. We knew before the alternator was put in that we had these strains to deal with, and I took some trouble to look into the clampings and fixings that were to be adopted. I found that the inch studs holding the clamps had been bent in various directions, and the coils themselves had got pushed out of place, but no breakage of the insulation or anything of that kind has resulted. Of course, we feel that something further is required, and after the most careful investigation which Mr. Miles Walker has made, I have the very greatest confidence he will succeed in putting our alternator in such a condition that even these movements cannot take place. A gentleman in another part of the country told me that his firm had made clampings for their alternators that nothing short of a miracle would cause the coils to move. I have not seen the clampings, but they must be very much stronger than those used by us. The reference to leaping cables reminds one of what happened in the days of the underground mains with copper strips. I might mention that at Glasgow I prevented trouble by making all my cables concentric. Also in Glasgow I had a case where in starting up a three-wire installation of a new type something went wrong at the generating station. Two dynamos were run up in such a way that the three-wire system instead of working in the proper way was working with the middle wire as another return for the two others, and all the street lights were out. Not wishing to stop the supply—it was rather late at night—I had arranged for the wrong side to be switched suddenly out and then transferred on to the right side by means of a battery. I switched off the dynamo and switched on the battery, and, at the instant of doing that, one of the cables broke down. There was no reason why it should be broken down except the surge. It was found that there was a constructive fault in the cable, but evidently at the moment of switching off or of putting on the reverse current—I think now it was the former—the cable broke down. I think that was exactly a case in point like Mr. Miles Walker's.

Professor Silvanus P. Thompson: This paper, like one that was recently read by Mr. Hope Jones before the Institution, shows what a valuable tool of research in every branch of electrical engineering the oscillograph has proved itself to be. Thanks to the oscillograph, we know more of what happens on big short-circuiting than we did before and, knowing what happens, we have the best means for preventing accidents occurring as the result of such short-circuiting. The arguments in the first paper about the amount of the enormous rise of current at the moment of short-circuiting recall to some of us the troubles experienced years ago in central stations using alternating generators, even with much smaller sizes, before these things had become matters of almost every-day occurrence. In those days when a short-circuit occurred it was a most terrible thing, because it upset the whole station. I remember discussing years ago in the old station of the City of London Electric Lighting Co. the effect of a breakdown of some of Mr. Mordey's earlier form of alternators, which were then the last new thing. At that time I expressed the opinion that the force acting on the conductors in short-circuit must have been such as to demonstrate that the short-circuit current was from 20 to 30 times the ordinary full-load current. That opinion was hotly disputed, not so much by Mr. Mordey, but by Mr. Rayworth, who stoutly maintained it was not more than two or three times the normal full load. I never was able quite satisfactorily in my own mind to explain the discrepancy till I saw Mr. Miles Walker's paper. It is evident now that the demagnetising effect of the short-circuit current has not time to come into play during the moment of short circuit, and therefore, because the field magnets have not time to become magnetised, the short-circuit current is, as he says, 20 or 30 or even more times as great as the normal full-load current. Another point of some interest is the reference to the re-action which occurs in those alternators which have laminated field magnets, where as there is no eddy current around to take up the burden, the re-action pumps itself into the exciting circuit, and the exciting current does its best to recover the situation. At the beginning of the second paper the author told us—and we smile at the publishing of it—that the proper thing was to fill the entire space of the rota with iron and, secondly, to fill the entire space with copper, each requiring as much space as it could get. Then he gave us a picture of an unrealisable ideal—a four-pole rota, with the copper in the right place, but impossible from a mechanical point of view. The author spoke about his compensated windings which he explained some years ago in a paper, the importance of which the world has not yet understood. I wish he would give us something more about the way in which he is able to adapt the winding in slots to the protection of the compensated winding which has so many virtues. It is no small gain to be able to increase the specific loading of the armature in the way Mr. Miles Walker has been able to do. One is accustomed in ordinary construction to say that the output limit of a specific load of an armature was something of the order of 600 and, possibly, 650 ampere-wires per inch of periphery. Now we go all of a sudden up to 1,000, and we are told that is not the limit—we may go further and yet not have such an amount of distortion or demagnetisation to make the machine a badly regulated one. It is a very remarkable result, and, if it is due to a particular form of rota which he suggests or prefers and to the compensating winding, it marks a real advance. The author emphasises quite rightly the advantage of not having ripples in the electro-motive force, which, he says, is a matter of commercial importance. Why should there be any ripples providing you take advantage of what is perfectly well known—that even comparatively strongly marked ripples may be smoothed out by not having slots in armature exactly parallel with those with the rota? I know it will add to the construction of very small machines, but it will control the ripple troubles.

Mr. H. M. Hobart: The author tells us that with one machine which he used the poles were slotted, and in that case the cross currents of the exciting circuit, instead of rising from the instant of the sudden short circuit,

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decreased at first; and that in the case of a machine with laminated field circuit that the current increased from the moment of short-circuiting in the exciting circuit. Six years ago I tested six 5,000 kw. machines for this effect. The pole shoes in this instance were laminated and the magnet cores were slotted. The current in the exciting circuit increased from the instant of short-circuiting. The machines were in some way very different from those tested by the author. In the case of my machines, the current rose to something like two or three times the value. It suggested to me that the whole phenomena could be removed by putting in a field circuiting cut-out at the part when the current was 50% more than the normal exciting current. The specification for the machines required "for the generator, when running at full speed and rated load, shall be able to withstand a short circuit at its terminals without displacing its windings or occasioning other mechanical injuries in any part of the generators." All withstood the test perfectly. The tests were by a rough commercial standpoint. We made tests with the oscillograph and the ripples, but what was most remarkable to me was the lasting proclivities of this current.

Mr. J. S. Cooper: The problem of clamping windings has come into prominence in connection with large turbo alternators. It is connected with open v-Clued slots. In America open-slot winding very easy to clamp has been developed. Open slots are also connected with field windings, but ripples are not so serious in the case of two and four-pole generators where gap is large. If it is desired to push turbo designs at highest speeds to the limit, mechanical strength becomes of great importance. Keying or dovetailing on poles or poletops must introduce a source of weakness. The forged steel field has been developed in America in a very remarkable way. The shaft hole is being done away with by making forgings in two or three pieces, the end ones being forged up with the shaft. The whole is held by longitudinal bolts. In two-pole fields the shaft introduces weakness, and limits winding space. The idea is to cut it out and wind right across the disc much larger than machines which would be built by many English firms. At any rate, they are much larger than machines would be built with laminated field construction with windings sunk in slots in the periphery. The test of this type of construction is that machines have been actually built in America for 3,600 r.p.m., giving an output of between 2,000 and 3,000 kw. This, of course, has not been approached in England, because, I think, central stations would not look at it. There is a reverse side to the medal, and that is that the machines are very suited for turbo construction.

At this stage the discussion was adjourned.

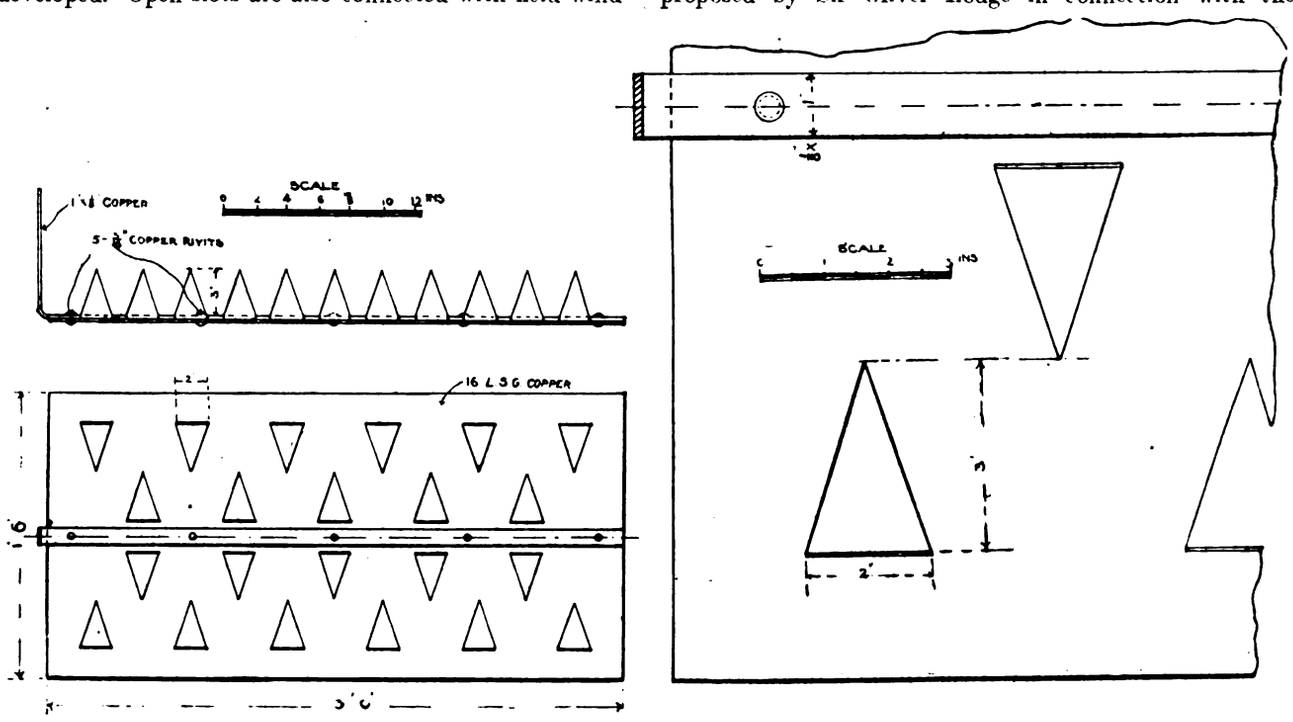
EARTH PLATES FOR LIGHTNING CONDUCTORS.

The London County Council has, during the last three years, been in the habit of using an earth plate in connection with lightning conductors, in which tongues are cut and bent outwards to form a number of points at which any discharge may more readily take place.

A sketch is attached showing the arrangement in detail for earth plates, 3ft. by 1ft. 6 in. It was the custom until recently to use two such earth plates with a branching tape; this has recently been modified, and one plate 3 ft. square only is now used, the specification for which is as follows:—

"The earth plate to be of copper, No. 16 gauge; the conductor to be riveted and soldered the full length of the plate; the joints to be thoroughuly washed free of acid and protected by a thick coat of tar; each plate to have four rows of triangular tongues formed out of the plate itself—two outer rows of six and two inner rows of five—so that the tips of tongues in adjacent rows point in opposite directions, each tongue 3in. long and tapering from 2 in. to a point: the tongues to be bent at right angles and point upwards when the earth plates are laid in position."

The loose earth or wood charcoal is filled in and well rammed on to the top of this plate. It will be noticed that the plate possesses the characteristics of that recently proposed by Sir Oliver Lodge in connection with the Elan Valley works protection from lightning scheme.



L.C.C. LIGHTNING CONDUCTOR EARTH PLATES.

It is interesting to quote here the rule as to earthing in the Phœnix Fire Office Rules, for the erection of lightning conductors, which have just been issued. Great stress is laid on the damp condition of the earth. "The earth connection," we are told, "should be made either by means of a copper plate buried in damp earth, or by the tubular earth system, or by connection to the water mains." "Church spires, high towers, factory chimneys, etc., having two down conductors, should have two earths, which may be inter-connected." We are next told that "If a copper plate is used it should not be less than 3 sq. ft. in area and not less than one-eighth in. thick, and rectangular in shape, with saw edges and surrounded with broken coke or graphite. If coke is used it must be thoroughly washed to eliminate any sulphur which may destroy the copper. The conductor should be firmly attached so as to make a permanent mechanical, and electrical, joint.

"The earth connections should be kept at least 12 ft. from gas mains.

"The use of copper plate is not recommended unless it can be sunk into the earth at such a depth as to ensure it always being in water or in moist earth.

"The tubular earth system is as follows, and is recommended for use where the ground cannot be disturbed for burying a plate, or where permanent moisture is at

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a considerable depth. A perforated pipe, furnished with a steel spike is driven into the ground until it reaches moisture, and then lengthened up to the surface, to a casting which marks the position of the earth. The copper conductor is enclosed in the pipe, and carried to the bottom of the tube which is packed with granulated carbon. A connection is made by means of an iron or lead pipe to the nearest rain-water pipe, so that a small quantity of rain is diverted to insure moisture, or a similar pipe may be opened up into a funnel shape at the surface of the ground, so that rain will enter, or water can be poured down.

"Where conditions permit connection to a water main, that is a satisfactory plan, provided that the main is not insulated by hydrant joints, or periodically disconnected."

CENTRAL STATIONS *V.* ISOLATED PLANTS FOR TEXTILE MILLS.*

By CHARLES T. MAIN.

Textile mills are in the business of manufacturing tops, yarns, cloth, carpets, or some other product for the market. The production of power required is an incident or detail, and usually the cost of power does not exceed 5% of the value of the product. In selecting a location for a new mill it is important carefully to consider the source and cost of power—and in estimating the value of a mill already existing—but the power is only one item for consideration and it should not be allowed to play too important a part in the decision.

The chief items of cost entering into the product of a textile mill are usually materials and labour. It is, therefore, more important to locate in some place where skilled operatives in the particular kind of business to be carried on can be obtained at reasonable wages, or where there can be obtained help who can be trained, and where the cost of transportation of raw materials and finished products is relatively a small amount, than it is to seek a location where cheap power can be obtained but where the other items are lacking. A saving of 10% in the cost of power would represent a saving of not over one-half of 1% in the cost of the product. The relative importance of locating a plant with reference to cheap power increases as the ratio of the cost of power to the value of the product increases.

Most of the earlier mills were located on rivers, and it was due to such water powers as were developed on the Merrimac, Connecticut, Blackstone and other rivers that the manufacturing cities were begun along their banks.

Most of these powers within reasonable reach in New England have been outgrown, and now there is found in some of the manufacturing centres a great preponderance of steam power over water power. New centres of manufacturing on tidewater have grown up which have little or no water power, but which can obtain cheap coal and low rates for transportation, and some of the most prosperous mills are driven by steam power.

In recent years the transmission of power by electricity has made it possible to locate the mills more advantageously for construction, light, railroad facilities, etc., and has made valuable water powers which, on account of their location, were hitherto valueless, and has enabled the construction of central steam plants to be located at the mouth of the mines or at tidewater where cheap fuel can be obtained.

Items in Cost of Power.

It can be said generally that the cost of producing power may be divided into two parts:

1. *Independent charges,* or the part which is independent of the output, embracing fixed charges on the plant—as interest, depreciation, insurance, and taxes, and, to a certain extent, repairs.

2. *Proportional charges,* or the part which is proportional to the output, including such charges as coal, labour, supplies, etc.

In general, steam plants may be said to have low independent charges, and high proportional or operating costs.

Water-power plants are usually the reverse, with high fixed charge accounts and low operating costs.

* Paper read before the American Institute of Electrical Engineers.

Another item which should be mentioned as affecting the cost of power is the "reliability-factor," which takes into consideration the spare machinery needed to insure continuous service. The charges on this spare equipment are apt to have quite a bearing on the cost of power in a central station supplying power for sale, where reliability must be one of the chief considerations, and more spare or duplicate plant is usually maintained than in a private plant.

Factors Affecting the Cost of Power.

The chief conditions which affect the cost of steam power, are as follows:

1. Cost of fuel delivered to the furnaces.
2. Amount of power produced.
3. The load-factor in its relation to fixed charges, whether the power is continuous and uniform, or intermittent and variable.
4. The net cost of power is reduced considerably in some concerns where the waste heat of the power plant can be used in the manufacturing processes in the form of low-pressure steam or warm water.

The chief conditions which affect the cost of water power are as follows:

1. Fixed charges on the development.
2. Amount of power produced in its relation to fixed charges.
3. The load-factor in its relation to efficiency of wheels, pondage, and reservoir capacity.
4. The cost of supplementary power necessary to make up for the fluctuations of the water power, if required.

Variation in Cost of Steam Power.

Steam power costs the most per unit of power when produced in small amounts. The cost is increased for fluctuating loads, and when used for purposes where the load-factor is small. By load-factor in this instance is meant the average output in per cent. of the full capacity of the plant.

Steam power costs the least per unit of power for comparatively steady continuous loads, as for paper mills and other similar industries; and the cost may be still further reduced where there is use for exhaust steam or other by-products from the plant. Such conditions as the last are found in colour textile mills. Power costs the most in plants having a low load-factor with a variable load, and where there is no use for the by products of the plant, as in a lighting or street railway plant.

Textile mills usually run about 10 hours a day, and have a comparatively low load-factor, but while the load is on, it is usually fairly steady. Public service plants usually have a load-factor somewhat lower than that in textile mills but the load is variable, which is not so favourable to economical operation as the textile load would be.

So far as we know, the net cost of steam power is the least, and the net value of water power also the least, for colour textile mills of any of the important industries. This is due to the usually steady load and to the fact that the waste products from the steam plant are valuable for manufacturing purposes to those industries.

The net cost of steam power for textile mills gradually increases from the costs to the mill, which can use all of the waste products which will have the lowest cost, to the case of mills making white goods, where only exhaust steam for warming the building and drying the yarn in the slashers can be used. In order to give a general idea of the usual costs of power under ordinary conditions in this section of the country, an analysis of the cost of power for a station of 2,000 kw. capacity is given below. This station is similar to some which have been constructed within the last few years.

As electric drive is becoming so common in textile mills, we will assume for the basis of these costs that the stations considered below will be electric, and of 2,000 kw. capacity, composed of two 1,000 kw. units. Usually, there is no spare apparatus in these plants. This may be considered as fair average practice at present for textile plants, but would not be tolerated for public service plants where reliability is necessary.

In making up the cost of power, all charges have been considered except the interest charges and taxes on the

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cost of land. These are usually not large items in textile mills, and are variable. The cost of land for the station has also been omitted from the cost per kilowatt of the station.

In making up these costs, interest has been taken at 5% depreciation and repairs on the apparatus for 10-hour power at 5% and on the building at 2·5% insurance, and taxes at 1%, making a total of 11% on the apparatus, and 8·5% on the building. For 24-hour power, the depreciation and repairs on apparauts is increased 2%, thus making the total charge 13% instead of 11%. A small amount is added in both cases for incidentals.

These rates of depreciation would not be proper for a station where the manufacture of current was the main product, as for a public service plant, for newer and more efficient types of apparatus would make it necessary to discard apparatus which was mechanically good. This course would not be so necessary in a manufacturing plant where the saving of a small percentage of the cost of power is not of such vital importance as are some other considerations.

With a steam engine plant, with direct-connected generators, the cost of the plant per kilowatt of capacity is about £25.

The cost of power from this station with coal at about 17s. a long ton, in the pocket, would be about £6 12s. per kw. per year of 3,000 hours, as a straight power proposition. This is equivalent to about £4 16s. per electrical horse power per year, and about £4 6s. per indicated horse power per year. This would be a cost of $\frac{11}{20}$d. per kw.-hour.

If steam turbines are used instead of steam engines, the cost of the station will be reduced to about £21 per kw. capacity.

The cost of power produced on steam turbines would also be reduced to about £5 18s. per kw.-year against £6 12s. for the engine plant. A part of this difference is made up from the reduced cost of the station and apparatus, and a part from the better economy of the turbines which we have assumed are using the superheated steam and high vacuum which is common practice.

If steam power were to be generated for 24 hours a day for 6 days in a week, or, say, 300 days a year, as for a paper mill and a few of the textile mills, the cost of power would be about £11 10s. per kw. per year for the engine plant, and about £10 12s. per kw. per year for the turbine plant.

The difference in the cost for the two kinds of power is due to the fact that practically the same amount of fixed charges is spread over a much greater number of kw. hours. There is also some saving in coal due to the elimination of banking of fires for a large portion of the time.

For industrial plants, under consideration, the load is nearly constant throughout the operating time, which means good operating conditions.

Public Service Plants.

In a public service plant, even with the same load-factor as for the 10-hour textile mill which would be high for most of these plants, the operation conditions would not be so favourable as in a textile mill, as about the same amount of banking would have to be done, and the prime movers would have to operate at variable loads. This latter undesirable feature would not be so serious in a large station as in a smaller one, so far as the efficiency is concerned, as the variation could be more nearly cared for by varying the number of units, and thus operating all of them at advantageous points.

The cost of power for this type of plant is more, other things being equal, than for a plant of the same size for a textile mill having the same load-factor. This is due to the effect of variable load towards a reduction in efficiency, and because of the greater cost of plant and consequent greater fixed charges per unit of output.

It should be borne in mind, however, that these public service plants are usually of very large size, and that their output delivered has to compete in price with the cost of power from very small stations. This would give the advantage all to the central station as far as the actual cost of making power is concerned. To the cost of making the power, the central station must add the cost of transmitting, distributing, and selling it.

These additional costs probably form a very large part of the total cost to the purchase of the power. The distribution of power in a city is expensive, meters must be read, accounts kept, bills collected, etc. So that while a central station may deliver a kw.-hour at the switchboard for less than a ½d. it can hardly afford to sell it for that.

Some years ago, the manager of some large public service properties testified that the cost of power to a plant of this type could not be more than one-quarter of the gross income. A representative of another company made the statement recently that it cost his company more to meter the current for their smallest customers than it did to generate it.

Effect of Use of Waste Products from Power Plant for Manufacturing Purposes.

It has been common practice for many years to use the by-products, such as exhaust steam and warm water, from the steam plant for manufacturing purposes, and for heating buildings, etc. It has been also very common practice to take steam out of the receiver, between the cylinders of a compound engine, for these purposes. In many mills all of the exhaust of simple non-condensing engines is used for manufacturing purposes.

The saving from using the exhaust of a non-condensing engine which would otherwise go to waste, is large, because there is no additional steam required for the engine, unless the back pressure is increased. Any use of the steam is nearly all clear profit, and if all of it is used the only part left to charge to power is the difference in B.T.U. due to the difference in pressure, and the condensation in the engine cylinder and jackets.

There seems to be no good reason why in time the practice of bleeding turbines should not become as common as bleeding engine receivers.

Receiver Steam.

Table I. shows the amount of coal chargeable to power when certain percentages of the steam entering the high pressure cylinder are taken out of the receiver. This table takes into consideration the effects on the economy of the engine of not passing all of the steam into the low-pressure cylinder, cylinder condensation, etc. The percentages in the first column are the percentages of the steam passing the high-pressure cylinder which is taken out of the receiver for manufacturing purposes. The second column is the total coal burned, and the third is the coal chargeable to power after deducting the coal chargeable to manufacturing.

Table I.

Per cent. of exhaust steam used for heating purposes.	Pounds of coal per 1 h.p. per hour. All coal charged to power.	Net pounds of coal per 1 h.p. per hour after deducting for exhaust steam used.
0	1·75	1·75
25	2·06	1·50
50	2·38	1·25
75	2·69	1·00
100	3·00	0·75

If the mill did not obtain its power from steam, so that it could use the low pressure steam of the plant for manufacturing, it would have to maintain a boiler plant of sufficient size to produce an amount of steam equivalent to that bled out of the receiver. The amount of B.T.U. or its equivalent in coal chargeable to power is represented by the amount of work done by the engine, and the losses due to the presence of the engine. The cost of generating the rest of the steam is chargeable to the manufacturing processes.

Examples of Manufacturing Plants.

A few examples of the reduction in cost of power due to the uses of the by-products from the steam engine plant, and the bleeding of steam from the receiver may be of interest.

In one coloured cotton and silk mill, the power to run the mill was about 1,800 indicated horse power, and for

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manufacturing purposes about 25% of the steam for this was required in the form of steam from the receiver.

Assuming the cost of power £6 12s. per kilowatt-year with no bleeding, the cost chargeable to power with 25% bled continuously is £5 19s. The saving is 13s. per kilowatt-year. This was for the use of low-pressure steam alone. Probably another material saving could be made by using the overflow from the condenser for water for dyeing purposes.

In another mill, where much more dyeing was done, requiring a large quantity of hot water, also a large amount of exhaust steam for manufacturing and heating, the cost of power if no steam and waste products had been used, would have been about £6 16s. per kilowatt-year, but when the proper credits had been allowed for items chargeable to manufacturing purposes, the cost was reduced to about £5 4s. per kilowatt-year, or a reduction of about £1 12s. per kilowatt-year.

In a plain or white goods mill, where no steam would be required for manufacturing, other than warming the building and slashing, the saving to be effected by using receiver steam for those purposes, would be about 8s. per kilowatt.

About three-fifths of this, or 4s. 10d., is for heating, and the rest for slashing; so about 4s. 10d. per kilowatt is the amount of the reduction which could be made in heating the buildings of an industry similar to a textile mill.

There are a few plants run by simple non-condensing engines exhausting into the dye-house, and if the dye-house is running full there is very little change in the boiler room whether the engine is running or not.

There is one plant run by a single non-condensing and a cross-compound engine. The exhaust from the simple engine and the condensing water from the compound engine are all used in the dyeing, finishing, and heating. The net cost of coal for power under the two last conditions is small.

In one mill which is run wholly by water power about 12,000 tons of coal are burned annually for dyeing, finishing, and heating the buildings. If a portion or all of this mill had been run by steam power, the waste products of the steam plant would have furnished a portion of the heat required for manufacturing purposes.

The above are fair examples of the requirements in textile mills.

The Cost of Water Power.

The cost of water power depends upon a great variety of factors, but the essential feature is usually the fact as to whether the combined result of all these factors is such as to make the cost of the development per horse power delivered, a reasonably small amount, so that the fixed charges shall not be excessive. In other words, the allowable cost of water power cannot be materially more than the net cost of producing the same amount of power for the same purpose in some other satisfactory manner, usually by steam.

The cost of maintaining and operating a supplementary steam plant to make up for the shortage of power during low water, flood periods, etc., must be carefully considered as it affects the actual cost of power delivered from the hydraulic plant.

For the reason that water powers usually have high independent charges, they are more valuable for use on loads with high load factors than with low load factors, and hence are more valuable for 24 hour power than for 10 hour power.

Many of the modern developments are of very large size, and the cost per horse power of the plant is in some cases small. In the determination of the cost of power, the cost per horse power of development should not be allowed to confuse or cause misrepresentation of the actual cost of power delivered. Usually the larger the development installed, the smaller is the cost per horse power of development, but it does not follow in all cases that the cost of delivered power will be smaller per horse power.

There are usually more elements of chance and more unknown factors in a hydraulic development than in a steam plant, and these facts should be taken into consideration and properly cared for. It is the lack of consideration of some of these items that has caused some of the water power developments to get into disrepute.

On the other hand, a development properly made and at a reasonable cost is a valuable asset, and one which bids fair to increase in value if the price of coal increases in the future as in the past.

Variation in Value of Water Power.

The value of a hydroelectric power to various industries will vary in approximately the same ratio as the cost of producing power in some other way, if considered as power, pure and simple, without taking into consideration other important items affecting the business, which are sometimes more vital than the cost of the power itself.

To illustrate the value and cost of power under different conditions, it may be well to mention the two following cases:

A price for hydroelectric power was submitted to a colour textile mill, of $\frac{3}{5}$d. per kw. hour. After due consideration, it was decided that the mill could not afford to accept the offer, the principal reasons being:

1. On account of the use of steam for manufacturing purposes and of the water of condensation for dyeing, the net cost of steam power would be less than the price of hydroelectric power.

2. It was considered better for the textile company to own and control its own plant, if it had the capital to build it, than to purchase current brought over many miles of pole line, and be tied up to some foreign company.

The cost of power per kilowatt at the switchboard from the hydroelectric company for the operating time of the mill was about £7 4s. per kw. year; and for the steam plant which the mill was proposing so instal, this cost was estimated at about £6 16s. per kw. year, but if the power had been bought from the hydroelectric company, the mill would have had to instal and operate a boiler plant nearly as large as the one required for both power and manufacturing.

It was estimated that the use of the waste products from the steam plant would reduce the net cost of the power at least £1 12s. per kw.

In another case an offer from a hydroelectric company was made to furnish power at $\frac{3}{5}$d. per kw. hour, the same price that was refused by the colour textile mill. For a plain cotton mill it was decided proper to accept the offer. The principal reasons for accepting it were:

1. $\frac{3}{5}$d. per kw. hour—about £7 4s. a kw. year, or £5 8s. on electric horse power delivered. This reduced back to 1 h.p. equals about £4 14s. per year, which was very near the estimated cost of steam power for the quantity required and at the price of coal for this particular industry.

2. The mill desired to postpone the expenditure necessary for a steam plant, if it could be done without serious loss.

Central Station Built by Mills.

Steam central station plants for the distribution of power to textile mills are being built and operated by the mills themselves to considerable extent, because it is acknowledged that a central station of large capacity can be run at less expense than several isolated plants, if considered for power only, without considering the other uses for steam and warm water. It is doubtful, however, if a central plant located at such a distance for the manufacturing processes as to make it necessary to forego the saving which can be made by the use of the waste product of the steam plant can be run as economically as several scattered plants from which low pressure steam and condenser water can be made of use. In some plants, it becomes a necessity to abandon this advantage owing to the growth of the plant and the necessity of separating the power plant from the mill.

Other advantages may be derived by the concentration of plants which warrant the change.

Nearly all of the recently built concentrated plants are for electrical transmission.

Hydroelectric Station.

There are comparatively few hydroelectric plants owned by other corporations which are supplying textile mills in the North with a portion of all the power required by them.

The reasons for this are as follows:

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Power costs more and can be sold at a greater price.

The power plants of textile mills are usually of a sufficient size to make them fairly efficient in fuel economy and fairly cheap to run in other respects.

There is usually no large amount of reserve machinery as the service is not severe, and as it is owned and controlled by the company itself, it can take some chances which could not be taken by a power company furnishing power to the mill.

The power plant is one of the items that goes to make up the whole plant, and is so considered. It is usually of very little trouble or care to the manager, and requires no additional salaries outside of the ordinary engineers.

The item of depreciation is not so great as it is in a central power station, for in the mill the cost of power is a small percentage of the value of the product, and there is not the necessity of change so frequently in order to get the utmost economy that there is in a power station whose product is power only.

With the mill plant, there are no large charges to be made to transmission costs and losses, to selling and metering the power, to franchises, administration, and other charges which are necessary and common to central power stations.

The most favourably situated and least expensive hydroelectric developments can make power and distribute it, and sell it to plain textile mills at prices which will be attractive, but it will be quite difficult to sell at prices low enough to compete with the net cost of power to the colour textile mills which use their steam power to the greatest advantages from power and manufacturing processes.

Surplus power which can be furnished for less than the whole year must be sold at low prices, as the mill must maintain its steam plant for emergency use and run it when necessary, thus adding to the cost of purchased power the fixed charges on the steam plant, and such operating costs as may be met from time to time.

In this section of the country but few of the textile mills have purchased power from any central station either steam or hydroelectric, but in the South it is not uncommon practice for the mill to purchase hydroelectric power.

Some of the reasons for this are as follows:

Most of the mills in the North are older than those in the South, and were built previously to the time of electrical transmission of power. They were, therefore, equipped with their own power plant, either water or steam, or both, and having made the investment, there is not the incentive to change, whereas a new plant might save considerable investment in power plant by the purchase of power.

Most of the Southern mills are plain white mills, requiring no large amount of steam for dyeing and finishing, and requiring also less steam for heating the mills.

The mills of the North average larger in size than those in the South, and the larger the plant, the less the cost of power per horse power, other things being equal.

As a rule, the Northern manufacturers are more accustomed to the supervision of their power plants.

Central Steam Power Plants Owned by Other Interests.

There are still fewer textile mills purchasing current from central steam plants, and the reasons for this are the same as stated for the hydroelectric stations.

The central station men claim that the mills do not know how much steam power is costing them. This may be true, in many instances, but not in all. The larger mills know the cost pretty closely.

Advantages to Purchasers of Electric Power.

Some of the advantages to the purchaser are as follows:

In a new enterprise, in which the power plant has not already been constructed, there will be required less investment for the power plant with the purchase of current, than if the power is produced by the company itself, and the manufacturing company will have more capital for other uses in its business.

Less space will be required on account of the omission of the power plant, and perhaps a better arrangement of buildings can be made on that account.

There will be less care to the managers of the mill if the power is purchased than if it is produced by the mill, but in a textile mill this does not usually seem to be very serious.

The company is enabled to postpone the introduction of a power plant until some later date, and in that way is able to take advantage of any improvements in power plant equipment which might be brought about during the time that current was purchased.

For the above reasons, I should expect that a mill would be willing to pay something more than the bare cost of power if the power were purchased from outside, but the mill should determine what the net cost would be from its own power plant, taking into consideration not only the cost of power, but also the saving due to the use of low pressure steam and warm water for manufacturing purposes.

If power is purchased, there must usually be added the cost of running a boiler plant at the mill for heating and manufacturing purposes in making the comparison with the combined plant at the mill for power, heating, and manufacturing purposes.

For the above reasons, the central station will have difficulty in contracting with large textile mills for power, except under the most advantageous conditions for the central station and the most disadvantageous conditions for the textile mill.

STORAGE BATTERIES AND ELECTRIC VEHICLES.*

By JULIAN WALTON, of the Edison Electric Illuminating Co., Brooklyn.

[In view of the constantly growing use of electric motor vehicles, and the opening thus afforded for the sale of current for charging accumulators, both by electric appliance dealers and central stations, the paper printed below is opportune, giving many practical hints.—Ed.]

Considerable dissatisfaction exists among some users of electric vehicles, due to the fact that these vehicles have not met their expectations or for some reason have failed to prove profitable. This is due to a very large extent to inexperience on the part of the owner of the car and his failure to appreciate the necessity for the proper care of batteries. Recent investigations into the electric vehicle conditions in Brooklyn, have shown that 95% of all cases of dissatisfaction have been due to the behaviour of the storage batteries.

Before going into conditions as they have been found, it might be well to state that the campaign of education has to deal with far more than the proper methods of charging batteries. The need, more than anything else, is to impress thoroughly on the users of electric vehicles the importance of keeping the electrolyte of their batteries free form impurities, as this is really the principal cause of battery failure. In diagnosing battery troubles, all failures are too apt to be attributed to overcharging or sulphating. In fact, there are few other well-known reasons for explaining the failure of batteries, these two causes being held responsible for buckling, growing, excessive shedding of active material, loss of capacity, etc.

Overcharging and abnormal sulphation are usually secondary evils which are caused by the introduction of impurities in the electrolyte.

In order to make the above statement clear to all, it will be necessary to cite the case of a new battery which, say, has a capacity sufficient to propel a vehicle thirty-five miles. This mileage has been accomplished and the owner of the vehicle grows to expect it each day from his battery. The specific gravity of the battery has to be equalised, and the water lost by evaporation replaced. This the attendant is ordered to do. He consults his instruction book and finds he must use distilled water, but he has none at hand. He reasons that hydrant water is good enough to drink and therefore it is good enough for the battery. In it goes, carrying with it many impurities, which begin their work on the plates and down goes the capacity of the battery. The owner, knowing that previously the battery had been of sufficient capacity to propel the vehicle thirty-five miles, endeavours to do so again. He no longer has his original

* Abstract of paper read before the Brooklyn Section of the National Electric Light Association.

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capacity, consequently, before he realises it, he has discharged his battery below the 1·8 volt mark, and has formed this excessive and insoluble sulphate.

He comes back to the garage and accuses the attendant of not having charged the battery thoroughly, and orders him to give the battery a long overcharge. The instructions are carried out, but the owner is surprised to find that this has restored but little of the lost capacity. He then decides to continue overcharging and finally, though he does not appreciate the fact, these impurities become oxidised, if they happen to be of a chemical nature, and become a lead-attacking agent. This change in their nature may cause an increase in the capacity of the battery, but this is soon overcome by the rapid deteriorating effect produced. This is a simple illustration of the effect of an impurity in the electrolyte, and may seem somewhat exaggerated, but it is typical of the care which most vehicle batteries receive. Actual conditions as shown, by investigations, are even worse than this assumed case.

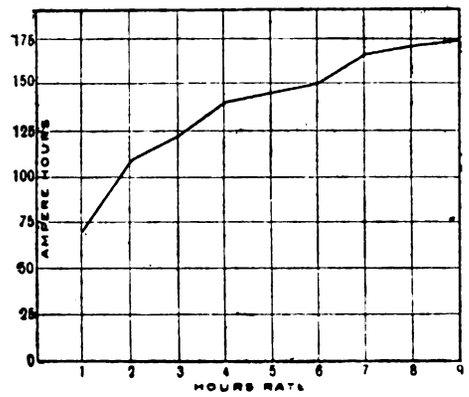

FIG. 1.—DISCHARGE CURVE OF OVERWORKED BATTERY.—*A*. NORMAL DISCHARGE OF RATE OF BATTERY; *B*. AMPERES DRAW CLAIMED BY MANUFACTURER.

In most cases where it has been found that hydrant water has been used, those in charge, when questioned, have invariably replied that it is distilled water. This explains how vehicle owners are sometimes deceived. An instance is recorded of a concern operating a large number of electric vehicles who were advised by a so-called battery expert in their employ, that Brooklyn water was even better than distilled water for their batteries. The management has since complained of short life from its cells.

The following may serve to illustrate some of the results due to improper handling: A lady owning a runabout, ordered a new battery built to replace the one which had failed. The garage man building this battery assembled the plates in their cells ready for the developing charge. Instead of using proper lead connectors to connect the cells, copper wire was wrapped from one terminal post to the other throughout the entire battery. The acid attacked these wires and formed a heavy copper sulphate, which was carelessly allowed to fall into the cells. When inspected, the negative plates were found to be copper-plated with a heavy coat of pure metallic copper. When attention was called to this fact, the builder made the statement that copper could do no possible harm, as long as it remained on the negative plates. It has since been learned that this battery is rapidly losing capacity and requires an enormous amount of overcharge to bring it to a condition where a satisfactory mileage can be obtained.

A similar case was caused by the gross neglect of the manufacturer. The battery was equipped with copper connectors in such a way that the copper was carried into the electrolyte. This battery failed in two months, the cause being attributed by the manufacturer to improper charging by the garage attendants. This shows the misrepresentations sometimes resorted to by the manufacturers themselves.

A garage keeper caring for several batteries had realised the importance of using distilled water in them and for reasons of economy bought his water in large quantities. He purchased several carboys of the water, and in order to return the emply carboys and collect the deposit, had the water emptied into an old corroded gasoline drum. When a sample of the water was taken for analysis, it was found to be mud-coloured, yet he was using it in all of his batteries, and was at a loss to explain why the plates deteriorated so rapidly and would not remain charged. It was also noted that an iron pipe was used for removing samples of acid from the cells for testing the specific gravity.

One case was found where acid of 1,500 specific gravity was used for replacing the water lost by evaporation, the attendant believing that he was using distilled water. This man could not understand why the specific gravity was so high.

In all probability these conditions are not alone confined to Brooklyn; in fact, a case was noted in England, where the purchaser received his battery, which had been shipped assembled, but without electrolyte. He had instructions to use pure sulphuric acid of 1·165 specific gravity. He had no sulphuric acid, so made use of common vinegar, and when the battery failed, he rushed it back to the factory, claiming that it was defective.

Knowing the above conditions exist, central stations should take immediate steps to remedy them, if the standard of the electric vehicle is to be raised. This necessitates a campaign of education. As a general rule, those who attend to batteries, especially the electric-vehicle type, have little conception of the treatment the batteries should receive. They ignore the instructions given by the manufacturer, or fail to comply with them for lack of sufficient knowledge of either electrical or chemical matters to appreciate what they mean. It is, therefore, useless to undertake to explain such matters in a technical manner, so that they may be impressed upon the garage man's mind. More satisfactory results can be obtained by imparting information by means of simple, but forcible illustrations, tending to show the importance of keeping the batteries clean and the electrolyte as free as possible from impurities, either chemical or metallic.

Very frequently plates going through the washing process are carelessly handled and set on concrete to dry. This concrete contains an abundance of iron and other impurities which plates will pick up and carry back to the cells. A good method to demonstrate this would be as follows: Take a sample of acid which tests free from iron; place a clean, dry wood-separator on the concrete floor, and pour some of the acid upon it; also pour some of the acid directly on the concrete floor. Then, by applying any iron test, it can readily be seen that there is no iron present in the acid on the wood separator, while the dense discolouration of that on the concrete floor will clearly

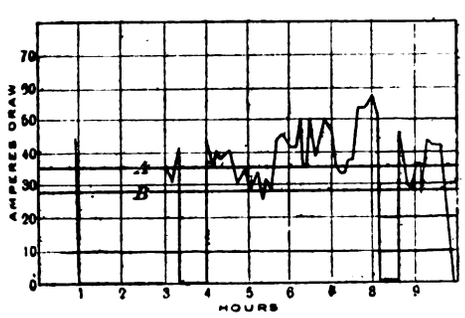

FIG. 2.—SHOWING REDUCTION IN CAPACITY OF OVERWORKED BATTERY.

show the presence of iron. A simple demonstration of this kind invariably leads to a better understanding of the care necessary for the proper handling of batteries and plates.

Another simple and effective method of demonstrating the importance of keeping foreign metals and their oxides or sulphates from entering into the batteries, is to take any two dissimilar metals, or preferably any metal common around the place, and a clean piece of lead. Place the two on a board and drop a few drops of sulphuric acid between them, and by means of a low-reading voltmeter show the difference of potential, and explain that this is what takes place in the cells. Caution users to be careful with burning irons, and not allow any foreign metal to come in contact with the plates of electrolyte. Instances have been recorded where iron tweezers have been used for removing foreign particles from a cell, and also where a

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battery engineer from one of the large battery works used his pocket knife to scrape sulphate from battery plates, also to test their hardness.

These remarks will apply to storage batteries in any class of work. Central-station batteries are in some instances neglected fully as much as the vehicle battery. Manufacturers should co-operate with one another and standardise their instructions. In many instances the manufacturer advocates the use of distilled water to prevent the introduction of impurities into the electrolyte; yet one vehicle-manufacturing concern advises the washing of batteries with a soda or ammonia solution!

An instance may be cited of a man who, in his endeavour to find enlightenment about the storage battery, had consulted a very old text-book, and was actually adding to his batteries sodium compounds, to prevent sulphating. Another case was that of an undertaker who thought he could improve his batteries by adding embalming fluid to the electrolyte.

Vehicle manufacturers should also pay as much attention to the battery requisite in the design of their vehicles as to the vehicles themselves. More attention should be paid to the discharge rates under which the battery works best. The curve (Fig. 1) will serve to illustrate how the battery is abused in this respect.

The data are taken from the actual working of one of the late model vehicles. The entire machine, just previous to the test, was thoroughly overhauled and put in first-class condition. Here, the manufacturer adapted a battery to his vehicle which was called upon to do its work at a rate far in excess of that claimed by its manufacturers, to be consistent or efficient. Owing to conditions under which vehicles have to operate, it is impossible to determine a constant or even maximum rate at which a battery will have to deliver its energy. By giving the battery more consideration as a part of the equipment in the design of the vehicle, these conditions can no doubt be improved.

Some battery manufacturers have decreased the number of cells per battery, without increasing their ampere-hour capacity. When the vehicle is intended for high speed service, the horse-power required will be the same as it is in the 44-cell equipment; consequently the watts required being the same in the two equipments, the ampere discharge rates will be inversely proportional to the number of cells. As the 44-cell battery from which the data for the curve (Fig. 1) were obtained shows excessive discharge rates, it can therefore be readily understood that the battery with a lower number of cells would be discharged at a dangerously high rate. Pleasure vehicles are frequently equipped with a battery which has a normal, or 4-hour discharge rate of from 28 to 35 amperes. These vehicles when operated on high speeds actually draw from 75 to 120 amperes from the battery.

Besides the extra wear and tear produced by these abnormal discharge rates, the curve (Fig. 2) shows how the total capacity is reduced.

Manufacturers should lay stress on the fact that a battery must not be discharged below 1·8 volts per cell, rather than claiming and advertising their vehicles to cover a certain number of miles per charge. No doubt low-discharge voltages are responsible for a great deal of loss of capacity in the vehicle battery. A battery may receive the best attention as far as charging and maintaining its electrolyte pure are concerned, but discharge this battery below 1·8 volts per cell and it may lose from 10 to 35% of its original capacity. This is due to the fact that an insoluble sulphate is formed after the cells are discharged below this point, and no subsequent overcharges will decompose this sulphate or restore the lost capacity.

If vehicle manufacturers insist upon claiming a maximum mileage for their vehicles, they should thoroughly advise the operator and familiarise him with all conditions which are liable to alter or prevent vehicles from accomplishing this maximum mileage, such as soft roads, hills or grades, soft ashphalt and largely temperatures.

In conclusion, it might be well to correct any impression that might have been formed that the storage battery is a delicate piece of apparatus or one which requires constant or expert attention. In reality, there are few, if any, electrical or mechanical machines which will do their work as effectively and require as little attention as the storage battery, It responds automatically to its lightest or heaviest loads.

Pay attention to its details and give it systematic attention, and the dissatisfaction which now exists will be eliminated.

INDIAN MINE EQUIPMENT.

We learn that Messrs. John Taylor & Sons, of the Kolar Gold Field Mines, have ordered an 800 h.p. electric main winding unit from Messrs. The Lahmeyer Electrical Co. This unit will be used to drive a converted steam winder, and the motor will be run off a three-phase 3,300 volt 25-cycle circuit. This will be the sixth electric winding unit supplied by the Lahmeyer people to the Kolar Gold Field, the other five being equipped with 350 h.p. motors. Four of these have been at work for about two years, and have given every satisfaction.

The same enterprise is being shown in connection with the coal fields. After maturely considering the question, the Raneegunge Coal Association and the Indian Collieries Syndicate came to the conclusion that a large measure of electrification was advisable, and it was decided to introduce electricity in their Alkusa, Kustore and Jamadoba Coal Mines. The contract for installation was given to the Electrical Department of the Russa Engineering Works, Ltd., through their Calcutta agents, Messrs. Milburn & Co. The contract for machinery was given to the General Electric Co., but part of the plant is being constructed by the British Thomson-Houston Co., Ltd., of Rugby, while the compound double acting high speed engines are being supplied by Messrs. Belliss & Morcom. At the Kustore Mines the engine is fitted with "V" type slide valves, runs at a speed of 375 r.p.m., and is coupled to a B.T.H. 3-phase alternating current generator, with an output of 200 kw. at 2,300 volt. It is so balanced that working with a power factor of 80%, it can sustain a 25% overload for two hours, and a sudden overload of 50%. Transformers will be used at various points to reduce the current for operating motors to 500 volt. These transformers, manufactured by the General Electric Co. at Witton, were illustrated in our issue of February 11 on page 167, special modifications having been introduced to meet local needs. It is understood that the equipment at the other mines will be, if anything, on a still bigger scale, and this is likely to lead to the adoption of electricity in many other quarters.

CHINESE PROGRESS.

The British Commercial Attaché in Peking says that the importation of electric lighting installations is on the increase. He adds: "Amongst others, electric light was installed at Antung, the plant being of British manufacture imported from Japan; the British Concession at Chinkiang was supplied with light by the native electric light company already lighting the Chinese city; an electric light company was formed with a small capital to light a new street at Chengtu, the capital of Szechuan, and contracted for an installation which may be extended if successful; electric lighting was started on a small scale at Chungking in June, 1908, with plant purchased from the United Kingdom through a British firm at Shanghai, and this year tenders from various firms were being considered for a large plant to light the whole city; the electric light company at Swatow was reconstructed with a capital of $140,000, and new engines ordered from Europe for relighting the town in July, 1909; a Chinese electric light company formed two or three years ago at Wuhu commenced operations in April, 1909, with 3,000 lamps, but with plant sufficient for 6,000 16-candle lamps —machinery mostly of British manufacture. The electric light company and the water-works company at Hankow imported over £260,000 worth of fittings direct from the United Kingdom in 1908; and the extensive electric lighting systems already at work at Shanghai, Canton, Tientsin and Peking continued to extend their operations. Electric lighting at Newchwang begins this year, and a project for lighting Amoy was mooted in 1908, but failed for want of capital."

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STEEL PRODUCTION.

In spite of the native reluctance to take up new methods, there is evidence that the electric furnace for the smelting of ores, and especially the production of steel, is gaining a footing in England. This was somewhat amusingly exemplified recently in Sheffield, when Mr. Gerald Hooghwinkel discoursed before the local Society of Engineers and Metallurgists on the place of the electric furnace in the iron and steel industry. One of the most caustic critics was Mr. C. K. Everett, who flatly declined to attach any importance to the ringing of the death knell of the crucible furnace, yet, as the President, Mr. J. R. Hoyle, did not fail to point out, the very firm with which Mr. Everett is associated are putting down an electric furnace. Although probably the electrical engineer would prefer to see the method taken up with enthusiasm, the gaining over of half-hearted doubters and the watching of the new furnaces' working by sceptics is not altogether a bad thing for ultimate success. Clearly, however, this attitude of doubt must not be persisted in too long. As Mr. Hooghwinkel showed, electric furnace practice is being adopted on a large scale both in Germany and America, with the result that steel can be produced at a low rate and of unvarying quality. He might have said that Belgium is not behind the times in this matter, and, naturally, Sweden and Norway are well to the fore. The Jörnkontoret, of Stockholm, representing a combination of Swedish ironmasters, is about to build a Grönwald electric smelting furnace at the Troelhättan Falls. In this case the Swedish manufacturers are adopting a working hypothesis of an extra cost of 8s. per ton in the production of electric iron. They estimate that in an ordinary blast furnace the cost is £1 7s. per ton of iron (the power for working the blast being derived from waste gases); while for the electric furnace, taking

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hydro produced current at £3 per h.p. year, and allowing 2s. for electrodes, the cost is calculated at £1 15s. per ton. Yet the higher quality, and larger output, it is held will counterbalance the extra cost, while there is every possibility of greater economies as the electric practice becomes better understood. At Notodden, in Norway, great things are also being contemplated. There the Tinfoss Co. are smelting iron ores from the Lango Mines, near Kragero, and the Klodeborg Mines, near Arendal, at the rate of about two tons of iron per diem. When the works were recently visited by an Electro-Metallurgical Committee, consisting of Professor Vogt, Professor Farup and Captain Thorne, all was found to be going well. It is proposed to equip very large iron-smelting works, and then to add in electric steel works, and in this way Norway hopes to regain its iron and steel trade, which was crippled so badly when the price of charcoal rose so high as the result of the timber and pulp trade development. In Germany, experience seems to point to a reduction in cost. Mr. Hooghwinkel, however, takes the same view as the Swedish ironmasters, and considers that higher cost need not alarm manufacturers, as the power item is a small one, and the advantages gained are manifold. He tried to convince his audience that even small manufacturers, having to pay from ½d. to 1d. per unit for current from a town supply, could use the electric furnace economically. His chief point seemed to be that the electrically produced steel was more uniform in quality, of greater homogeneity, specially suitable for the production of high-class castings, high resistance rails and tool steel. There is much more to be said for his contention that electrically produced steel will give the better quality of rail that is now demanded than his Sheffield listeners as a body seemed prepared to allow. There can be no question that at present railway, and, to some extent, tramway engineers, are far from content with rails produced. This is, of course, mainly due to the much higher speed and far greater weight of traffic than prevailed in days gone by. Sheffield steel men argue that if railway engineers would pay more for rails they could easily have better ones. But the disturbing fact is that in America and Germany the better class rails are being produced at no higher price, thanks to the electric furnace. After lengthy experiments, the German State Railway authorities have put forward a specification for electric steel rails in which the tensile strength is raised to 99,000 lbs. per square inch, as against the 85,000 lbs. for ordinary basic steel rails, the life of the rails at the same time being raised to 10 years. As we showed some time ago in this column, the Germans are producing good steel castings from cheap materials. In these days, too, when huge contracts are the rule, uniformity becomes of greater importance, and in this matter the electric furnace is far and away more reliable than the crucible furnace. Electricity certainly produces uniformity and gives greater powers of resistance. This is even seen in the matter of electric welding as was shown by Mr. A. Scott Younger when dealing with the Continental methods of ship repairing (ELECTRICAL ENGINEER, Vol. XLV., page 220). The case for the electric furnace in smelting has been abundantly proved, its use in steel production is really no more doubtful, and it only remains to overcome the inertia so generally, though not universally, displayed among those who control our old and well established industries. The way to meet competition is to act like the late Sir Alfred Hickman did, go in for every mechanical device promising saving of labour, greater output, or more uniform results, and to scrap old, uneconomical plant. But, as we said, it is an encouraging sign to find that even those who are pessimistic about electricity are so far listening to reason as to give it a trial.

THE METAL FILAMENT LAMP.

The metal filament lamp has been very much in evidence at recent meetings of electrical supply corporations, and effective testimony has been forthcoming as to its efficiency and economy. Presiding at the annual meeting of the Metropolitan, Mr. Harrison Cripps said there was no mystery as to the falling off in revenue; it was almost entirely due to the extended use of metal filament lamps. The Chairman of the County of London Co., Mr. J. Braithwaite, offered similar testimony to the economy of the new system, but in the case of his undertaking there has been no diminution in revenue. In fact, it has been all the other way, and so it will doubtless be with other undertakings in due time, for there can be little doubt that the most effective method of popularising the use of electricity is the cheapening of its cost to the consumer. In this connection we venture to think that Mr. Harrison Cripps, in addressing the shareholders of the Metropolitan, fell into an error. After observing that in many cases, especially in private houses, consumption had been reduced by 30% or more, he said it was interesting to notice the various ways in which a householder would diminish his expenses, but the one which was least satisfactory to them was his desire to give the family as little light as possible. We fancy that this reflection upon the householder is unmerited. The experience of the past 18 months has made it fairly clear that the average householder is using a great deal more candle-power than he did before the advent of the metal filament. Candle-power for candle-power, the metal filament shows a saving of something like 70% in current consumption, so that if the clients of the Metropolitan are reducing consumption only by 30%, they may logically be presumed to be increasing their candle-power by at least an appreciable proportion of the remaining 40%.

LONDON ELECTRIC SUPPLY BILL.

The text has been published of a Government Bill to authorise the London County Council to become the purchasing authority in respect of five electric supply companies in London. An Act of 1908 gave the Council the necessary authority with regard to nine of the fourteen companies in existence.

In a memorandum to the Bill it is pointed out that the President of the Board of Trade gave an undertaking that at the earliest possible moment compatible with the procedure of the House in private Bill legislation, he would introduce a Bill with the object of transferring to the London County Council the power to purchase the undertakings of the five companies now dealt with.

The effect of the Bill, adds the memorandum, will be that the London County Council will become the purchasing authority with respect to the undertakings of all the London companies, but will not be able to purchase the undertaking of one company without purchasing the undertakings of all.

The five companies now affected are the Kensington & Knightsbridge Lighting Co., the Notting-hill Electric Lighting Co., the St. James's and Pall Mall Electric Light Co., the Westminster Electrical Supply Corporation, and the Central Electric Supply Co.

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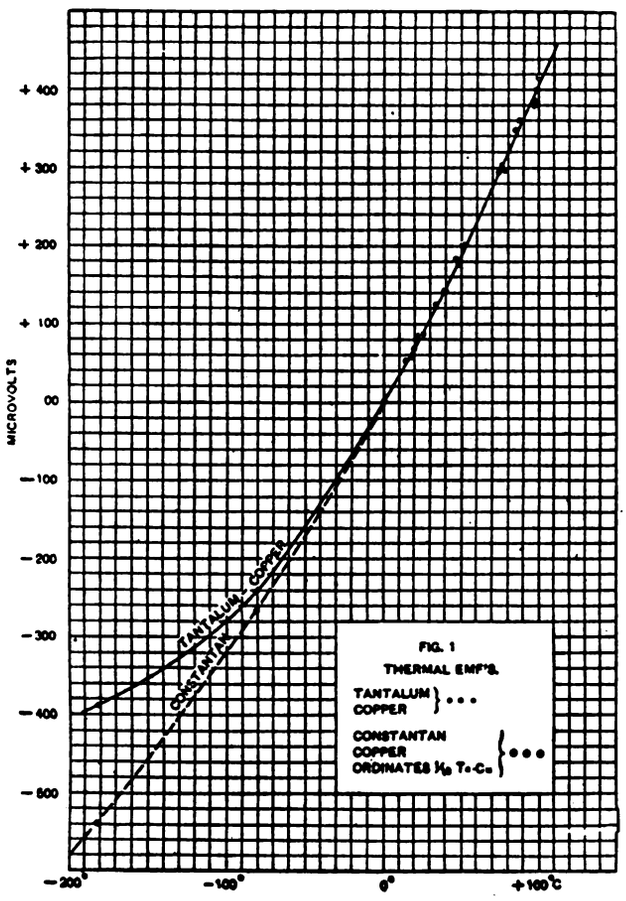
THERMO-ELECTRIC BEHAVIOUR OF TANTALUM AND TUNGSTEN.

The thermo-electric behaviour of tantalum and tungsten forms the subject of an interesting paper by Mr. W. W. Coblentz, which is published in the Bulletin of the Bureau of Standards, U.S.A. In the tantalum test the wire employed was 25 cm. long and 0·048 mm. in diameter, and had been taken from an unused lamp. The resistance was 0·85 ohm. per cm., or about 0·9 that of a sample of steel wire. The ends of the tantalum wire were wound tightly around copper wires, about 0·1 mm. diameter, and then soldered. The copper wires were joined to a potentio-meter, by means of a mercury reversing switch, and the comparisons made against a standard cell. Observations were also made on copper constantan and on iron constantan couples made of wires 0·0513 mm. in diameter. The temperature was varied from 10 to 100 degrees, and an attempt was made to eliminate the lag of the mercury thermometer. Observations were also made at the temperature of liquid air and of solid carbon dioxide. The results are shown in Fig. 1, in which the black dots indicate the observations on the tantalum-copper couple drawn to scale. The observations at 10, 24, 32, and 47 degrees respectively, belong to the first series. The observations at 17, 50 degrees, and higher temperatures were made

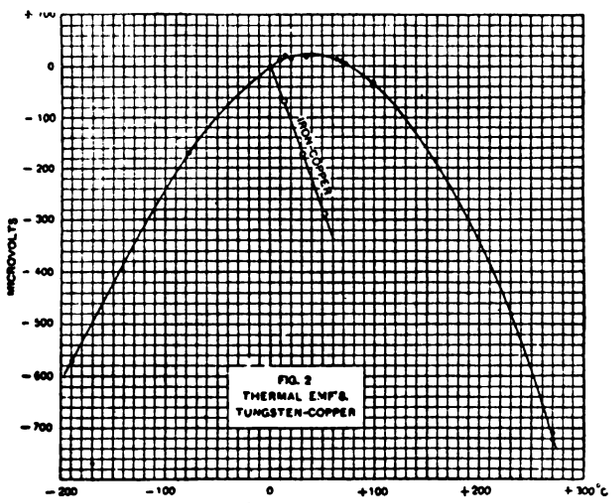


on a new couple and show no marked variation from the preceding. The circles show the observations on the constantan-copper couple, the ordinates (microvolts) being drawn to one-tenth the scale of the tantalum couple.

The results show that throughout the range investigated the thermo-electric power of tantalum (against copper) is about 4·1 microvolts per degree, which is one-tenth that of the copper-constantan couple. The direction of the current is the same as in the copper-constantan couple.

The tungsten wire used in the present experiments was taken from a large "series" lamp. It was about 11 cm. long and 0·26 mm. diameter. To the ends were wound copper wires 0·1 mm. diameter and covered with solder. Tungsten is very brittle, and the sample was accidentally broken before the observations were completed, so that the observations at 231 and 269 degrees (the freezing points of tin and bismuth, respectively) were made with a length of wire less than 6 cm. long, the copper wires being fused to the tungsten. It was found that this did not affect the results.

The thermal electro-motive force curve of tungsten is given in Fig. 2, and is rather unusual in that its inversion temperature occurs at about 40° C. Other combinations, which have an inversion temperature near 0°, are cadmium-iron at 170°, and copper-zinc at about 30° C. From its appearance it is inferred that the thermo-electric curve



is not a true parabola, as was also observed by Dewar and Fleming on numerous other metals. For temperatures below —100° C. the thermo-electric power (against copper) is about 3·5 to 4 microvolts per degree, while above + 200°C. the thermo-electric power is about 4·5 microvolts per degree, so that tungsten, like tantalum, shows no apparent advantage in thermo-electric work.

BURSLEM WORKS EXTENSION.

POSSIBLE POTTERIES ELECTRICITY COMBINATION.

Last week the extensions at the Burslem Corporation Electric Light and Power Station were formally inaugurated by Councillor Thos. Willett (the chairman of the Electric Lighting Committee), in the presence of the Mayor and members of the Town Council, officials, and visitors.

It is well to mention that is was only in May, 1903, that the Corporation considered the supply of electricity in conjunction with a refuse destructor, and Mr. Ashton Bremner, M.I.E.E., the present electrical engineer to the borough, was appointed to design and carry out the scheme. In 1905 the first installation of generating plant took place, this consisting of a 100 kw. Howden-Dick-Kerr direct current dynamo, supplying at a pressure of 440 to 500 volts. Six months later an additional 200 kw. similar set was installed, and at the end of 1908 a further 350 kw. similar set was put to work. In March of last year the engineer reported that further extensions were necessary to efficiently and economically deal with the expansion of business, and as a result plant was laid down that was set in motion on the present occasion. A mixed pressure turbine, having an output of 600 kw., or practically doubling the capacity of the station, has been installed. The new set has important advantages. Use is made as far as possible of the exhaust steam from the three reciprocating sets, any deficiency being made up with live steam direct from the main steam range. Then, again, the set can be run as a separate unit on live steam, and will thus supply that stand-by plant which is an absolute necessity for the safe running of a power station. Messrs. Belliss and Morcom are the makers of the turbine, and Messrs. Siemens are the makers of the generator. Messrs. Isaac Storrey & Sons, of Manchester, have supplied the condenser and cooling tower with accessories. An additional Babcock and Wilcox boiler, capable of evaporating 10,000 lb. of steam per hour, has been erected, making the fourth of its size at present erected in the works. A CO-2 recorder to measure samples of the flue gases from each boiler and a Lea recorder to measure the discharge from each engine have been installed. It is in contemplation to furnish mechanical apparatus to deal with the ash and clinker by means of an aerial ropeway.

Mr. Willett, in the course of an interesting speech, said that when they began they did so in a little way, intending to go step by step; the engine house end was temporary,

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and it was intended they should enlarge still further. When they looked at what they were doing to-day he would not be surprised if, in twelve months, they were called upon to put down another set bigger than the one inaugurated that day. After this diversion Mr. Willett said that in 1908 they put down a 350 kw. set, and at the end of 1909 they had put down the set they had just inaugurated, which was a mixed turbine of 600 kw., equal to all the other sets put together. They had seen the turbine running that day; it was running with the exhaust steam from the other engines. The other day when the reciprocating engines were generating 275 kw. the turbine from the exhaust steam, which would otherwise have gone up in the air, was generating 141 kw., which was 51%, and this was being done practically for nothing. This turbine they had seen that day might be used either as an auxiliary power, by exhaust steam, or it could be used as a stand-by plant driven by live steam. Supposing they drove it by live steam, it would run at something like 20% less cost than the present machines were running. The result of having these machines, which were the very best they could get, put down after a great deal of thought and consideration, had been that to-day they were generating electricity at a less cost than any other installation in the country of the same size.

They had a very active rival in their immediate neighbourhood in the Stoke works, which was doing extremely well. In Burslem the cost per unit for generating was ·84d., Stoke, ·98d., but in Hanley the cost was 1·34d. per unit. The average selling price in Burslem was 1·55d. per unit or about 1½d., at Stoke 1·71d., which he thought was very good, and in Hanley it was 2·46d., or almost 2½d.

The time, he thought, must come when the different installations of electricity in the Pottery towns would be coupled up into one system. He had an idea about it; he did not know if he might venture to give it. It was this—that Stoke should supply the other end of the Pottery district, and he thought they would be well able to supply not only Stoke, but also Fenton, Longton, and part of Hanley, and, on the other hand, he thought Burslem would be well capable of supplying this end of the district, comprising Tunstall, Wolstanton, Burslem, and part of Hanley, and he was not afraid of saying that, in his opinion, Hanley ought to drop out. When he thought of the time, which would come very shortly, when these things would have to be dealt with, it caused the blood to run a little more quickly and freely through one's veins, and he felt as though he would like to be present. At any rate, they were going to hand over to the new authority that installation. He could assure those who would receive it in charge that the works had a heart as sound as a bell, lungs strong and vigorous, and muscles developed splendidly, and if it was developed with care and skill its future would be prosperous. He trusted the future of the works would justify all he had said about it.

Mr. W. Parker, of Messrs. Siemens, who supplied the generator, said the new machine represented a big advance. One of the great things nowadays was to utilise waste products. A Burslem man that day told him that between the oven of his manufactory and the chimney stack there was installed a separate kiln in which certain fluxes could be heated up, and a good deal of heat which would otherwise be going up the chimney was utilised, and by this means several hundred pounds were saved every year. That was precisely what had been done at the station in installing a turbine. The machine they had started was quite modern, and very few corporations in England had bought these generators. The development of this particular generator had been an exceedingly difficult task on the part of Messrs. Siemens. Probably the development of this particular kind of generator had cost their firm in experiments alone as much as £20,000.

MUNICIPAL & COUNTY CLUB.—Mr. James Chas. Inglis, M.Inst.C.E., President of the Institute of Civil Engineers, was the guest of the evening at a House Dinner, held at the Municipal & County Club on Monday, when Sir Edwin Cornwall, M.P., D.L., was in the chair, in the absence of the President (The Lord Chief Justice), through illness.

DIRECT CURRENT STEAM TURBINE FOR THE BELFAST CORPORATION.

Particular interest is attached to the decision of the Belfast Corporation to extend their tramway generating plant by the addition of a 1,500 kw. Willans Impulse "Disc and Drum" type turbines, coupled to a direct current dynamo, in view of the strong opposition brought forward against the adoption of direct current turbines when the previous contracts were settled during February, 1907. It will be remembered that on the previous occasion two units of 1,000 kw. were required, and the feeling expressed in many quarters at that time was in the direction that *direct current* turbo dynamos, were not sufficiently reliable for purposes of meeting the requirements of a tramway load. After considerable discussion, and not till the matter had twice been referred back from the Council to the Tramway and Electric Lighting Committee, did the Belfast Council finally decide to place themselves in Messrs. Willans & Robinson's hands for the supply of two 1,000 kw. direct current turbine units.

These units have now been in daily operation for some two years, and it is generally known that the performance of the dynamos (which were considered the doubtful factor) compares favourably with the best results obtainable with dynamos running at more moderate speeds.

As a result, Mr. Bloxam, the Belfast Engineer, has recommended his Council to instal a further unit of 1,500 kw. capacity, and as it is intended to obtain this output from one dynamo (and not by installing tandem dynamos, as has previously been the case when dealing with this output), the present unit will be the largest single direct current turbine set installed in this country, being somewhat larger than the two 1,200 kw. units which Messrs. Willans & Robinson Ltd., have in hand for the Admiralty for the Devonport Dockyard.

ROSARIO ELECTRIC COMPANY.

It is instructive to note the view taken locally concerning the Rosario deal. The *Review of the River Plate*, in commenting on the matter, expresses practically the same opinion as we did last week. Our contemporary says:—"Telegrams have been received from London to the effect that a Belgian syndicate has obtained the option of purchase of the Rosario Electric Co. for the sum of £518,000. According to official returns of this company its capital stood at the beginning of 1909 at £260,000, and we believe that a fresh issue was recently made for construction of new works at Sorrento, and for the general extension of the existing system. The Belgian syndicate that has obtained the option is, we believe, the same that is interested in the electric tramways of Rosario. We are surprised at the shareholders being willing to dispose of this property, for since the re-organisation of the company a few years ago it has made very satisfactory progress, and has been paying an 8% dividend, and every year it was making further progress. If the enterprise is worth almost double its capital to the Belgian syndicate, it is surely considered to be capable of producing a dividend, even at the purchase price, so that we think the shareholders have not acted wisely in getting rid of the property. It is also a pity to see another English company disappear from our midst and it will also mean that orders which would have been placed with British firms will now go to the Continent, and the English members of the staff will also be replaced by others. The price that is being paid for the company is a sign that it is considered to be a valuable property, and such being the case we should have thought that the shareholders would have preferred to have held on to it, especially seeing the great future that lies before it.

PEEBLES STAFF BALL.—The staff of Messrs. Bruce Peebles & Co., Ltd., held their annual ball at the North British Station Hotel, Edinburgh, on Friday evening last. Mrs. Lee Murray (wife of the General Manager of the Company) received the guests at the entrance to the ballroom. Amongst those present were several of the directors, as well as Branch Managers, outside representatives and agents of the Company, most of whom brought their wives. About 150 ladies and gentlemen were present and a most enjoyable evening was spent, dancing being kept up until the "wee sma' oors."

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PUBLICITY.

In this Section of "The Electrical Engineer" we give Publicity to New Inventions and Specialities.

OSRAM STREET LAMPS AT CROYDON.

In view of the extremely satisfactory results that have been obtained by the use of Osram lamps for street lighting, and the consequent increasing interest in the subject amongst municipal engineers, it may be useful to readers if we continue to give from time to time some details of the principal installations which are already in operation. In the case of Croydon, where all the tramway routes, apart from the main route, are lighted by Osrams, the lamps are fixed mostly on alternate trolley poles, but in some cases on small arc poles. The average distance apart is 65 yards, and the height of the reflector from the ground is 20 ft. 3 in. Each lantern is provided with three 110-watt Osram lamps, each lamp-holder being spring suspended.

Photographed at night (reproduced from an untouched point).
Osram Lamps for Side Street Lighting at Croydon, Wellesley-road.
Single 88-watt Osram Lamps fixed at a height of 12 ft. from ground.

In the same municipality Osram lamps are largely used for side-street lighting, and in this connection are rapidly displacing gas lamps. The lamp posts are placed at an average distance apart of 75 yards, and a single 88-watt Osram lamp is fixed with a conical vitreous enamel reflector at a height of 12 ft. from the ground. The enterprising Borough Electrical Engineer, Mr. A. C. Cramb, states that the average light of Osram street lamps obtained has been very satisfactory.

SMART WORK.

Messrs. Marshall, Kaye & Marshall, Ltd., fancy tweed and coating manufacturers, who had the misfortune to have a serious breakdown of the main driving engine at one of their Ravensthorpe Mills, bringing the whole of the machinery to a standstill, consisting of nearly 400 i.h.p., were able in less than 10 days to re-start practically the whole of their various departments. This feat, which reflects the greatest credit upon all parties concerned, has been made possible by the aid of the Yorkshire Electric Power Co.'s supply, and the work of fixing the electric motors and putting into operation of the machinery, was commenced immediately after the breakdown. When it is remembered that a stoppage of perhaps five to six months would have been occasioned while the necessary repairs were being effected to the engine, we are sure the present result will be highly gratifying to Messrs. Kaye, their workpeople, and all parties concerned.

MODERN SHIP INSTALLATION.

Electric lighting is no longer confined to the hotels and restaurants of the land, for many of the great floating palaces which are now constructed for passenger transit are replete with the latest improvements and are electrically equipped. Travelling in the present day, by rail or sea, is not accompanied by the many inconveniences that prevailed some years ago which were most fatiguing and irritating. Especially in illumination great reforms have been made, and old and crude methods have been superseded by the more modern. A striking example of the excellent apartments which are found on the most up-to-date vessels is furnished by the accompanying illustration. This is the saloon of a steamer which in every way resembles the dining hall of one of our first-class hotels. Everything is, of course, rigidly fixed, so that there may be no disorder caused by the "roll" of the ship. In this instance, "Tantalum" lamps are installed for illumination in small fittings fixed to the ceiling at equal distances apart. For ventilation several electric fans are installed, and the best possible lighting effect is obtained, whilst the temperature can be regulated exactly as required. Messrs. Siemens Brothers Dynamo Works, Ltd., Tyssen-street, Dalston, London, N.E., have completed many high-class installations of similar character for some of the leading steamship companies. Their "Tantalum" lamp is eminently suitable for train and ship lighting, as the filament is a "drawn" wire which has a greater tensile strength than mild steel of the same cross-section. "Tantalum" lamps combine the advantages of superior strength with economy and longevity, whilst they are easy to install, being suitable for any type of electric light fitting. Messrs. Siemens Brothers have also designed numerous fittings which are specially suitable for this class of work, and all who are interested in new installations are advised to write for full particulars.

"TANTALUM" LAMPS ON BOARD SHIP.

SOUTH AMERICAN LIGHTING CONTRACT.—Messrs. Siemens Bros., Tyssen-street, Dalston, London, N.E., have obtained a very large contract for street lighting fittings of special design for a district in South America.

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Electrical Contractors' Section.

A Survey of New Things and Business Prospects.

LOOP WIRING.

Despite the fact that such jointing materials as soldering pastes, fluxes, tapes, etc., are still supplied in considerable quantities, and despite the increase in the number of such materials available by the introduction of "Amalgaline," noticed in these columns last week, there should be practically no jointing necessary in a modern wiring installation. Ceiling rose, switch and distribution board terminals are now made sufficiently large to accommodate several conductors, either single or strand. The feed wires into ceiling roses and switches are merely looped into the block and out again when the wiring is being done. On the switch runs conduits must naturally be provided for three or more wires, according to the number of switches used. The old-fashioned T joint, with crossover or under block (for casing are things of the past). Joints can, of course, be made more easily when wood casing is used, but they do not seem to fit so readily into the scheme of things with conduit. Loop wiring should always be carried out in every installation. Its advantages are sufficiently obvious to render further comment unnecessary.

ELECTRIC LIGHT ACCESSORIES.

The past lighting season has revealed little new in electric lighting accessories. It has, however, further increased the popularity of metallic filament lamps, and has witnessed a vast multiplication of new types on the market. Fortunately British makers have now established this branch of the electrical industry on a secure footing, and the trade generally are well satisfied with the quality of the lamps produced by such firms as the Bryant Trading Syndicate, of Highbury, London; the British Thomson-Houston Co.; Edison & Swan United Electric Light Co.; and others who have shown commendable enterprise in this direction. It will be a thousand pities if the price-cutting campaign recently started is allowed to injure British makers, and much as all of us would welcome a legitimate reduction in the price of lamps, the fact must be borne in mind that the electric supply undertakings are scarcely able to stand a rapid acceleration of these lamps in their consumers' premises, and that the chief *desideratum* of users of these lamps is that the quality should be improved. However, the new lamps have come to stay, and their influence has already been felt. A recent visit to the centre of the brass fitting industry in Birmingham revealed the fact that the makers of electric light fittings are contemplating some radical changes in the design of these fittings, in order to better adapt them to the new form of lighting; and, although it is too early to state the directions in which the changes are contemplated, we would advise electrical contractors to keep on the lookout for some interesting productions during the next lighting season. While in the neighbourhood, we came across an interesting device which the Fleet Brass Co., of Fleet-street, Birmingham, are introducing. This is a pneumatic anti-vibrator for metallic filament lamps. It consists of an indiarubber ball enclosed in a spring cage, and attached to the flexible cord of the lamp by means of wood clips. In fixing this device, it is necessary to open the flexible cord for the space of an inch or two in the required position, and to insert the ball inside the loop thus formed. Then the wood grips, which are formed in two sections, are attached to the cord, top and bottom of the loop, and the cage is clipped on to them. Finally, an ornamental brass shell is slipped over the apparatus, and the anti-vibrator is complete. This device is easy to fix, and is extremely sensitive, and as it is sold at a very low price, it will probably attract a good deal of attention. Metallic filaments are all too quickly broken by vibration, and if, as is claimed, this apparatus absorbs vibration, it should, by prolonging the life of the lamps, secure a good demand. Falk, Stadelman & Co., Ltd., of 83–87, Farringdon-road, London, E.C., have, by the way, introduced a very neat type of lantern for both interior and exterior use, under the trade name of "Aladdin." This lantern is intended for use with the Effessa or other metallic filament lamps, and is especially applicable for the lighting of shop fronts and doorways, interiors, railway stations, etc. These lanterns are made in several shapes and sizes. During the past season, "cluster lighting" has been very much in vogue, and we may look forward to a continuance of this form of lighting during the 1910–1911 season. The fires in drapers' shops have put flexibles and separate lamps somewhat under suspicion, and there is, therefore, sure to be an increased demand for lamp clusters, which will concentrate the illumination point, yet ensure a wide distribution of light. There should be a good business to be done among shopkeepers who will require their existing lighting arrangements altered to suit what are undoubtedly more efficient and more modern appliances. The metallic filament lamp cluster, in conjunction with powerful reflectors and excellent diffusing shades, is in for a long run, and every class of electric light user is a prospective customer for one or other of such cluster fittings. But it is necessary that the electrical trade should carefully cultivate the demand.

AN ELECTRIC "SERVANT"——.

The complex servant problem, which has been the ban of so many good housewives, seems now well on the way to a solution by the introduction of domestic electric appliances. The latest novelty introduced is an electrically-driven domestic machine, for which Mr. R. Borlase Matthews, Bank-buildings, Kingsway, London, W.C., is responsible. This device comprises a portable combined electric motor and driving gear, so arranged that the one apparatus can drive any standard domestic labour-saving machine—from a wringing machine to a rotary brush. A radius arm, carrying a pulley driven at reduced speed by a belt from the motor spindle, is attached to the base of the motor. The pulley is rigidly attached to a small friction wheel, which can be placed in contact with a driving pulley of any appliance that it is desired to drive. A spring, mounted on the tail end of the radius arm, ensures that the friction wheel is pressed against the pulley wheel of the machine sufficiently hard to drive it. The motor runs at about 2,000 r.p.m. when driving a vacuum cleaner or a mangle; the gear is dispensed with, the motor driving direct through a leather cord. Among the appliances suitable for driving by this apparatus are knife cleaners, coffee grinders, meat choppers, dish washers, sewing machines, etc.

OSRAM LAMPS FOR THE POST OFFICE——

A most important contract has just been secured by the General Electric Co., Ltd., viz., for the supply of Tungsten filament lamps of 16, 25, 32, 50, 100, 200, 300 and 400 c.p. to the Post Office for their requirements all over the United Kingdom for the ensuing six months. It may be mentioned that the Osram lamp has held this contract for the past year.

AND FOR BUCKINGHAM PALACE.

A further order has, we understand, been placed with the General Electric Co., Ltd., for the supply of 100 210-volt 32 c.p. half-obscured Osram lamps for use in Buckingham Palace to the order of His Majesty's Office of Works. Large numbers of Osram lamps are, we understand, already installed in Buckingham Palace.

CONTRACTS WORTH WATCHING:—

Below we present a list of building contracts which have recently been placed or for which tenders are invited. We have no means of ascertaining whether electricity will be used at all; but it is evident that in the majority of cases electricity will be used either for lighting or for power, or for both. Where names of firms are mentioned they are those of the builders or contractors who have the work

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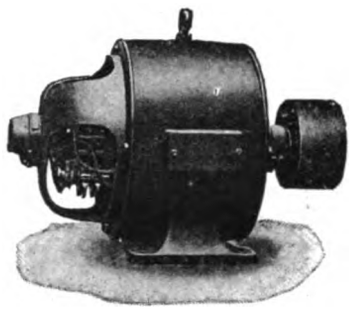

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in hand, and it will repay electricians to keep in touch with these jobs :—

Chester.—Thomas Mayers, Rowton, Chester. School extensions, £3,000.

Hinton.—E. Walters & Son, 3, Richmond-terrace, Bristol. School.

Bledington.—Geo. Howman & Co., Stow-in-the-Wold. School extensions.

Norwich.—Electric light extensions for the Town Council. £17,783.

Wilmslow.—Fire station for the Urban District Council. £2,500.

Wednesbury.—Electric light meters, mains, and services for the Town Council. £2,925.

Southampton.—Tramways and car sheds for the Town Council. £15,248.

Preston.—W. H. Broadhead & Son, proprietors. New theatre on site of Express Rink.

Margate.—Anderson Bros., 14, Hawler-street, Margate. Pavilions.

Ashby.—Scorer & Gamble, architects, Lincoln. Elementary school. (Builders, Messrs. Hickman, Market Harborough. £3,064.)

St. Margaret's (near Dover).—Worsfold & Hayward, architects, Dover. Residence.

Walton-on-Thames.—Crickmay & Sons, architects, 13, Victoria-street, London, S.W. House on the Adelaide Estate.

Kingswood.—E. Clark & Sons, Drummond-terrace, Bristol. School extensions.

Balby.—Mullins & Richardson, Balby. Church extensions.

Heathfield.—Thos. Rich, Horsham. School.

Wigan.—Electric light extensions for the Town Council. £36,000.

Kent.—Secondary school at Chatham for the County Education Committee. £8,500.

Dundee.—School Board propose to erect a new Academy in West End.

Navan.—Meath County Council's new offices at Navan.

TRADE NOTES.

Messrs. Siemens Bros. Dynamo Works, Lamp Department, at Dalston, inform us that they are about to place upon the market a range of high and low voltage high candle-power metal filament lamps of an efficiency of approximately 1 watt per c.p.; 100 c.p. lamps will very shortly be on sale, and we learn that lamps of 200, 300, 400 and 600 c.p. are to be expected at a somewhat later date. We understand that full details will be forthcoming in the course of a week or two, as regards price, size, etc. Messrs. Siemens hope that their new lamp, which is to be styled the "One-watt" lamp, will have the same wide popularity as is at present enjoyed by their "Tantalum" lamps.

NOTICE.

Contract and Miscellaneous Advertisements should reach this Office by Mid-day on Wednesday. For rates apply to the Manager, 149, Fleet Street, London, E.C.

CONTRACTS.

COUNTY BOROUGH OF HUDDERSFIELD.

ELECTRICITY DEPARTMENT.

The Corporation of Huddersfield invite Tenders for the supply of 1,000 single-phase alternating current meters to be delivered as required during the ensuing two years. The successful tenderer will be required to execute a Contract, the draft of which may be inspected at the Town Clerk's Office, Town Hall, between 10 and 4 o'clock. Specifications and other particulars can be obtained on application to Mr. A. B. Mountain, Borough Electrical Engineer, St. Andrew's Road, Huddersfield.

Sealed Tenders, endorsed "Tender for Meters," signed in the handwriting of the Tenderer or his Agent, and addressed "Town Clerk, Town Hall, Huddersfield," must reach him not later than 12 noon on Thursday, the 31st day of March, 1910. The Corporation do not bind themselves to accept the lowest or any Tender.

J. HENRY FIELD, Town Clerk.

Town Hall, Huddersfield,
March 16, 1910.

CONTRACTS—continued.

CORPORATION OF BEDFORD.

NOTICE.

The Corporation of Bedford invite Manufacturers to tender for one 750 kw. Direct Coupled Steam Driven Single-Phase Alternator and Exciter.

Specification, Form of Tender, etc., may be obtained on application to the undersigned on receipts of a deposit of one guinea, which deposit will be returned on receipt of a bona fide tender.

Sealed tenders endorsed "Alternator" to be delivered not later than noon on March 28, 1910, addressed to the Chairman of the Electricity and Street Lighting Committee, Electricity Works, Cauldwell-road, Bedford.

The Corporation does not bind itself to accept the lowest or any tender.

R. W. L. PHILLIPS, A.M.I.E.E.,
Borough Electrical Engineer.

Borough Electrical Engineer's Office,
Cauldwell Road,
Bedford.

COUNTY BOROUGH OF NEWPORT.

ELECTRICITY AND TRAMWAYS DEPARTMENT.

To Dealers in Scrap Material, Purchasers of Unclaimed Property left on tramcars, Buyers of Old Dry Cells, Lamps, Meters, and Sundry Electrical and other Disused Articles.

TENDERS are invited for a Quantity of SECOND-HAND MATERIAL which is being OFFERED FOR SALE, in Lots.

Particulars may be obtained on application to the undersigned on and after March 17.

Tenders to be sent, sealed, in the envelope provided, to the Town Clerk, and must reach him by the first post on Saturday, March 26.

The Corporation do not bind themselves to accept the highest or any tender.

By Order,

H. COLLINGS BISHOP,
Borough Electrical Engineer and Tramways Manager.

Town Hall, Newport, Mon.,
March 14, 1910.

CORPORATION OF SUNDERLAND.

STORES.

The Corporation are desirous of receiving TENDERS for the various kinds of STORES used in connection with the Electric Tramways, viz.: Paint and Oil, General Electrical and Car Supplies, Ironmongery, Wrought Iron and Steel, Timber, and Overhead Line Materials.

Further particulars, with form of tender, may be had, and samples inspected, on application to the General Manager, Mr. A. R. Dayson, Tramways Offices, Sunderland.

Tenders, in sealed envelopes, endorsed "Tender for Tramway Stores," must be delivered at my office not later than 12 o'clock noon on Thursday, March 31, 1910.

The Corporation do not bind themselves to accept the lowest or any tender.

FRAS. M. BOWEY,
Town Clerk.

Town Hall, Sunderland,
February 28, 1910.

GLOUCESTERSHIRE COUNTY COUNCIL.

EXTENSIONS TO SHIRE HALL, GLOUCESTER.

The Committee of the Gloucestershire County Council are prepared to receive TENDERS for the ELECTRIC LIGHTING OF THE EXTENSIONS TO THE SHIRE HALL, GLOUCESTER.

General Conditions, Specification, Plans, etc., may be seen and Forms of Tender obtained at the Office of the Consulting Surveyor in the Shire Hall.

Sealed Tenders, endorsed "Electric Lighting," must be addressed to me and delivered not later than the 2nd day of April, 1910.

The Council do not bind themselves to accept the lowest or any Tender.

EDWD. T. GARDOM,
Clerk to the Council.

Shire Hall, Gloucester.

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THE PROPRIETOR of BRITISH PATENT NO. 18641 of 1900, relating to Improvements in fore-carriages for motor cars, desires to enter into arrangements by way of license or otherwise, on reasonable terms, for the purpose of developing and practically working the same in this country. Enquiries should be addressed to W. P. THOMPSON & CO., Chartered Patent Agents, 285, High Holborn, London, W.C.

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Advertisements under this heading: Twenty-four words, 1s. per insertion; three insertions for 2s. 6d.; or each additional line of eight words. 4d.

HORIZONTAL HIGH PRESS CONDENSING ENGINE for sale by Woodhouse & Mitchell, capable of developing 20 to 30 h.p., first rate order. Selling as more power is wanted. —For particulars apply Box O, c/o THE ELECTRICAL ENGINEER, 149, Fleet Street, E.C.

FOR SALE. ELECTRIC LIGHTING PLANT, consisting of shunt-wound Dynamo, belt-driven, and National Gas Engine; also Switchboards, &c.; output 30 amps. at 100 volts. —Address, W. H., c/o THE ELECTRICAL ENGINEER, 149, Fleet-street.

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PLATINUM UTENSILS, SCRAP, LAMP TOPS.—Best prices given by DERBY AND CO., LTD., 44, Clerkenwell Road, London, E.C. N.B.—Platinum Sold.

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Exceptionally light and spacious OFFICES, near Victoria-street, Houses of Parliament, and District Railway station, consisting of 16 rooms on two floors, with private staircases, and having a total floor space of about 6,300 ft. super. Rent very moderate.—Particulars, plan, and order to view of Messrs. Trollope, 5, Victoria-street, Westminster.

WANTED COPY of THE ELECTRICAL ENGINEER, Sept 3rd, 1909. Box W.D, c/o. THE ELECTRICAL ENGINEER, 149. Fleet Street, E.C.

APPOINTMENTS.

SHIFT ENGINEER WANTED. Previous experience in D.C. and A.C. Power Stations, and Technical and Workshop Training desirable. Salary 35/-, rising to 45/- per week. Applications, stating age and experience, with copies of testimonials to be delivered to S. J. WATSON, Electricity Works, Bury, not later than Friday, the 18th inst.

WANTED, to sail in April, fully qualified Engineer (single), for Mombasa Electric Light and Power Station, used to installation work. State experience, terms required, giving copies of testimonials, to CENTRAL TRANSLATIONS INSTITUTE, 16, Eastcheap, E.C.

SITUATIONS WANTED.

DRAUGHTSMAN, 28, Bavarian, speaking French, some English, experienced with switchboards, low and high tension, installation, electrical apparatus, general engineering, requires situation in England. Highest references.—KOLB, 24, Avenue Carnot, Paris.

WANTED to apprentice, or article, as a Pupil to the Electrical Engineering, a boy, age 16. Reply stating premiums required and full particulars to L, c/o. GOTILIE LIBRARY, Church Parade, Hounslow.

WILLANS-IMPULSE STEAM TURBINES.

As is now generally known, Messrs. Willans & Robinson, Ltd., of Rugby, have recently placed on the market a turbine of the plain Impulse type, and also a turbine of the Impulse "Disc and Drum" type. These two types of turbines, in conjunction with their well-known Willans-Parsons turbine, being intended to meet the varying requirements with which turbine manufacturers are daily confronted. Orders for turbines of the plain Impulse type are at present under construction for the Ashton-under-Lyne Corporation, Messrs. Charles Moore & Co., and others, whilst turbines of the Impulse "Disc and Drum" type are in hand for the Belfast Corporation, the Calcutta Electric Supply Co., the Bridlington Corporation, and others.

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COUNTY OF LONDON ELECTRIC CO.

METALLIC FILAMENT LAMP AND MORE ELECTRICITY.

The sixteenth ordinary general meeting of the County of London Electric Supply Co., Ltd., held at Winchester House, Old Broad-street, E.C., Mr. J. B. Braithwaite (chairman of the company) presided.

He said: In moving the adoption of the report and accounts I will trouble you with one or two remarks on the affairs of the company for the past year. Turning first to the balance-sheet you will see some very considerable changes in our capital account. During the year we have issued the balance of the last issue of Preference shares, raising the amount now outstanding to £550,000, as against £500,260 last year. Then during the year we received the concurrence of our First and Second Debenture stockholders to raise their amounts of Debenture stock in each case from £400,000 to £500,000. Of that increase of £100,000 in each case we have issued £50,000, so that our 4½% First Debenture stock stands at £450,000, as compared with £400,000 last year, and our 4½% Second Debenture stock also stands at £450,000, as compared with £400,000 last year. You will see that we have received approximately £150,000 of additional capital during the year. That has been applied in meeting our capital expenditure for the past year, which has amounted approximately to £60,000, and the balance has been applied in paying off a portion of the loans due to the bank, which at the date of the last balance-sheet stood at £119,500, and at the date of this balance-sheet stood at £50,000, a reduction of £69,500. That leaves us available for further capital expenditure £50,000 First Debenture stock and £50,000 Second Debenture stock, and, of course, we have other resources in the way of additional Preference or Ordinary shares as and when required. On the other side of the balance-sheet the capital account has been increased by the expenditure which we have made, the bulk of which, as usual, has gone into mains. Our capital expenditure now stands in the London districts at £1,703,958. The capital actually expended during the year on account of the County of London areas was £57,026 9s. 6d. As I told you last year, and as will be the case for some time to come, with the very large area we have to supply, a large proportion of that expenditure will be for mains. During the past year out of that £57,000, £33,728 was expended in extension of our mains. That represents nearly 60% of the total. It was not necessary to put in any additional generating machinery during the past year, but we have had to put in additional transformers, motors and meters for supplying our customers, costly instruments, switchboards and general miscellaneous plant, which have absorbed between them a little over £15,000, and other items, such as rental wiring, slot meters, etc., have absorbed £7.847. So much for our capital expenditure.

We have a supply of generating plant which is sufficient for our present needs, and for some little time to come, probably, and the bulk of our capital expenditure will no doubt be expended in extending our mains. We have such a very large area of supply on the southern side of the river that that expenditure for mains will go on, I hope for many years to come, because, as you know, we do not lay additional mains unless we have customers waiting to take supply from us to an extent that will fully justify the expenditure we propose to make. That being the case, we can only hope that the expenditure on mains will continue for a great many years to come. Then, if we turn to the revenue account, there, again, I think, we have no cause for dissatisfaction. You will remember that I told you last year that the advent of the metallic filament lamp was introducing a new element into our calculations. Whilst we cordially welcomed the lamp as one of the means for cheapening the cost of electricity to the consumer, and therefore one of the means which we believe will ultimately tend to increase the sale of units, yet during the transition period, while existing consumers were changing from the old carbon lamp to the new filament lamp—which, I am glad to see, we have in this room—we had to take into account the fact that there would be a period when we should experience a temporary falling off in our revenue, and it was impossible to say to what extent that might go, or how far it might affect us. I think it must be gratifying to you all to see that, in spite of the fact that we have had during the year to face, I think I may venture to say, the worst part of this transition period, our London stations come out with a larger profit than they did last year, and our revenue has gone up. That is not the case with all electric supply companies, as you will have seen by their accounts, but in our case I am glad to say it is so. Our gross revenue has increased from £172,996 in 1908, to £177,303, and our revenue from current sold and meter rentals has increased from £164,829 for 1908, to £168,706 for the past year, or approximately £4,000 more, and we are able to retain the great bulk of that as net profit, for if you look at the bottom of the revenue account No. 2 you will see that we carry to net revenue account £104,727, as against £101,037. In other words, we retain £3,690 actually as net. That is due, again, to the success of our staff in still further reducing the cost of supply. I pointed out to you in past years that that cannot go on indefinitely. Our coal costs this year constitute a fresh record. They have come out at ·33d. per unit, which, I think all who know anything about coal costs will agree, is a very satisfactory figure. The result is that, although we have generated a large number of additional units, our actual generating expenses are practically stationary. Then when we turn to see the application of this money, we shall find in our net revenue account that the changes which I pointed out to you in the capital account are reflected there. Whilst we have a larger amount to pay in interest on debenture stock—£35,936, as against £34,200—we have a reduction of a slightly smaller amount in interest on temporary loans. Then we have to pay interest on the additional amount of preference shares. I do not know that I need weary you with the detailed figures; they are all before you in the report. The net result is that, after making the same provision for depreciation which we did last year—namely, £16,000—and after writing off between £4,000 and £5,000 from the various suspense accounts out of revenue, we are able to declare the same dividend as last year, with a very slight reduction of our carry forward.

Naturally, you will ask what are the prospects for the current year, and there I am always loth to prophesy. At the same time, we have gone into the matter very carefully, with a view to seeing how far the increase of units sold to new consumers is neutralising the saving in current which is effected by old customers having adopted metallic filament lamps. Of course, you will readily see that new customers coming on are using metallic filament lamps, so that is all to the good. As far as we are able to judge, I think we may say we have seen the worst of the depression caused by the transfer of old customers from the carbon filament to the new lamp, and are justified in looking for something like our normal increase of revenue to reassert itself during the current year. With regard to the summary of results for the past year, I think we have every reason to be satisfied. Our net applications for the past year equalled 107,391 30-watt lamps, as compared with 84,021 last year, showing an increase of 28%. Then our consumers have increased by 1,560 during the year, and now stands at the substantial figure of 15,205. Our units sold amounted to 14,736,109, an increase of 8·3% over the previous year. Our coal costs, as I pointed out to you are ·33d. per unit, which shows a decrease of 14½% on the costs of last year, and our total costs, including repairs, are ·706d.—something inside ¾d. So far as the current year is concerned, the indications are all favourable up to the present time. The 30-watt lamps applied for are 19,594 since January 1, as against 10,088 last year, showing an increase of 95%, or very nearly double. The units sold are 3,304,945, showing an increase of 10% over the same period last year. Of course, it is the sale of units that is making your money, and if we continue to increase our units sold, our profit should increase with it. Therefore, the fact that, in spite of the metallic filament lamps, we have already in the current year had an increase of 10% in the number of units sold for power and lighting purposes, I think, justifies what I said before, that we have seen the worst of the temporary depression, and that we shall now resume something like our normal rate of increase, in which case the accounts for the current year ought to show a substantial increase in our profits. I

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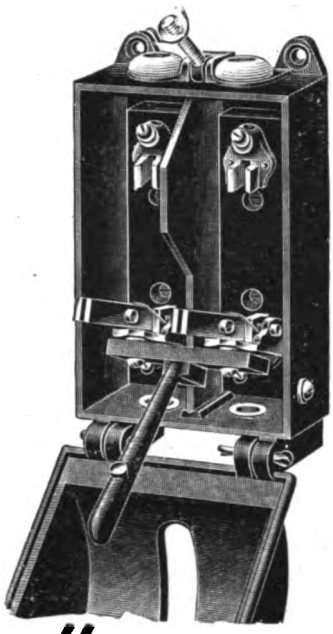

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Double pole, quick-break, self-adjusting for wear, all working parts insulated. For pressures up to 500 volts.

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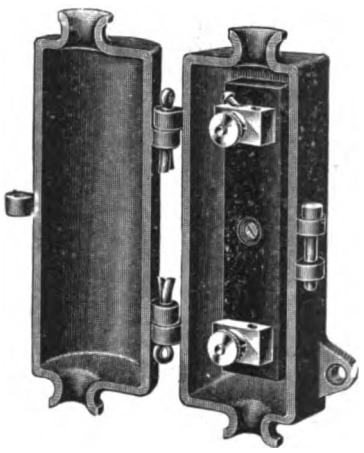
Can be used with strip or fuse wire up to 250 volts and cartridge fuses up to 500 volts. Fitted for screwed barrel or bushed for wire.



ASK FOR CIRCULAR 184 D.

THE SUN ELECTRICAL CO., LTD.,
118-120, CHARING CROSS ROAD,
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need not warn you not to expect an increase in the dividend, for I have told you several times that the amount we are transferring to our depreciation reserve is not all we should like, and the first improvement in our profits will go to strengthen our reserve. That is in your interests in the long run, and I certainly look for a substantial increase in our profits this year, which should enable us to increase the amount of £16,000 which we have provided out of revenue to our depreciation account during the past year.

Then, with regard to the other companies in which we are interested, the Bournemouth and Poole Co. continues to do well. Richmond continues to do very well, and up in the North, at Coatbridge, we have a very considerable expansion of business. We have sold something like 500,000 units more than last year, and we are getting a further accession of important power consumers in that district, and I think the prospects there are decidedly better. In Croydon rural we are making some progress; we have about trebled our output, and we have now a substantial number of customers. It is a steadily growing district, which I think will go on improving for a considerable time to come. I do not think I need trouble you with any other matters at the moment, but I shall be very glad to reply to any questions which any shareholder may wish to put. I will now conclude by moving: "That the report of the directors produced, together with the balance-sheet and statement of accounts at December 31, 1909, duly audited, be now received, approved and adopted."

The Chairman moved a vote of thanks to the officers for their loyal and efficient services to the company during the past year, remarking that they were extremely fortunate in having an exceedingly efficient and loyal body of officers.

Mr. Lighton seconded the motion, which was unanimously adopted.

We are offering our "A" Enclosed Lamp at a greatly reduced price, prior to taking stock.

This lamp is remarkable for its steady and reliable burning. It gives 1,000 c.p. on 400 watts per hour and burns 60 hours at every trim.

We supply the "A" for either 100-200 volts direct or alternating supply—series or parallel working. Although we have so greatly reduced the price we are still maintaining our high standard of workmanship and material.

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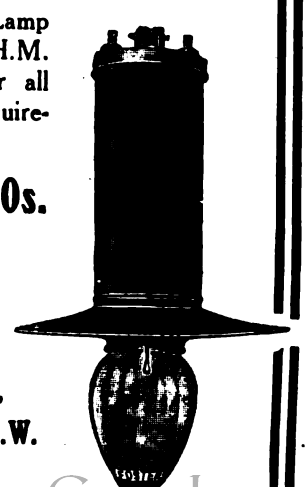

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Electrical Progress at Home & Abroad.

A Review by our Special Correspondents.

TYNESIDE.

NEWCASTLE-ON-TYNE.

On Wednesday, the 9th inst., a paper was read at Armstrong College by Mr. H. J. Fisher upon "Electrical Breakdowns, their Cause and Prevention." The paper was somewhat of a stop-gap character, owing to a hiatus in the arrangements for a paper from the central organisation, but notwithstanding this, it was of first-class interest. Mr. Fisher tabulated a list of electrical breakdowns as contributed by some of the members of the Newcastle section, and some of the more interesting figures were as follows: Out of 23 recorded breakdowns on cables, 4 were caused by bad insulation, 2 by falls of roof, 4 by runaway sets, 7 with water, and 6 by bad workmanship. There were 8 breakdowns on trailing cables due to falls of roof, and 2 by water. With motors, 80 breakdowns were recorded, 11 being due to bad design, 3 to overload, 14 to defective insulation, 1 to careless operation, 12 to water, 12 to contact of rotor and stator, 9 to dust collection, 11 to oil in the windings, 4 to breakage of field coils, and 3 to mice, etc. In switch gear and controllers, of 65 breakdowns there are 35 due to bad design, 4 to inefficient size, 9 to careless operation, 1 to water, and 13 to failure of trip gear or over-fusing. Mr. Fisher recommended thorough compounding of cables, and showed a special design of joint boxes specially worked out to eliminate the spreading of a sectional fault to the whole district. He drew attention to the lack of sufficient insulation on bar-wound stators and rotors, and recommended a German speciality, impregnated with paraffin wax, as being water-proof and suitable for use in windings. He emphasised the importance of taking daily reports, and suggested that designers of plant should have better opportunity for studying actual running conditions of electrical plant in mines.

The Discussion on the Paper.

The discussion on the paper was of an exhaustive and practical nature. Mr. Spence (of the General Electric Co.) argued in favour of the ordering of the electrical plant by the engineering rather than the non-technical staff. Mr. Wood, of Messrs. Ernest Scott & Mountain, said that from his experience in repairing mining machinery of all manufactures, he thought the majority of the breakdowns was due to oil soaking into the windings, and recommended more care in bearing design. A member pointed out that the dust problem was very serious, as it was almost impossible to get rid of fine dust by blowing. Another member suggested the total enclosure of the ends of rotors to eliminate the dust difficulty, and suggested the need of careful standardisation in order to eliminate the keeping of too many spares. Mr. Morgan referred to the out of balance of high-speed rotors and the effect which the flexure of the shaft due to this cause had been the working of the oil along the shaft into the windings; he also emphasised the necessity for solid foundations for high-speed machinery. Considerable discussion arose concerning the burning out of the first few coils of a stator in switching on due to the choking coil action which they had, and auxiliary chokers in circuit were recommended. During the course of the discussion, Mr. Fisher gave in further detail particulars of the various breakdowns which had been classified in his paper, and a very interesting discussion was brought to a conclusion by further informal conversation over coffee.

Mining Exhibit at Brussels.

I have been informed that various colliery companies in this area are combining in order to exhibit at the Brussels Exhibition this year, and as electricity is playing such an important part in the operation of many of the large collieries, it is not surprising that there is a representation of this in the colliery exhibits. One of the items is to take the form of a model colliery, showing by means of elevation and section a typical East Coast mine in working operation, and part of the gear represented is, I understand, an electrical main and tail haulage on a small scale, while electric lighting, both at the pit bottom and at the face, is to be shown in miniature. In contrast with this, there are also to be exhibited some of the old and historic types of safety lamps, which have been preserved from the early days of safety appliances in mines.

Newcastle Corporation Tramways Department.

A festive event of unusual interest took place at the Continental Restaurant, Newcastle, on March 10, when 60 members of the Corporation Tramways Department Staff dined under the chairmanship of their manager, Mr. Ernest Hatton. A smoking concert was afterwards held, when songs and music were rendered by Messrs. Faddy, Watson, Thomson, Baker, Mansfield, and others, while Mr. Harold Glover contributed to the disorder by giving a Tyneside reading entitled "Geordie tries Cookin'." Through the kindness of Mr. Wells, the manager of the Empire Theatre, the company was favoured by a turn from Ted E. Box, which delighted everybody present, and the evening furnished such evidences of harmony and goodwill that it has been decided to make this occasion an annual one.

THE MIDLANDS.

BIRMINGHAM.

The discussion by the Birmingham Section of the Institution of Electrical Engineers of Mr. R. Orsettich's "Notes on Standardisation" last week brought out a great deal of useful comment. Mr. M. Railing, who was in the chair, showed himself strongly in favour of standardisation. It protected the manufacturer by enabling him to produce more cheaply and in larger quantities than if he had always to work to individual specifications. One machine was as troublesome as a hundred, and, under present conditions, often requires more special attention. Manufacturers would welcome standardisation as giving full employment to machines, tools, and workmen, and reducing the cost of production. The designer could make the best use of his knowledge and materials, for it was better to concentrate over standard component parts than to worry over one machine. The public would benefit by standardisation not only in regard to cheapness and the perfection of types, but also in being able, in case of breakdowns or urgent requirements, to draw readily upon existing stocks. Apparently, the rules laid down by the Institution were not by any means regularly adhered to by consulting engineers. If the rules did not cover the whole ground, they had better put their heads together and try to enlarge them. In regard to standardisation, their Continental friends were very much ahead of them, and the question of standardisation had become one of great national importance.

Designers' Tasks.

The designers' point of view was dealt with by Mr. S. P. Smith, who pointed out that in an electrical machine works the material was a much more expensive item than the labour, though it varied considerably for different kinds of machinery. The designer, therefore, might assist economy by designing the machines so as to secure good workmanship, and, at the same time, cut the material to the best advantage in relation to productive efficiency. Mr. Smith cited as an example the insulation of the slots. If only a small amount had to be paid for winding the armature it was clear that they could not expect the same quality of workmanship as when a higher price had to

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be paid, but if a somewhat higher price was paid the work would be done more carefully, and the designer would be able to use a finer insulation, the effect being that in the end the output of machines would be increased. With regard to the quality of material, it would be found that the extra cost would be amply repaid by an increased output for given rates. They must have a commercial interest in the machine as well as a scientific interest, and it would be to the interest of the consumer and of the manufacturer if the works cost could be reduced and the same efficiency guaranteed. One point upon which Mr. Smith insisted most strongly was the improvement in output, and indirectly in cost, that could be obtained by attention to ventilation and insulation. It seemed to him also very desirable that speeds should be reduced to some kind of geometrical order, with constant ratio, and in subjection to some law that the ratio should get larger as the speed increased. The great difficulty at present in the way of standardisation was the practice of specifying. It might be a very good thing for the consulting engineer, but there should be greater readiness to work to the manufacturer's specification.

Varying Frequencies.

The great variety of frequencies in use in this country was one of the principal points dealt with by Mr. Rosher. He found there were no fewer than 16 frequencies in use and they varied within such small limits as ·5. One important station had 83·5, and if a scheme could be reduced to decimals in that way it was a very efficient one. The speaker took up the cudgels for the engineers and said that his own experience was that the specifications for induction motors were very harmless and not at all unreasonable to work to.

Points in Construction.

The plea for standardisation was strongly supported by Mr. A. E. Gott, who said that the object of standardisation was to produce the maximum value at the minimum cost, and so enable them to compete with the foreigners who sent large quantities of stuff into this country, practically at works cost. The manufacturer had much to gain from standardisation, as without it it was almost impossible for him to stock for orders, a thing which was equally desirable from the purchaser's point of view. It was surprising the amount of money that was sometimes spent and often wasted in the locating of small oversights which greater standardisation would have prevented. He thought electrical motors, generally speaking, were too high in speed for good application, and that this largely accounted for their having more troubles than were found in other classes of machinery. Again, they could not have standard designs without standard voltages, and variations in this country were far more numerous than in America and on the Continent. Among the details mentioned by Mr. Gott as requiring consideration as a step towards standardisation was the arrangement of terminals. Very untidy arrangements were too often to be found. Sometimes they were fastened on the bed-plate because they had been left out of the designing machines. If machines were to be turned out quickly terminals ought to be so arranged that the assemblers could put the coils on to the terminals direct in such a way that the minimum of labour would be required.

Invention and Standardisation.

A fear that invention would be discouraged by standardisation was expressed by Mr. A. E. Anderson, while Mr. Willmot dwelt upon the importance of correct drawings as affecting shop organisation. It would be a great help to standardisation, the latter said, to have a correct code system for parts in the drawing office. Mr. Holt, in his remarks, deprecated the suggestion that progress would be stultified by standardisation, and expressed the opinion that though the development of electrical machines had not been sufficiently advanced until recently to allow of standardisation to any great extent the time had now arrived when types were sufficiently perfected to make standardisation an advantage. With regard to the ball bearings, Mr. Holt expressed himself more favourably than did the reader of the paper, and mentioned a machine of heavy type in which, although there was some little trouble at first, ball bearings had been successfully used. On this point, however, Mr. Orsettich, in his reply, said that he believed that that particular machine now had roller bearings, as it had been found impossible to run more than three or four weeks without the breaking of a ball. The Admiralty, he pointed out, would not accept ball bearings, and, as a split ball, if undetected for a time, would damage not only the bearings but also the shafts, this was a very serious matter. He had been surprised at the leniency shown that evening towards ball bearings, because at Glasgow the previous evening, in discussing his paper, the speakers were strongly hostile to them.

In Reply.

Among other points dealt with by Mr. Orsettich, in his reply, were the suggestions with regard to drawings and inspection. He agreed with the speakers as to the importance of these matters, but said that he had reserved them with other questions of shop organisation for a future paper. The matter of split rings had been referred to by some of the speakers, and with regard to that Mr. Orsettich said that the general rule was to divide any part which it took more than two men to lift undivided. With regard to metal for frames and yokes, he expressed a general preference for malleable cast iron, though he said there were many cases in which phosphor bronze answered equally well, though it was more costly and less durable. Manufacturers who had not a foundry no doubt often found it more advantageous to buy steel castings, but where there was a foundry a variety of patterns could be more readily secured by casting on the premises.

LANCASHIRE.

MANCHESTER.

Business is being well maintained in the district, and the works generally have sufficient orders in hand to keep them going comfortably. It is interesting to note that there are at the present moment some rather good contracts open in the district. At Bootle, the Corporation are requiring an automatic reversible traction booster, as well as some switchgear; while at Warrington a contract will shortly be placed for a 1,000 kw. turbo-alternator, a 750 kw. rotary convertor, as well as a quantity of switchgear. After Easter is over we shall be able to get some idea of what amount of replacement work is to be obtained from the mills and factories during the year. The cotton trade will then be in a more settled position, and depending on its prospects, the volume of re-construction work will vary.

Exhaust Gas Engines.

The advantages accruing from the utilisation of exhaust steam through exhaust turbines is pretty well known. It is not so generally known that steps have been taken to extract the heat from the exhaust gases of the gas engine. One way of doing this, which in the past has been rather successful, is to pass the gases through the flues of special exhaust boilers. In this way some 2 to 2½ lbs. of steam can be generated per b.h.p. Mr. Lockwood, of Sheffield, has been proposing a more direct and simpler method of using the exhaust. His method is to box in the crank chamber of the engine and to use two single-acting cylinders, though the method is not restricted to this. The exhaust gases enter this chamber together with a spray of water from the jacket water. This spray is converted directly into steam, and expanding helps to force the pistons back on the return stroke, at the end of which the steam and gas exhaust to the atmosphere. While there may, perhaps, be practical difficulties in carrying out this idea as suggested, it certainly deserves consideration as a means of cheapening power production.

Building Trades' Exhibition.

The sixth Building Trades' Exhibition was opened in Manchester on the 8th inst. by Sir Wm. Bailey, has been attracting considerable attention here. Coal, gas, and electricity are all represented in their adoptions to household service. There are several exhibitions of machinery running (chiefly for wood working), and these are all motor driven.

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G. Brady & Co., of Ancoats, Manchester, have a very interesting exhibit of lifts and hoists. There is an entirely new type of electric service lift to raise loads up to 56 lb. This is working, and one of its novelties is the use of steel tapes instead of wires or ropes, and it has been designed with a view to producing a reliable and efficient lift at a low price. It can be operated by push-button or hand-rope control. Other interesting exhibits on this stand are a worm-geared electric lift with two cages for quick service; an electric cat-head hoist for 2 cwt. loads at 80 ft. per minute winding (shown in operation); revolving shutters for large gateways, as at main sheds, etc.

C. C. MacCarthy & Co., of Manchester, show some specially powerful fans as used by the White Star Line. The blading is specially made so that the fan is kept very small in proportion to its capacity. A fan some 2 ft. in diameter direct coupled to a ¼ h.p. 800 r.p.m. motor is shown, which is claimed to equal in service an ordinary 36 in. box type fan. Some Admiralty pattern motors are also shown, the small 2 h.p. size being fitted with swivel bearings and double ring lubrication, while the terminals are enclosed in a very satisfactory manner.

J. Dugdill & Co., Failsworth, Manchester, also have a good show of their patent movable fittings for electric lighting. There is shown a "telescope tube pendant," with ball stem and universal joint. When lowering the lamp it is switched on, when raising, off.

The Fluxite Stand.

This stand seemed to attract a constant stream of interested spectators of the wonderful soldering and lead-burning demonstrations carried out by the firm's representative to demonstrate the capabilities of Fluxite. I had the pleasure of seeing it used to solder up a crack in a motor cylinder casting, which it did without any previous preparation. I also saw it used to tin iron through a thick coating of paint, as well as for lead burning with an ordinary blow-lamp. This preparation will solder any metal except aluminium without cleaning. There is only about ·05% of acids in it, I am told, as against ·3%, the usual amount in resin. It is stated to be entirely non-corrosive, and is being used by many of the largest engineering firms in the country for all kinds of work. One test I saw perhaps demonstrates its wonderful properties more clearly than the others. It consisted in the jointing of two pieces of ⅜ in. compo gas-piping. The two pieces were first well coated with *soap*, and then after smearing with Fluxite the solder was run round. A perfect joint was made at once without any trouble, and although the joint was afterwards well hammered and flattened, it did not "start" or break. With resin soldering the joint would start with very little knocking, while it would be necessary to scrape off every speck of soap before attempting to solder with it.

Matthews & Yates, Ltd.

This is a fine exhibit, and fans and exhaustors of all kinds are shown in operation. Some of the fans shown are separately driven by small "Swinton" motors (which this firm makes), while others are of the self-contained type. Some very interesting wood refuse collecting apparatus for use with wood-working machinery is shown in operation, while there is a model on view of a bank of six boilers for the Leeds City Tramways, which the firm have recently fitted with induced draught. Several types of open and protected fans were shown mounted on steel frame-work carrying all the necessary control gear. Altogether the exhibit attracted a good deal of attention, and the firm report a good haul of orders and enquiries.

The Reason Manufacturing Co., Ltd.

The exhibit of this firm consists chiefly of electric clocks of various descriptions, suitable for observatories, schools, hotels, factories, private houses, and other places where uniform time-keeping is required. Both pendulum and balance-wheel types were on view. These are made under Murday's patents, and are worked from two small dry cells contained in the clock case. These are sufficient to run the clock for an average period of three years without attention. In the balance-wheel type, a rather neat method of giving the wheel the necessary impulse to take it round is used. At intervals of about 1½ minutes a solenoid is momentarily energised, and causes the balance-wheel to receive an impulse which keeps it going for that length of time, contact being again made when the wheel slows down to a certain point. A "Mermaid" electric clock in a handsome case, with 4-inch dial, was shown running off the 220 volt mains to which it was connected through a wall plug. A new door control device was also on view. This exhibit was interesting, in view of Mr. Hope's recent paper, and attracted much attention.

GERMANY.

BERLIN.

A few particulars about the electric power stations belonging to the towns of Botzen and Meran are now to hand. They supply light and power not only to the towns named, but also to many neighbouring places. The source of power is the river Etsch, which, with a head of 70 metres, and an average flow of 15 cu. metres per sec., yields 16,000 h.p. from the turbines, six in number. A 92-phase current of 12,000 volts supplies Botzen and the neighbourhood by means of a cable 30 miles long. Meran, on the other hand, requires a smaller current, which reaches the transformers at from 3,000 to 3,600 volts, while supplying 2,000 h.p. to the Electro Bosna ferro-silicon works. It goes without saying that these currents feed the street trams. The work is to be supplemented by getting power from the Schnalsbach, a tributary of the Etsch, which, with a head of 310 metres, is expected to yield 15,000 h.p. with a flow of five cubic metres per second.

Wireless on Sailing Ships.

The first sailing ship to be equipped with a wireless installation is the *President Herwig*, a collector from the fishing vessels in the North Sea. It is true that nothing much has been done yet with the installation, but it has not yet had a proper chance. If it proves useful, all the other collectors will be equipped in the same way.

Wireless Communication between Germany and Her Colonies.

Investigations which have been proceeding for a long time with a view to establishing wireless communication between Germany and her colonies have resulted so favourably that the erection of wireless stations has begun in German East Africa, German South West Africa, the Camerons, and in the German islands in the Pacific. We hear, too, that the Russian Government wants the United States to instal wireless telegraphy between Kamschatka and Alaska, across the Behring Sea, a distance of nearly a thousand miles.

Problem of Electric Power Source in Pforzheim.

Pforzheim, which is the Birmingham of Germany, is seeking for fresh sources of electric power, as those at the disposal of the municipality are becoming inadequate. All sorts of suggestions have been made to the authorities. One has reference to the river Enz above the town and on Wurtemberg soil. Another chooses the same river, but prefers to tap it below the town. A third contemplates getting power from the Nagold at Dillstein, while others think the Murg will be best. Perhaps all schemes may be adopted.

Company Notices.

The Leipzig electric street railways are paying 5½% for 1909, as against 5% for 1908, and are increasing their capital from 6¼ to 8 million marks.

The fall in prices of metal filament lamps in Germany still continues. The firm of Julius Pintsch, A.G., has lowered their price from 3 marks to 2 marks for pear-shaped lamps of from 25 to 50 c.p., requiring from 100 to 135 volts. For 50 c.p. lamps requiring 170 to 250 volts, the reduction is from 3½ to 3 marks each. The spherical forms are, of course, dearer, but have been reduced in the same proportion.

UNITED STATES.

NEW YORK.

Not by any means for the first time, it has been suggested in the course of a paper read recently before the Boston meeting of the A.I.E.E., that tungsten and tantalum, wonderful though they are, have only brought us to the threshold of the new era of electrical illumination. Though an immense stride has been taken from the carbon to the

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metal filament, illuminating engineers are confident that still more remarkable developments are coming in the very near future. Fresh experiments now in progress in their laboratories indicate that though much has been achieved, much more still remains to be accomplished. In the course of the paper referred to, which was read by Mr. G. H. Stickney, the writer points out that the tungsten lamp has practically revolutionised commercial lighting. It is, he says, by far the most efficient of the incandescent class, and though the maintenance may seem high, in some cases, it is rapidly being reduced with the progress of development, while where lamps are protected from excessive vibration and shock, the tungsten is giving an exceedingly long burning life. The remarkable developments of the last few years, he adds, and the remoteness of ideal efficiency, give promise of further development and improvement in illuminants. "The importance of these developments in cheapening and at the same time improving the artificial illumination of industrial processes behoves the manufacturer to keep abreast of the times. It should be borne in mind that the first cost of almost every type of electric lamp is relatively small, as compared with the cost of a year's operation, so that the user can afford to take advantage of the developments, even to the extent of throwing out his old lamps and putting in new ones at reasonable intervals."

The Central Station Specialist.

The necessities of the age and the new conditions which obtain with regard to the production, distribution, and sale of electricity have produced in the United States a new type of central station specialist. According to the Chicago *Electrical Review*, not a few of the smaller companies have found the work of power solicitation difficult and perhaps costly; and many times the most painstaking efforts to obtain and keep motor service have fallen short through the absence of a broad knowledge of power economics in the soliciting staff. Out of the incompleteness and obstacles which have occupied the stage in many cases has come an economic demand for a new type of central station specialist, who can give a number of co-operating companies the benefit of a wide and deep experience, take command of difficult situations with a fair prospect of success, and point out wherein progress can be made in the handling of established and anticipated customers' power situations. The *Review* cites a case in which a start has been made in this direction with the prospect of decided gains in the power earnings and profits of the companies which are availing themselves of specialised advice.

Co-operative System at Work.

While to a certain extent the work of the specialist naturally follows that of the consulting electrical engineer, who makes a speciality of industrial power problems, it has this point of interest to the central station, the specialist in power service retained by one or more companies in the same general district makes a particular point of securing this business for the public utility combinations which employ him, and as the basis of a much wider experience than an ordinary company can afford to pay for in the form of a regular employé earning a relatively high income. In this way several companies, the number being immaterial, may combine to secure the supervision of the power specialist in connection with their new business departments; and the old staff of solicitors may be retained or removed as occasion dictates. The power specialist under this plan is retained for a moderate yearly sum per company, he maintains a general oversight and correspondence with his clients on the basis of this fee, and when his presence is demanded by difficult conditions or other factors, he visits the client at a per diem rate lower than many outside firms of engineers would charge. So far as the work has gone in the instance cited, the *Review* says that the companies have received the benefits of broad experience in the handling of existing installations; established customers' plants have been improved in efficiency from 20 to 30%; the solicitation of new business has been brought under the eyes of technical ability derived from many years of actual contact with the immediate problems of small motor applications in industrial plants; the making of contracts has been placed upon a standard basis; guaranteed results have been placed in front of the prospective consumer; the influence of the power load upon the economy of production at the power station itself has been recognised, and the client organisations have availed themselves of a source of data covering a wide variety of industrial applications, much of the material being hitherto inaccessible to single companies.

Catenary Suspension Tests.

Details are published this week of the results which have so far been noted in connection with the service tests of catenary suspension systems, which have been in progress for nine months past on an 11,000 ft. section of the Connecticut Railway. Six leading manufacturers, the Ohio Brass Company, the Westinghouse Electric and Manufacturing Company, the Electric Service Supplies Company, the Electric Railway Equipment Company, the Johns-Manville Company, and the General Electric Company were each requested to erect an installation of about 1,700 ft. of single catenary for wheel operation at speeds of 40 m.p.h. The messenger sag, the types and spacings of hangers, and the general details of design and installation were left to the manufacturer, subject, however, to the condition that the poles were to be spaced 150 ft. apart on tangents and 75 ft. apart on curves, with the nearest face of the pole distant at the level of the top of the rail, 10 ft. 6 in. from the centre line of the steam track, and 7 ft. 6 in. from the centre line of the track in the highways. Bracket construction was specified for tangents, and both span and bracket construction for curves of all details of the various installations are given in the *Electric Railway Journal* for February 26, and are well worth careful study. The behaviour of all the installations was satisfactory, but the general result of the test was once more to emphasise the need of standardisation.

Effects of Single-phase Development.

In the course of some editorial comments on the tests, the *Journal* observes that it was recognised at the very beginning of the single-phase railway movement that the adoption of a tenfold and even twentyfold greater trolley wire potential would require radical variations from the types of bracket and span construction than in use for direct current railways; but few people foresaw that the new construction would react in revolutionary fashion on the apparently fixed standards of the older lines. The alternating current catenary construction was evolved primarily to satisfy more onerous electrical conditions, but its mechanical advantages have become so pronounced that there is now a strong feeling that the two-wire suspension should be considered also for low tension, direct current roads operating in open country. "Advantageous as the catenary suspension may be, however," adds the *Journal*, "there is still a wide divergence of opinion as to the details of construction. Until some general standards have been fixed, many railways will refuse to leave the companionable road of custom. In this connection the Connecticut Company's experimental work deserves particular notice. It is hoped that the observations to be taken will make it possible for the company to draw up eventually a standard form of specification which will satisfy the requirements for direct current interurban railways operated at moderate speeds."

A New Starting Switch.

To meet the problem involved in the circumstance that the starting current of an alternating current induction motor is often practically three times the normal running current, so that if the controlling switch is fused to carry running current only, the fuses are apt to blow when the motor is started, a new alternating current motor-starting switch has been designed by the Trumbull Electric Manufacturing Company, of Plainville, Conn. The motor is started by throwing the switch into the unfused contacts, the blades being held for a few seconds until the motor speeds up, when the switch is thrown over into the fused end which carries the normal full-load running current. At the unfused or starting end of the switch is a spring attachment which automatically throws the blades out of contact, thus obviating any danger of leaving the switch closed on the unfused end. All the 30 amp. switches are

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made of 60 amp. material, but fused for 30 amp., and similarly for the larger switches. A special angle spade handle is used, which enables the switch to be thrown from the starting end without twisting the wrist, and it is so raised as to have a good clearance over the fuses. The switch is built in two styles, for 250 and 440 volt alternating current work.

New Power Developments.

Work on a $600,000 power plant for the California Edison Company will begin this spring in Santa Ana canyon, says a correspondent of the Chicago *Electrical Review* and *Western Electrician*. The plant will be known as No. 3, and will be the largest operated by the company in this section. It will have a 7,000 kw. capacity or double what any one of the present plants have. The structure with the other extension work will amount to about $600,000.—The Maumee Rapids Electric Company, with an authorised capital stock of $350,000, has acquired a power plant at Miami, where it will instal new machinery, using water power from the canal. It has water rights at Maumee and Grand Rapids, O., and will build plants at these places giving about 10,000 h.p. Under its State franchise it is able to get into the heart of Toledo along the canal bank.—The Commonwealth Power and Water Company has been incorporated in Spokane County, to expend $5,000,000 in developing power on the Spokane, Columbia, and Snake Rivers. This will be in connection with an extensive irrigation plant designed to supply moisture for a large tract of land near this city, also providing light and power for a number of towns in the district.—The Kennebec Development Company has made plans for the retention and utilisation of some of the power now running to waste in the Kennebec River. Three dams are to be built at a probable expense of $9,000,000, and the 91,000 h.p. developed will be transmitted to all parts of Maine.—It is also announced that the plant of the Washington Water Power Company, of Spokane, at Little Falls, on the Spokane River, will be ready for operation early in June. The work on the plant, which will develop more than 30,000 h.p., has been in progress 22 months. The turbines, of which there are four, are designed to develop upward of 9,000 h.p. if put to fullest capacity.—Spokane Railway and Power Company, capitalised at $2,000,000, has filed articles of incorporation to build a plant to develop between 30,000 and 35,000 h.p. in the Spokane River, 30 miles below Spokane. The plant will cost $1,500,000, and is to be in operation within two years. The President of the Company says: "We will enter the Spokane market as distributers of electric light. This does not mean that we are in opposition to the Washing Water Power Company, but we recognise Spokane as an open market, and we will develop our power for the purpose of sale and distribution in Spokane. We will be able to sell power delivered in Spokane at $14 a horse-power. Our power plant will cost about $1,500,000 when completed."

Bituminous Gas Producer Plant.

The Amarillo (Texas) Water, Light, and Power Company has recently installed a Westinghouse bituminous gas producer plant for supplying its 300 h.p. Westinghouse gas engine-driven alternator set. This new bituminous type T producer is charged with coal costing $3·50 to $4·75 per ton, and delivers fuel gas having a calorific value of 110 effective B.T.U. per cubic foot. The gas engine is of the single crank horizontal type, with cylinder 18 by 26 in., and delivers 300 brake h.p. Three-phase, 60 cycle power, generated at 2,300 volts, is used for local lighting and power in Amarillo. The development of a successful bituminous gas producer plant has received the attention of the engineers of the Westinghouse Machine Company for several years, and in this direction severe and prolonged tests were carried out on the apparatus, before the present highly successful bituminous producer was placed on the market.

Cost of Electric Power.

The report of the Public Service Commission on the charges imposed for electric power by the Buffalo General Electric Company and the Cataract Power and Conduit Company claims to demonstrate that Buffalo manufacturers are compelled to pay from 25 to 50% more for power than the contract rates in Toronto, despite the fact that the electricity is produced at Niagara Falls in both cases, and that Toronto is 70 miles farther away from the Falls than is Buffalo; that electric lighting for householders and offices in Buffalo is 80% higher than in Toronto, although the Canadian city is more than four times the distance from the Falls; that of a total capitalisation in the two companies of $9,250,000, the "watered" stock amounts to $5,750,000, which is declared to mean that the people of the city are paying in their electric power bills a profit on more than 60% of fictitious capital; that even on this enormous capitalisation the company was able to put away a surplus in 1908 of $64,122 after paying dividends varying from 5 to 6% on the bonds and stock, "water" and all; that the Cataract Power and Conduit Company—the transmitting company between Niagara Falls and Buffalo—buys power from the generating company on a 24 hour basis, and sells it to manufacturers in Buffalo during the working hours, and at night the General Electric Company sells it for lighting, thereby making two big profits on the same commodity in the 24 hours; and, finally, that the Buffalo General Electric Company—the distributing company in Buffalo—the Cataract Power and Conduit Company, and the producing company at the Falls, are practically all one, the latter owning more than one-half the stock of both the other two, thus subjecting Buffalonians to the tyranny and rates of a monopoly.

Other Charges.

This is pretty severe—though it has to be remembered that the Corporations concerned have yet to be heard from—but it is by no means all. The report goes on to say: "We find the monthly bill for electric house lighting, which, to a citizen of Buffalo is $4·50, will be to a citizen of Toronto only $2·50, and that this $4·50 bill to the Buffalonian will be $4·95 if paid on the 11th instead of the 10th of the month. We further find that the power for which a manufacturer in Buffalo would pay $6·025 per year will cost the manufacturer in Toronto only $5,180. Yet Buffalo is 70 miles nearer than Toronto to the common source of supply, and ought, therefore, if for no other reason, to have lower prices." It is also declared by the Commissioners that more than five-sixths of all the electric power consumed in Buffalo is produced on the Canadian side at Niagara Falls. The Cataract Power and Conduit Company transmits the power from the Falls to Buffalo, and while it purchased during 1908 only about $100,000 worth of electricity from the Niagara Falls Power Company on the American side, it paid $468,752 to the Canadian Niagara Falls Power Company, and $72,444 to the Toronto Power Company. The Cataract Power and Conduit Company paid to the producing companies at the Falls $641,196 for power in 1908, and received for this power a total revenue of $1,055,481, or a difference of $414,285. The Buffalo General Electric Company bought during the same year electric power for which it paid $250,793, most of it being purchased from the Cataract Company, a fraction having been obtained from the Niagara, Lockport and Ontario Power Company. For this $250,793 paid for power in 1908 the Buffalo General Electric Company received the enormous amount of $891,476, or nearly four times as much as paid for it to the Cataract Power and Conduit Company and Niagara, Lockport and Ontario Power Company.

Current Items.

Electric railroad men in the Western and Central parts of the State are planning a 2,000 mile trolley trip to be begun in the early part of May. It is planned to take a special car and be on the road 12 days. Among the places to be visited are Cleveland, Columbus, Cincinnati, Indianapolis, Louisville, Fort Wayne, Toledo, and Detroit.

Consolidation of the interests of the Susquehanna Smelting Company of this city and the Electro-Metallurgical Company of Niagara Falls is announced by H. C. Harrison, vice-president of the former concern. Both firms manufacture a product known as ferro-silicon, used in the manufacture of steel. Losing competition with the foreign market and greater economy with their interests united are stated to be the reason for the move.

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Business Notes and News.

LIGHTING AND GENERAL—Home.

COOKSTOWN (Ulster).—A proposal is before the Urban Council that they take steps to provide electricity for public and private lighting.

DUNDEE.—A scheme is on foot for supplying electricity for power and lighting purposes to the roundabouts, etc., in the Green Market. The borough electrical engineer estimates that a cable costing £120 would be necessary for this.

EDINBURGH.—The City Electrical Engineer and Architect are preparing plans of cooling towers to be erected at the municipal electricity works.

HARROGATE.—There is a proposal to convert the whole of the street lamps for electric lighting.

LEEDS.—Business men are urging that in view of the G.P.O. taking over the National Telephone system next year, the service should be municipalised.

LONDONDERRY.—A Local Government Board inquiry is to be held on the 22nd to consider the application for sanction to raise a loan of £10,000 for electric light extension purposes.

LOWESTOFT.—It has been decided to substitute electric for gas lighting in thirteen thoroughfares. The transformation is to take place gradually.

NORWICH.—Application is to be made to the Local Government Board for authority to borrow £17,783 to defray the cost of new mains, services, exhaust steam turbine with condenser, steam exhaust, water pipes, etc., centrifugal pump, coal elevator, feed water filter, and other plant.

OSWESTRY.—The Oswestry Electric Light Co. have written to the borough council complaining that the lamps in the Cross Markets were of obsolete type and of varying pressure, to the prejudice of the consumers and the company. A scheme for replacing the old with a less number of modern lamps is to be prepared.

SOUTHPORT.—It is proposed to apply to the Local Government Board for powers to borrow £31,255 for development of the electricity works. The suggestion is to gradually dispose of the machinery at Llanarth-street and to concentrate generating at the East Usk station.

WARRINGTON.—It has been decided to invite tenders for new machinery at the electricity station, to cost about £8,000. This would increase the works capacity by about 50%. When tenders are received the whole scheme is to be finally considered by the Council.

WEDNESBURY.—A Local Government Board inquiry has been held into an application for sanction to the borrowing of £2,095 for the purpose of the electricity undertaking. The greater part of the money was required for the purpose of small mains, extension of services and meters, and a portion of the outlay has already been incurred. In view of this the Corporation asked that the application should be for a loan of £2,925. The Inspector commented on the fact that there had been a loss of about £4,000 upon the undertaking; but the Town Clerk, in reply, stated that there was reason to believe the undertaking had now reached the turning point. The present loan was needed for extensions, which it was hoped would lead to the electricity scheme becoming a financial success. There was no opposition.

WIGAN.—At the Local Government Board inquiry into the application for powers to borrow £36,000 for electricity purposes, Mr. James Slevin, the borough electrical engineer, explained that it was proposed to remodel the two existing stations, whereby it would be possible to effect a saving of £2,667 on the generation of the present output of 3,743,183, so that, allowing for interest and sinking fund, a net saving of £500 per annum would be made, while the capacity would be extended by 520 kw. It was also intended to expend £2,410 on a low tension cable to be laid in Ince-in-Makefield, whose Provisional Order Wigan had recently taken over.

YORK.—The new scheme for lighting Fulford-road, consisting of fixing Osram lamps to alternate tramway poles is giving complete satisfaction, and may be extended.

LIGHTING AND GENERAL—Overseas.

NAPLES.—The Societe Italiana Elettrochimica of Rome has started making a big station for supplying Naples with current, at Torre dei Passeri, where a waterfall on the river Pescara is expected to yield 27,000 h.p. In view of the distance between the station and Naples, about 120 miles, the current has to leave the starting point at a very high tension. The voltage contemplated is 88,000, and will be the highest as yet employed in Europe for similar purposes. The plant will be driven by four turbines of 900 h.p. each.

MELBOURNE.—The Chiltern Valley and South United Mine, Rutherglen, Victoria, is to be re-opened. The power is to be electrical, Messrs. Siemens supplying the plant through their Melbourne house; and Messrs. A. Cowan & Sons, Melbourne, acting as agents of Messrs. Crossby, will supply two 100 h.p. suction gas engines to drive the generators.

MONTREAL, QUEBEC.—The Bergmann Electrical Works, of Berlin, Germany, are introducing their Tungsten lamp into the Canadian market through their representative, Dr. C. Rossner. Dr. Rossner, who, before taking his present position, was for a time assistant secretary of the Montreal Trust Co., states that if the business of the company shows sufficient growth, branch works for the manufacture of the Bergmann Tungsten lamp will be established in Canada. The recent alterations in the tariff arrangements between Canada and Germany means that these lamps will enter Canada from that country at an average duty of about 30% instead of 40% as formerly.

PERTH, WESTERN AUSTRALIA.—The City Council having rejected the previous proposal of the Perth Electric Tramways, Ltd., that the company's lines should be taken over by the council at once for the sum of £400,000, instead of in 1939, when they would become the property of the council without purchase, a fresh proposal has now been made by the company, namely, that the suburban rights, which do not lapse at the same time as the city rights, be bought out at £100,000. The offer is being discussed by a civic conference.

TORONTO, ONTARIO.—It is reported that the Ontario Electrical Development Co. will increase the capacity of their plant from 50,000 to 85,000 h.p. In the supplementary estimates of the Provincial Treasurer are included the following items: Electric plant, Hamilton Asylum, $12,000; electric plant, London Asylum, $25,000; electric plant, Ontario Agricultural College, Guelph, $15,000; new wing at Osgoode Hall, $50,000; colonisation roads, $464,000; other public works, $37,940.

TRACTION—Home.

BELFAST.—It has been decided to promote "a Bill in the present session of Parliament to confirm an agreement between the Cavehill and Whitewell Tramway Co. and the Corporation for the purchase of the company's tramway and their lands at Drumnadrough and Glengormley, at a price to be fixed by an arbitrator, and to wind up the said company; to determine out of what fund or funds, rate or rates, the costs and expenses attending the promotion of such Bill shall be defrayed; and to pass such resolution or resolutions touching the matters aforesaid as the said Council may deem expedient." It is estimated that the purchase price would be about £60,000, but another £20,000 would be required to double the line.

LINTHWAITE (Yorks).—The Urban Council have accepted Messrs. J. H. Hanson & John Haigh's plans and specifications for the reconstruction of the tramways.

LINTHWAITE.—The arbitration order, whereby the council was made liable for relaying the Huddersfield Corporation tramway track throughout the borough by the end of May next, is causing much anxiety. Negotiations for the sale of the tramway line to Huddersfield are still proceeding.

LOWESTOFT.—Messrs Wimpey & Co. have completed their work on the tramway track and have received the Corporation's vote of thanks for excellence and despatch.

TRACTION—Overseas.

BAHIA BLANCA.—The first section of the electric tramway has been thrown open for traffic.

BREDA (Holland).—The communal authorities have under consideration an application from Messrs. J. Presse & Co. for a concession to construct and run an electric tramway.

BUENOS AIRES.—Messrs. F. Martinez de Hoz & Co. have applied to the Municipality for a concession for a subterranean network of a mono-rail system.

CONSTANTINOPLE.—The Minister of Public Works has drawn up a general memorandum relating to electric lighting and traction, and that, with a view to the granting of a large number of concessions for electric tramways, and electric lighting and power plants, a circular has been sent to the principal towns in Turkey requesting the local authorities to state their views on the matter and to forward a reply within one month.

GOOISCHE (Holland).—The municipal authorities have granted a provisional concession to the Gooische Steam Tramway Co. for the proposed extension of the line from Hilversum to Bussum, the electrification has, therefore, apparently been dropped.

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HILVERSUM.—Mr. Zeurcher is seeking a concession to construct an electric tramway between Hilversum and Hieuwersluis railway stations, and this will be granted by the municipalities, subject to the approval of the respective railways.

JAMALPUR, INDIA.—Orders have been placed at home by the East India Railway Co. for machinery connected with the electric installation at the Jamalpur locomotive workshops, which will comprise three 25 h.p. electric motors, together with the necessary cables, portable hand lamps, etc.

RIO DE JANEIRO (Brazil).—H. M. Consul General reports apropos of the extension and electrification of the Victoria-Diamantina Railway, that "definitive studies" were to be begun at once from the Barra do Rio Santo Antonio, on the river Doce, to Itabira do Matto Dentro, and from Itabira to Santa Anna dos Ferros, a total distance of 300 kms. (about 186 miles). It is hoped to complete these surveys within a very short time.

CONTRACTS OPEN.

HOME.

ABERDARE.—Urban Council invite tenders for: (*a*) Generating station buildings; (*b*) two high-speed reciprocating engines, direct coupled to direct current generators (200 kw. and 100 kw.), balancer, booster, switchboard, steam and exhaust piping; (*c*) battery of accumulators (500 amp. hour capacity); (*d*) cables, sheet work, junction boxes, switch pillars, etc. Particulars from Clerk to the Council, Aberdare. April 9.

BEDFORD.—Corporation invite tenders for one 750 kw. direct coupled steam driven single-phase alternator and exciter. (Particulars from Mr. R. W. L. Phillips, Borough Electrical Engineer). March 28. *See* page 340.

BOLTON.—Borough Council.—Electricity Department.—Annual supplies. (Particulars, Borough Electrical Engineer, Spa-road). March 31.

COLINTON.—The Colinton Tramways Co. invite tenders for the excavation and banking for formation of roadway. Note: This contract is mainly for earthwork and does not include track laying or electrical equipment. Particulars from J. & A. Leslie & Reid, engineers, 72a, George-street, Edinburgh. March 23.

DUNDEE.—Town Council invite tenders for the supply of: (*b*) General stores; (*c*) meters to be delivered over a period of 6, 9, or 12 months as required; and (*d*) for the insurance for the next year of the boilers at the Carolina Port Generating Station. Particulars from the City Electrical and Tramways Engineer. Tenders by March 31.

GLASGOW.—Corporation Electricity Department.—Cables, meters, carbons, gas and steam tubes and fittings. (Specification £2, W. W. Lackie, 75, Waterloo-street). March 29.

NEWPORT.—Tenders invited for second-hand material. Particulars from Borough Electrical Engineer. *See* page 340.

SALFORD.—Education Committee invite tenders for the electric wiring of the Wellington-street Boys' School, Pendleton. Particulars from Borough Electrical Engineer. March 31.

SUNDERLAND.—Borough Council.—General electrical supplies. (Particulars from Borough Electrical Engineer). March 31.

WARRINGTON.—Borough Electricity Department invite tenders for: (1) 1,000 kw. turbo alternator; (2) 750 kw. rotary converter; (3) switchgear. Particulars from F. V. L. Mathias, borough electrical and tramway engineer, Horley, Warrington. March 22.

OVERSEAS.

ANTWERP.—Lower Scheldt Works.—Electric lift for vehicles on floating pier. Dep., £320. (Specification No. 19, 2d., plans 1s. 5d., Direction du Service Spécial de l'Escaut Maritime). June 16.

BUKAREST.—War Office.—Incandescent lamps, Edison globes, projectors, etc. (Particulars, Direction de la 7me Intendance Militaire). April 1.

CUBA.—The "Gaceta Oficial" of February 9, publishes a notice inviting tenders for the establishment and working at Santa Fé (Island of Pinos) of a telephone system within a radius of ten kilometres. Tenders, enclosed in sealed envelopes and accompanied by a provisional deposit of 200 pesos official currency, should be addressed to the "Secretaria, Direccion General de Comunicaciones, Gobierno Provincial," Havana, where they will be opened at 2 p.m. on March 28.

GHENT (Belgium).—Municipal authorities invite tenders for the supply of three electric cranes. Tenders, accompanied by a deposit of 2,000 francs (£80), should be addressed to "Monsieur le Maire, l'Hôtel de Ville," Ghent, and should reach their destination not later than April 2.

ROME.—Italian State Railways.—50,000 metal filament lamps. (Particulars, Direzione-Generale, *via* Ludovisi.) April 24.

TENDERS ACCEPTED—Home.

ST. MARYLEBONE.—Tenders accepted: (1) For the supply of paper insulated lead covered and armoured cable, at the following prices per 220 yards, viz.: Aubert Grenier & Co.: S.W.G., 7/20, 5 core, £11 19s. 2d.; ·050 sq. in. concentric, £18 1s. 8d.; ·1 by ·1 by ·05 sq. in. triple concentric, £41 1s. 4d.; ·15 by ·15 by ·075 triple concentric, £55 13s. 8d.; ·25 by ·25 by ·125 triple concentric, £86 12s. 4d.; ·4 by ·4 by ·15 triple concentric, £124 9s. 4d.; ·5 by ·5 concentric, £120 10s.; 1 sq. in., single, £115 3s.; ·15 by ·15 by ·075 triple concentric, armoured, £64 14s. 8d.; ·25 by ·25 by ·125 triple concentric, armoured, £97 0s. 4d.; ·4 by ·4 by ·15 triple concentric, armoured, £139 9s. 4d.; 1 sq. in., single, armoured, £125 13s.—Standard Cable Manufacturing Co., Ltd.: S.W.G., 7/18 single, £4 0s. 6d.; 7/16 single, £5 2s.; 3/20, twin, £6 10s.; ·025 sq. in. concentric, £11 11s.; ·025 by ·025 by ·025, triple concentric, £16 11s.; ·050 by ·050 by ·035, triple concentric, £26 10s.; 7/20 S.W.G., 5 core armoured, £16 5s.; ·025 sq. in. concentric armoured, £15; ·050 sq. in. concentric, armoured, £22 10s.; ·025 by ·025 by ·025 triple concentric, armoured, £21; ·050 by ·050 by ·035, triple concentric, £30 10s.; ·1 by ·1 by ·05, triple concentric, armoured, £47 15s.; ·5 by ·5 concentric, armoured, £131. (2) For the supply of cut-outs, house service boxes, and disconnectin boxes, and have selected the following (which are the lowest), viz.: Lucy & Co., Ltd.: Cut-outs, ·03 concentric, 6s. 5d.; ·03 triple concentric, 9s. 4d.; ·06, concentric, 6s. 6d.; ·06, concentric, 9s. 5d.; lead service boxes, positive, negative, and triple, 3s. 7d., 4s. 4d., and 4s. 11d., respectively; positive service box fittings, 10½d.; disconnecting boxes and C.I. pits, 4 way, £6 10s. 6d.; 3 way, £6; extras, 6s. 9d.; C.I. pits only, 13s.; covers only, 11s. 6d.—Consolidated Electric Works and Appliances, Ltd.: Cut-outs, 1, ·15, and ·25; triple concentric, 12s.; ·4, ditto, 12s. 6d.—Callenders Cable and Construction Co., Ltd.: C.I. service boxes, positive, negative, triple, and double, 6s. 1d., 7s., 6s. 9d., and 7s. 6d. respectively; lead boxes, double, 11s. 1d.—Sykes & Sugden, Ltd.: Service box fittings, negative, 1s. 9d.; plain bridge type, 1s. 6d.; triple service box fittings, 1s. 9d.; double service box fittings, 1s. 11d.—British Insulated and Helsby Cables, Ltd.: Service box fittings, positive plain bridge type, 10¼d. We recommend that the tenders of the above firms for the supply of cut-outs, service boxes, and disconnection boxes, at the prices stated, be accepted, and that the seal of the Council be affixed to the necessary contracts.

SOUTHPORT.—Leyland Motor Co., Ltd., Leyland, near Preston, for supply of a motor tower wagon for the Tramways Department, £475 (accepted), The Vulcan Motor Co., Southport, £385.

TENDERS ACCEPTED—Overseas.

PRETORIA (Transvaal).—The Town Council accepted the tender of Mr. H. Rainey for the laying of the electrical tram track, for £43,408, and reserved the right to accept the same tender for macadamising the outside of the track, making up of streets, etc., for a total sum of £75,551.

COMPANIES' MEETINGS AND REPORTS

GATESHEAD AND DISTRICT TRAMWAYS.

The directors recommend a 6% dividend on the Ordinary shares for 1909.

CANADIAN GENERAL ELECTRIC.

The directors have declared a dividend of 1¾% on the common stock for the three months to March 31, being at the rate of 7% per annum, and a dividend on the preference stock at the rate of 7% per annum, for the half-year to the 31st inst.

MADRAS ELECTRIC TRAMS.

The directors of the Madras Electric Tramways (1904), Ltd., have declared a dividend of 1% (1s. per share) on the deferred shares, and at the rate of 4½% per annum, in addition to ¾% actual, on the preferred ordinary shares, making 5¼% for the year to December 31. The sum of £3,000 is transferred to depreciation and renewal fund, £41 to surplus dividend account, and £663 carried forward.

TORONTO ELECTRIC LIGHT.

The report states that the income for the year to December 31 was $1,292,545, and the expenses (including interest on debentures) were $761,838, leaving a balance of profit of $530,707, out of which have been paid four quarterly dividends at the rate of 8% per annum, amounting to $315,493, leaving a balance of $215,213 to be carried

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forward to profit and loss, and bringing the amount at the credit of that account up to $226,174. Of this amount, the sum of $200,000 has been transferred to the reserve account.

MIRLEES WATSON CO.

At the annual meeting, held in Glasgow, the profit and loss account submitted showed a profit on the trading account of £24,530, and after providing £3,521 for depreciation and for interest and directors' fees, a balance of £18,802 remained, which the meeting resolved should be applied as to £9,375 in payment of dividend of 7½% on the share capital, free of Income Tax, as to £5,000 in providing for new tools, and as to £4,000 by transference to general reserve fund, the balance of £1,677 (including £1,250 brought in from last year) being carried forward.

MELTON MOWBRAY ELECTRIC LIGHT.

At the tenth annual meeting Mr. W. New presided. The directors recommended a dividend at the rate of 2½% per annum. In moving the adoption of the report, the chairman said he thought it must be admitted that whatever the company might have done, it had been salvation to the ratepayers as regarded the cost of street lighting. In 1901, when their company first tendered for public lighting, the town was paying £385 per year for lights at 146 points, amounting to a total of about 1·836 c.p. The present contract was only £357 10s. for 178 lighting points, and the total candle power was about 21,000.

SCARBOROUGH ELECTRIC SUPPLY.

The report of the directors of the above company is as follows:—The amount of energy supplied during the year has increased to 846,022 units, as against 837,835 units for the year 1908, but the receipts have fallen owing to the reduced nett price obtained per unit. This is mainly due to the greatly increased use of the new metallic filament lamps, which consume much less energy than the old carbon lamps, having reduced the number of units sold at the higher rates. The consequent cheapening of the electric light has, however, been the means of bringing on a number of new consumers. The accounts show that after placing the sum of £1,500 to depreciation account, there is a balance on revenue account of £3,851 2s. 1d. The directors recommend that a dividend be paid free of income tax at the rate of 3% for the year, which will absorb £3,000 leaving a balance to be carried forward of £851 2s. 1d.

BASTIAN METER CO.

The twelfth annual general meeting was held at the Inns of Court Hotel, when the chairman, Mr. J. W. Salisbury, was able to inform the shareholders that the result of the year's trading showed an increase as compared with last year. The report stated that the directors having written off patents and goodwill the sum of £870 6s., the nett amount of profit for the past year as shown in the balance sheet was £322 12s. 9½d., to which had been added the balance brought forward from 1908 of £582 2s. 4d., less £120 13s. 2d. paid on June 30th, 1909, for 6% cumulative preference dividend to December 31, 1908—making together a sum of £798 1s. 11½d. The directors recommended the payment of the 6% dividend on the cumulative preference shares and also a 2½% dividend on the ordinary shares for the year ending December 31, 1909, which, together would absorbed £368 12s. 2d., and that the balance, £415 9s. 9½d., be carried forward. The report was adopted and Mr. T. H. Thurburn was re-elected a director.

COUNTY OF DURHAM ELECTRICAL POWER DISTRIBUTION CO.

The report for the year ended December 31, 1909, states that the total connections to the company's system at the end of the year (including the connections of its Associated Parliamentary Company, the County of Durham Electric Power Supply Co.), amounted to 35,024 h.p., which, compared with the previous year's figures of 29,336 h.p., shows an increase of 5,688 h.p. The profits of the year, together with the balance of £151 2s. brought forward from 1908, amount to £31,262 17s. 4d., against which has been charged interest on loans and debenture stock, £12,500 15s. 2d., leaving an available balance of £18,762 2s. 2d., out of which the directors recommend (1) the declaration of a dividend of 5% on the preference shares (of this an interim dividend of 2½% was paid in October last amounting to £6,250), £12,500; (2) the transfer to depreciation and reserve account of £6,000; (3) carrying forward to next year, £262 2s. 2d. The consumption of electrical energy throughout the area—and, consequently, the revenue of the company—has been adversely affected by the depression in manufacturing business generally, and particularly through the unsettled state of the coal trade. The expenditure on capital account during the year has been £15,166 9s. 1d., of which £8,062 13s. 8d. represents the outlay on the company's account, and £7,103 15s. 5d., the outlay on behalf of the Parliamentary Company, for which this company receives shares.

ASCOT DISTRICT GAS AND ELECTRICITY CO.

At the annual meeting, held at the London office, Mr. J. Mainwaring, who presided, spoke of the progress made by the undertaking during the past year, and amongst other things, he said that there had been an exceptional demand for the electric current in the immediate neighbourhood of Sunningdale, so much so, that it was found necessary just before Christmas to lay down another feeder main from the works to Sunningdale. The profit from electricity was shown at £374 as against £32 the previous year, but it had to be borne in mind that those charges which were common to both gas and electricity had to be allocated under the Act considerably to the disadvantage (for the time being) of the electrical department, otherwise a larger profit would be shown in this respect. It might have been expected that with the advent of electricity the gas output would have suffered, but they were pleased to say that the output of gas had increased to the extent of 1,150,000 cu. ft. On the other hand, the revenue charges had decreased by the amount of £266 leaving the profit on the gas undertaking £288 more than in the previous year. They did not wish to hide from themselves the fact that the present prosperous state of the company would not have been possible without the loyal and hearty co-operation of the engineer (Mr. A. E. Brooks) and of the Secretary (Mr. W. A. Schultz). The board had recognised that in advancing the salary of the engineer from January 1 last, they were indebted to Mr. Schultz to a great extent for the successful initiation and carrying through of the electric lighting scheme, whereby they had been enabled to maintain the profits of the gas department unimpaired. At the close of the chairman's remarks a dividend at the rate of 5½% was declared.

SALISBURY ELECTRIC LIGHT CO.

At the annual meeting of the Salisbury Electric Light and Supply Co., Ltd., Mr. W. M. Hammick (chairman) presided. The report stated that the generating plant had been sufficient to meet the output and the whole of the plant was in thorough working order and capable of dealing with a considerably increased demand. The profit on the year's working, including £299 4s. 1d. brought forward from the last account, amounted to £6,038 11s., and after paying £1,431 interest on debentures and an interim dividend at the rate of 4% for the half year, amounting to £700, there remained a balance of £3,907 11s. to be dealt with. The directors recommended that a further dividend at the rate of 7% for the half year be paid, and that £2,400 be carried to reserve, leaving £282 11s. to be carried forward to the next account.

The chairman said he moved the adoption of the report with great pleasure because although the auditors referred to the insufficiency of their reserve fund in past years they were quite satisfied with the amount they were putting by this year. It was an exceptionally large sum to put to reserve as it practically equalled 3½% on the actual capital of the company. During the year they had done very good work. They had sold more units than before and the shareholders must consider the trading account

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satisfactory. When the company was started the Free Wiring Co. wired several houses so that they could supply electricity to them. On that wiring they had to pay interest but they had the option of purchase and during this year they had bought it at the satisfactory price of £2,150. Many boards of directors would wish to pay a bigger dividend, but they thought it was better to be on the safe side, and although they had the opportunity of paying a larger dividend and carrying a slightly less sum to the reserve fund he thought the dividend they would pay was a fair return for the shareholders money. Therefore, they asked to be authorised to pay 7% per annum on the last half year, which with 4% paid during the previous half year would make, as in the last two or three years, 5½% dividend on the year.

CAMBRIDGE ELECTRIC SUPPLY CO.

At the annual meeting the Chairman of Directors, Mr. D. Munsey, presided. The Directors reported that during the year 1909, there had been connected 175 additional consumers, having the equivalent of 6,407 (30 watt) lamps, making a total to date of 65,979, whereas in 1908, 102 consumers were connected with 3,924 lamps. In spite of the great increase in the number of new consumers, the number of units supplied during the year had been only 621,448, a decrease of 38,710 units. Owing to the greatly increased use of the new metallic filament lamps (referred to in the last report of the directors), which consume much less current than the old carbon lamps, the Company's receipts for the year had been greatly reduced by reason of the decrease in the number of units sold. The consequent cheapening of the electric light had however been the means of obtaining a record number of new consumers. These included Emmanuel, Pembroke, Corpus and Magdalene Colleges, Ridley Hall, and the General Post Office, most of whom had, however, only been connected three months of the year. The directors had therefore every reason to believe that the prospects of the company were encouraging. A number of premises were now being wired and the supply mains had to be extended in several directions. The directors, after very careful consideration had taken out an insurance policy for the redemption of the leasehold property of the company at the expiry of the lease. The accounts of the company showed a total profit for the year of £7,349 18s. 9d. which, added to £122 12s. 10d. brought forward from 1908, makes £7,472 11s. 7d. After deducting debenture and other interest £1,754 5s. 9d., placing £1,000 to depreciation fund account, which would bring up the total placed to the credit of that account to £14,000, and writing £500 off suspense account, there remained a balance of £4,218 5s. 10d. An interim dividend of 2%, absorbing £1,696 2s. 10d., had already been paid and the directors recommended the payment of a further dividend of 2%, making 4% for the year. This would absorb £1,696 2s. 10d., leaving a balance to carry forward of about £826.

HASTINGS AND DISTRICT ELECTRIC TRAMWAYS.

The report for 1909 states that there has been a decrease in the gross receipts of £1,493, due to a continuance of the general depression and to even worse climatic conditions than those prevailing in 1908. There have, however, been savings in expenses under all heads amounting to £2,486, the result of the account being a credit balance of £20,749, which has been handed over by the statutory company as dividend upon its shares, which are all owned by this company. In effecting the economics in working above shown, due regard has been observed to the efficient upkeep of the system. In order to be thoroughly satisfied on this point, the directors obtained from the consulting engineers, on November 26 last, an exhaustive report, in which they state that in their opinion the whole of the system has been efficiently maintained in a manner which they consider would compare favourably with any other system of tramways of a similar character with which they were acquainted. The revenue account of this company shows receipts aggregating £20,760, against £19,767, and expenses of administration £1,405, as against £2,100, or a saving of £695, mainly due to the directors having taken for the year only half of the fees to which they were entitled under the articles of association. The balance is £19,354, which, after adding the amount brought forward, £417, against £1,767 added last year, and deducting £11,129 for Debenture and bank interest, etc., leaves available the sum of £8,642. The directors consider that in previous years an insufficient sum has been set aside for depreciation. They, therefore, propose on this occasion to transfer £8,000 to depreciation account and to carry forward the balance of £642. The directors have under consideration the question of the reorganisation of the capital account. The negotiations with the Corporation for a revision of fares on certain routes, reported at last meeting, have since been concluded, with the result that the Corporation agreed to the company's scheme in a modified form for increased fares on the Hollington and Cemetery routes. This alteration came into force on May 1 last. It is difficult to gauge the result with any degree of accuracy, owing to the different weather conditions prevailing at the comparative periods, but the change of fares had the effect of arresting the decline in traffic receipts on these sections, which has, unfortunately, been continuous upon the other lines throughout the year. The mechanical stokers referred to at last meeting have been installed, and came into operation during July and August last, with the result of effecting a substantial saving in the cost of fuel.

BOURNEMOUTH AND POOLE ELECTRICITY SUPPLY CO. LTD.

The report states that the capital expended during the year under review, on account of the Bournemouth Order, 1890, the Poole and Branksome Order, 1897, the Christchurch and District Order, 1899, and the Pokesdown Order, 1902, amounted to £10,701 4s. 2d., making the total expenditure on account of these Orders up to December 31 last, £443,200 10s. 5d. As regards revenue, the balance from the last account, after payment of the final dividends on the preference and ordinary shares of the company for the half-year ended December 31, 1908, less income tax, £912 18s. 2d.; balance from revenue account No. II., after deducting generation and distribution costs, rent, rates, taxes, wages, directors' fees, general establishment, and other charges, and proportion of salaries, £33,806 0s. 7d.; making a total available revenue for the year 1909 of £34,718 18s. 9d. From this should be deducted the following items: (*a*) Interest on debenture stock to December 31, 1909, and interest on temporary loans, less income tax, £8,291 8s. 11d.; (*b*) interim dividends on 7,500 4½% preference shares, and on 15,000 6% second preference shares for half-year ended June 30, 1909, less income tax, £5,852 6s. 11d.; (*c*) interim dividend on 15,000 ordinary shares at 5% per annum for half-year ended June 30, 1909, less income tax, £3,546 17s. 6d.; (*d*) leasehold and special redemption funds and interest, £1,567 8s. 11d.; (*e*) amount written off suspense accounts, £319 18s. 7d.; (*f*) amount carried to reserve for depreciation, repairs, renewals, etc., £4,000, that is £23,578 0s. 10d., leaving for distribution, £11,140 17s. 11d. The following dividends have been paid and require confirmation: (*a*) Interim dividends on the 7,500 4½% preference shares and on the 15,000 6% second preference shares for the half-year ended June 30, 1909, less income tax; (*b*) interim dividend on the 15,000 ordinary shares at the rate of 5% per annum for the half-year ended June 30, 1909, less income tax; (*c*) final dividends on the 7,500 4½% preference shares and on the 15,000 6% second preference shares for the half-year ended December 31, 1909, less income tax. The directors now recommend: (*d*) That a final dividend on the 15,000 ordinary shares for the half-year ended December 31, 1909, at the rate of 6% per annum less income tax, *be declared*, and that the said dividend be paid to all proprietors registered on March 9, 1910. The final dividends (*c*) and (*d*) absorb £10,064 1s. 3d., and leave a balance of £1,076 16s. 8d. to be carried forward. The total applications received at December 31 last amounted to the equivalent of 223,156 30-watt lamps (6,694 kw.), being an increase of 16,971 (509 kw.) for the year. The total number of Board of Trade units sold for all purposes was 2,973,487. The directors of the Richmond (Surrey) Electric Light and Power Co., Ltd., have declared a dividend of 6% on the ordinary shares of that company in respect of the year ended December 31 last.

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HYDRAULIC WATER AND ELECTRIC ENERGY.

At the annual general meeting of the General Hydraulic Power Co., the chairman (Mr. William T. Western) said that the features of the year's working were that in London the number of machines contracted for had increased by 145, or 2¼%, but the quantity of power absorbed by each machine had diminished by about 2½%, and the average price obtained per 1,000 gallons bad fallen by about one-tenth of a penny. The drop in consumption occurred in the summer months of the year. The last quarter showed an appreciable recovery, which was apparently continuing. An interesting point in the business was that, while during the year 80 machines ceased to take supply owing to vacated buildings, 25 of these supplies were re-connected during the year, and 56 machines in buildings which had been vacated in previous years were re-connected to the mains. The competition of electric energy continued, but had only succeeded in taking from the company 20 machines out of over 6,000, and these 20 were mostly old machines installed at a time when the capabilities of hydraulic lifts for high speed and economy were not as well understood as at present. The competition turned principally on a question of price. The net profit in London was practically the same as last year. Liverpool had followed on the same lines as London. In Liverpool they were hampered by the high charge made by the corporation for water. The capital expenditure for the year—apart from the construction of Grosvenor-road station in lieu of Millbank, the cost of which was provided for by the County Council—had principally been upon the enlargement of Falcon Wharf and two trunk connecting mains. The mileage laid for general purposes was about 1½ mile. All these extensions were to meet actual present demands for power and were all within the existing area of supply. It was expected that the new station at Grosvenor-road would be ready for use in the autumn of this year. The company would then be enabled completely to close the Millbank station, and should become entitled to receive from the County Council £32,000, the balance of the agreed cost of removal. In anticipation of this event, and with the aid of the enlarged plant at Falcon Wharf and of the trunk mains alluded to, they had partially closed Millbank. To provide for the company's requirements on capital account, the Board had arranged for a loan on debenture for £100,000 at 4½%, of which £60,000 had been taken up. The loan was repayable in 20 years by a sinking fund of £3,600 a year. The profits of the year were sufficient to provide the first instalment of £3,600 on this account, and to pay a dividend of 5% on the share capital. The surplus would then be £3,000, which, added to previous surpluses, enabled the Board to transfer £10,000 to general reserve account and carry £5,900 to next year's account. He moved the adoption of the report.

In the discussion Mr. Wells made a personal criticism upon Mr. Ellington, the engineer to the company, in reference mainly to his dual capacity as purchaser of machinery for the company and as seller through his official connection with the company supplying the machinery. Mr. Ellington explained the circumstances under which this policy had been brought about, and whilst admitting that possibly the directors would not allow the same arrangement to be continued by his successor, yet he expressed the belief that shareholders would not look at the matter in the same light as did his critic. The report was adopted.

HARROW ELECTRIC LIGHT AND POWER CO.

The fourteenth annual general meeting of the members of the Harrow Electric Light and Power Co., Ltd., was held at the Company's offices, West-street, with Mr. J. N. Stuart, chairman of directors, presiding.

The annual report, submitted by the directors, stated that during the past year 101 new consumers representing 1,772 additional lamps had been connected to the mains. The number of consumers at the end of the year totalled 1,223, their demands representing the equivalent of 36,376 lamps. The output of electrical energy, notwithstanding the influence of the new metal-filament lamps, showed a favourable increase, 410,276 units having been sold to the consumers as against the 400,402 units sold in the previous year. The extension of the generating work had been completed, and the new plant had proved to be highly efficient and economical. Various small extensions of the distributing mains had been carried out during the year to meet the demands of new consumers. The re-arrangement of the debenture capital had been carried out in accordance meeting. There was a balance of £5,950 of the new 4½% with the terms reported to the shareholders at the last debentures still available for issue, which the directors were prepared to reserve for a reasonable period for the shareholders and existing debenture holders. The balance to the credit of the net revenue account, after deducting debenture interest and the interim dividend on the preference shares, was £2,490 12s. 1d., which the directors recommended should be dealt with: In payment of the final dividend on the preference shares, £374 19s. 3d., and in payment of a dividend on the ordinary shares at the rate of 5% per annum, £1,666 15s., leaving a balance to be carried forward to 1910 of £448 17s. 10d. The directors had deemed it prudent to set aside out of the past year's profits a sum of £2,400 for depreciation purposes.

The Chairman, in moving the resolution that the report and accounts be adopted and dividends declared, said: I have the great pleasure to submit the report of the company for the past year, and think you will all agree that it shows a record of fair progress, nothing out of the way, but steady. The increase in the number of consumers is larger than that of any of the three previous years, but the increase in the number of lamp connections is not so great as in 1906 or 1907; this is due to the fact that the larger houses in the district are nearly all installed with electric light, and we have now to go to the smaller houses for an increase in our consumers. The increase in units sold is only 2½%; that it is not more is due to the increased use of metal filament lamps, which, while appearing to be against the interests of the Company, are really indirectly in its favour, for as people realise that consumers are getting their light cheaper, new customers will come in. As a proof of the progress made by metal filament lamps, I may mention that 72% of the lamps sold by our Wiring Department were of that type. A notable feature of our records is that the consumption by slot meters is nearly 50% above that of 1908, and more than double the consumption of two years ago, showing that small houses are finding this method of lighting satisfactory and economical. Our revenue shows an increase of nearly £500, and our working expenses a reduction of £23. Our coal bill is less by about £150, but in rates and taxes, establishment charges, and upkeep of mains, there is a slight increase. The serious item in the cost sheet is the steadily increasing expenditure under the head of "Distribution." On this head I cannot hold out immediate hopes of reduction, as we are of opinion, and you will no doubt agree rightly so, that our mains must be put into thoroughly sound condition, and all weak places gradually rectified. You will notice in the report that the extension of the generating works has been completed, and the new plant proved to be highly efficient and economical. We hope that during the current year the result will show more clearly in the accounts, as, of course, the new plant was not working during the whole of the past year.

Previous to the meeting, electrically-prepared tea and coffee were served in the Company's showroom, which was much appreciated by the shareholders, and a demonstration of electrical ironing attracted no small amount of attention from the ladies.

COMPANIES REGISTERED.

MAXIM LAMP WORKS.—Capital, £8,000, in £1 shares. Objects: To take over the business carried on by the receiver for the Debenture-holders of the Maxim Electrical Co., Ltd., at Shernhall-street, Walthamstow, and to carry on the business of electricians, mechanical and electrical engineers, etc. Private company. The first directors (to number not less than two nor more than four) are: T. Taussig and J. F. Poynter. Qualification, £500. Remuneration, as fixed by the company. Registered office, Maxim Works, Shernhall-street, Walthamstow.

WALKER, HORROCKS & Co.—Capital, £5,000, in £1 shares (2,500 Preferred Ordinary). Objects: To carry on the business of electricians, engineers, suppliers of electricity for light, heat, power and other purposes, etc.; to acquire certain inventions relating to improvements in the generation, storage, and use of electric power for lighting and other purposes, and in dynamo-electric machines and internal combustion and other engines;

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and to adopt an agreement with C. B. Walker. Private company. The first directors (to number not less than two nor more than five) are: T. Horrocks, F. Horrocks, and C. B. Walker (all permanent). No qualification required. Remuneration, as fixed by the company. Registered office, Cornwall-buildings, 45, Newhall-street, Birmingham.

WRIGHT ELECTRICAL SALES CO.—£2,000 (£1). To take over the business of an electrical engineer and dealer in electrical appliances carried on by H. J. Wright at 5, Upper Mill-hill, Leeds, as the Wright Sales Co. Private company.

REVIEWS.

"Engineering Units of Measurement." By John Ramsay, A.M.Inst.C.E. Glasgow: J. Smith & Son. Price 1s. net.

As the author explains in his preface, his object in writing this little book has been to give a lucid account of the fundamental and derived units, with their definitions and measurements, under both the foot-pound-second and the centimetre-gramme-second systems. Following on a wonderfully concise but perfectly comprehensible list of definitions of mechanical and general units, we have in Part III. an equally good section dealing with electrical units. Then follow tables of analogies between linear and angular motions; symbols and abbreviations; metrical and decimal equivalents of fractions of an inch and foot: equivalents of imperial to metric weights and measures for use in trade (excellently done for ready reference); and principal cases of stresses and strains. While avowedly compiled for students, it will be found a trustworthy friend by those engaged in practical work.

"Practical Testing of Electrical Machines." By L. Oulton, A.M.I.E.E., and N. J. Wilson, M.I.E.E., Assoc.Am.I.E.E. London: Whittaker & Co.

This is essentially a practical book, meant for the student and engineer, but chiefly the latter. It goes direct to the point, wastes very little time over theory. The numerous illustrations are very helpful. It is a book for a busy man's table.

FINANCIAL NOTES.

A quarterly dividend of 2½% is announced by the Sao Paulo Tramway, Light and Power Co., payable on April 1.

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PERSONAL.

A certain amount of re-organisation of the Burslem Corporation Electricity Department's staff has taken place. Mr. Brenner, Chief Engineer, has had his salary increased to £400. Mr. H. W. Edwards, Assistant Electrical Engineer, has had his salary increased by 4%. Mr. H. C. Heath, Chief Shift Engineer, has been appointed Mains Superintendent, and Messrs. A. T. Gilbride, H. C. Cotton, E. Thomas and J. Bickerton, have each had a move up.

Mr. R. E. Pigott, who was appointed from the late Madras Railway to this new post on the Bombay, Baroda and Central India Railway, has been promoted from Rs. 1,250 to Rs. 1,375 per mensem from January 1, 1910. The electrical department of this railway is now one of importance, says *Indian Engineering*, and the appointment of the chief engineer in charge a very responsible one.

Mr. J. D. Pember, electrical engineer to the Urban District Council of Dartford, has had his salary raised from £250 to £275 per annum, the general expression of the Council being that this was well deserved, seeing the extra work undertaken by Mr. Pember and the handsome profits realised.

CATALOGUES AND PRICE LISTS.

Messrs. G. Braulik have issued a price list of "Eclipse" yellow flame metal core arc lamp carbons. Prices are given for both direct current and alternating current.

It is not always desirable to instal metal filament lamps, and for those special purposes where carbon lamps are preferred, Messrs. Siemens Bros. Dynamo Works, Ltd., have got out an illustrated list, showing both low and high voltage lamps in many designs—the ordinary globe form, spherical, flame shape for candelabra, tutulas for shop windows with anchored filaments, and photographic lamps also with anchored filaments.

The Wellington Turbo Works, Ltd., Great Bridge, Tipton, Staffs, have compiled a most handy list in tabular form of net prices of tubes with the express desire to assist buyers to overcome the present intricate discounts system. Particulars are given of "Internal Diameters in inches," "Gross price per foot," and "Cost at" discounts ranges from 35 to 90%. The card should be of considerable use to all large buyers of gas, steam and water tubes.

An eight-paged small folder giving a description, with illustration, of the improved 1909 Pattern Bartian Electrolytic Meter is well worth filing. It contains a table of code words for meters of from 2½ to 20 amps.

The British and Colonial Department of the Maschinenfabrik Oerlikon have sent us an illustrated leaflet showing electric hand-drilling machines for column and work table use.

Messrs. Connolly Bros., Ltd., have issued a second edition of their book on "Connolly's Enamel Insulation." It is well compiled, and gives a large amount of useful information.

The Elektromotoren werke Heidenau, G.m.b.H., Heidenau, near Dresden (whose announcement will be found in our advertising pages), have sent us a copy of their new catalogue, printed in German. It is a wonderful production—giving excellent views of their various apparatus, with very full details arranged in tabular form.

The Foster Arc Lamp & Engineering Co., Ltd., are sending out to all who are interested in the subject a new catalogue of their auto-transformers. They have recently effected considerable improvements in these apparatus. For instance, the no-load losses have been greatly reduced, and are now at a fine margin, as is shown in the "losses" column of the list. The regulation has also been greatly improved, which is shown by the standard efficiencies on the second page. What will, no doubt, specially interest our readers is the fact that Messrs. Foster have been able to effect considerable reductions in their prices. A special feature with them is prompt despatch. With standard sizes, they can despatch within two days from receipt of order. It is to be noted that although they do a large business in auto-transformers, the firm have had considerable experience in step-up transformers, transformers for separate windings and similar apparatus. The Foster automatic switch is illustrated and described on the last page. This, of course, is used in conjunction with the transformer for cutting the latter out on no-load. With the Foster switch no auxiliary batteries are required, the apparatus being entirely self-contained. Particulars are also given of the electric bell transformer. The size of this small instrument is 3½ in. by 2½ in. These can be supplied, as can be seen, for any periodicity.

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NATIONAL ELECTRICAL MANUFACTURERS' ASSOCIATION.

At the Fifth Annual General Meeting recently held at the Association's offices, Mr. H. H. Berry was in the chair.

Before the report was considered, the Insurance Expert attached to the Association made his report to the meeting and explained that an appointment such as he held, although unusual in this country, was frequent in the United States. He explained to the members the very material benefits to be secured in utilising this department of the Association.

Many of the members had thus been able to obtain considerable reductions in premiums besides valuable aid in the adjustment and settlement of claims, etc.

The Committee's Report, which was taken as read, was commented on by the chairman, and various members of the Committee who had specially dealt with the different items mentioned gave further explanations of this.

Various suggestions as to increasing the utility of the Association were made by the different members, the general view being that the present position of the Association was one of much greater benefit to the members than had ever been the case previously. There was also a concensus of opinion that the work done by the Association is insufficiently appreciated by manufacturers and attention was drawn to the fact that much more could be done if the membership were increased.

The report (the more important items of which were referred to in a recent issue of this paper) was unanimously approved and passed, as also were the accounts.

The following constitute the committee for the current year:—Messrs. H. H. Berry (Berry, Skinner & Co.), H. Bevis (Pirelli, Ltd.), H. W. Butler (Electrical Power Storage Co., Ltd.), E. J. Clark (Hart Accumulator), D. N. Dunlop (British Westinghouse Co., Ltd.), T. J. Grainger (Sunbeam Lamp Co.), B. Longbottom (Electromotors, Ltd.), A. P. Lundberg (A. P. Lundberg & Sons), F. H. Nalder (Nalder Bros. & Thompson, Ltd.), H. Oppenheimer (International Electric Co.), A. P. Pope (Johnson & Phillips), B. Broadhurst (Brush Electrical Engineering Co., Ltd). H. C. Siddeley (Lancashire Dynamo & Motor Co., Ltd.).

Messrs. Beaver and H. Stanley Marsh were elected Hon. Auditors.

After considerable discussion on the question of date, it was decided that this Association should hold an Electrical Exhibition in London at Olympia, in October, 1911. Full details of the arrangements regarding this exhibition will shortly be given.

Messrs. The Adams Manufacturing Co., Ltd., of Bedford, and Messrs. Rhodes Motors, Ltd., of Doncaster, were elected members of the Association.

EDUCATIONAL.

MUNICIPAL SCHOOL OF TECHNOLOGY, MANCHESTER.

The award of The James Grescott Joule Commemorative Medal (presented by Sir W. H. Bailey) for 1910 will be made in September next by the Manchester Education Committee. The medal (in silver) will be awarded for the best essay dealing with Physical Science or Engineering, preference being given to subjects concerned with the transformation of energy. The competition is confined, for the present year, to past and present students of the Manchester Municipal School of Technology whose ages are not less than 16 years nor more than 26 years. Essays, which should be written on one side of the paper only, must be sent in to the undersigned not later than July 1, 1910, in a sealed envelope, accompanied by a separate slip giving the name and address of the author, age, and years of studentship in the school. Envelopes must be endorsed "Joule Commemorative Medal."

GLASGOW TECHNICAL COLLEGE.

The Tramways Committee of the Glasgow Corporation have presented two disused tramway motor equipments for the use of students.

NORTHAMPTON POLYTECHNIC INSTITUTE.

The appointment of Associate-Head of the Electrical Engineering and Applied Physics Department was rendered vacant by the resignation of Dr. C. V. Drysdale, who has been on the staff of the Institute since its opening in 1896, first as Chief Assistant, afterwards as Associate-Head of the department. Dr. Drysdale's valuable work at the Institute during this period is well known.

Mr. Francis Medforth Denton, of the Carnegie Technical Schools, Pittsburgh, has been appointed to the vacant post. Mr. Denton received his technical training at the Central Technical College of the City and Guilds of London Institute, obtaining the Associate's diploma in 1901. At this college he held a Yorkshire County Council Scholarship which he had obtained when at Hymer's College in Hull. On leaving the Central Technical College, Mr. Denton spent a year-and-a-half in the instrument making works of Messrs. Elliott Bros., London, and subsequently was for two-and-a-half years at the well-known Oerlikon Works in Switzerland, where he was engaged in important design and other work. From the Oerlikon Works Mr. Denton was brought back to the Central Technical College to a position on the staff of the Electrical Engineering Department, which he occupied for one year, and at the expiration of this engagement he went to the United States to join the staff of the General Electric Co. in various departments at Pittsfield, Mass., and at Schenectady. After occupying these positions for one year, he was, two-and-a-half years ago, appointed lecturer in electrical engineering at the new Carnegie Technical Schools at Pittsburgh, a position which he still occupies, and is resigning to take up his London appointment.

DIARY.

FRIDAY, MARCH 18.

NORTHAMPTON INSTITUTE ENGINEERING SOCIETY.—At the Institute, "Oxidation of Atmospheric Nitrogen in the Electric Arc," by Mr. S. Field.

SATURDAY, MARCH 19.

ROYAL INSTITUTION OF GREAT BRITAIN.—Albemarle-street, at 3 p.m., "Electric Waves and the Electromagnetic Theory of Light" (Lecture VI.), by Professor Sir J. J. Thomson, F.R.S.

NORTHAMPTON INSTITUTE ENGINEERING SOCIETY.—Visit to the National Physics Laboratory.

JUNIOR INSTITUTION OF ENGINEERS.—At 3 p.m., visit to the New Engineering Laboratory, workshops, etc., of Finsbury Technical College, Leonard-street, City-road.

MONDAY, MARCH 21.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.—At the Lecture Theatre of the Literary and Philosophical Society, Newcastle-on-Tyne, at 7.30 p.m., "A Heat Diagram for use in Steam Turbine Design," by Mr. John Morrow, M.Sc., D.Eng.

TUESDAY, MARCH 22.

INSTITUTION OF ELECTRICAL ENGINEERS (Manchester Section).—At the Physical Laboratory, University of Manchester, at 7.30 p.m., "Some Properties of Switch and Transformer Oils," by Mr. W. Pollard Digby and Mr. D. B. Mellis.

SATURDAY, MARCH 26.

ASSOCIATION OF ENGINEERS-IN-CHARGE.—Annual dinner.

"WIRELESS" TELEGRAPHY IN ZANZIBAR.

A copy of a Decree (No. 6 of 1909) has been received from the Zanzibar Government giving regulations relating to wireless telegraphy in the Protectorate.

The Regulations provide that no person shall establish any wireless telegraph station or instal any apparatus for wireless telegraphy in any place in the Dominion of H.H. the Sultan of Zanzibar, except under a licence granted in that behalf by the First Minister.

Persons establishing wireless telegraph stations or installing apparatus for wireless telegraphy without a licence are liable to a fine not exceeding 1,500 rupees or to simple imprisonment for a term not exceeding 12 months, or to both, and in either case to the forfeiture of the apparatus installed or worked.

ELECTRICAL ENGINEERS (London Division) (Territorials).—Orders for week ending March 26: Officer Commanding Col. R. E. B. Crompton, C.B. Monday, March 21, "A" Co., Recruits' Infantry Drill, 6 to 7 p.m.; Technical Drill, 7 to 9.30 p.m. Tuesday, March 22, "B" Co., Technical Drill, 7 to 9.30 p.m. Wednesday, March 23, Gymnasium, 6.30 to 9.30 p.m. Thursday, March 24, "C" Co., Technical Drill, 7 to 9.30 p.m. Friday and Saturday, March 25 and 26, headquarters closed. (Signed) P. H. Campbell, Capt. R.E., Adjutant.

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and to adopt an agreement with C. B. Walker. Private company. The first directors (to number not less than two nor more than five) are: T. Horrocks, F. Horrocks, and C. B. Walker (all permanent). No qualification required. Remuneration, as fixed by the company. Registered office, Cornwall-buildings, 45, Newhall-street, Birmingham.

WRIGHT ELECTRICAL SALES CO.—£2,000 (£1). To take over the business of an electrical engineer and dealer in electrical appliances carried on by H. J. Wright at 5, Upper Mill-hill, Leeds, as the Wright Sales Co. Private company.

REVIEWS.

"Engineering Units of Measurement." By John Ramsay, A.M.Inst.C.E. Glasgow: J. Smith & Son. Price 1s. net.

As the author explains in his preface, his object in writing this little book has been to give a lucid account of the fundamental and derived units, with their definitions and measurements, under both the foot-pound-second and the centimetre-gramme-second systems. Following on a wonderfully concise but perfectly comprehensible list of definitions of mechanical and general units, we have in Part III. an equally good section dealing with electrical units. Then follow tables of analogies between linear and angular motions; symbols and abbreviations; metrical and decimal equivalents of fractions of an inch and foot: equivalents of imperial to metric weights and measures for use in trade (excellently done for ready reference); and principal cases of stresses and strains. While avowedly compiled for students, it will be found a trustworthy friend by those engaged in practical work.

"Practical Testing of Electrical Machines." By L. Oulton, A.M.I.E.E., and N. J. Wilson, M.I.E.E., Assoc.Am.I.E.E. London: Whittaker & Co.

This is essentially a practical book, meant for the student and engineer, but chiefly the latter. It goes direct to the point, wastes very little time over theory. The numerous illustrations are very helpful. It is a book for a busy man's table.

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Controlling Electro Magnetic Clutches.

20413.—1909. D. Dusseris, Paris. This improved means for controlling electric clutches comprises a commutator containing two independent series of contacts insulated from each other, each series being connected to a pole of suitable electrical source; a third series of insulated contacts and a handle enabling communication to be made between the first or second and the last series of contacts.

Dynamo Brush Holders.

4276—1909. O. Höhme, Radebeul. The brush holder comprises two parts arranged telescopically, and a carrier, provided with pins pivoted to it. The brush box is sus-nded by slanting slots on the pins, and a spring mounted he box presses on the brush for the purpose of enabling rbon to contact constantly with the box. The box ble of receiving carbons of various size.

Regenerating Electric Accumulators.

. Friedrich, Cologne. This is a process for ctric accumulators which show a decrease in owing to contamination or shrinking of rials. The process consists in carrying before charging, and with the working in a slightly acid aqueous electro- addition of solid electrolytic substances.

Electric Cables.

1909. J. Stratton and E. A. Claremont, Manchester. The cable has two conductors, each of which are embedded in a separate bed of vulcanised bitumen of cross section shape, so that when laid up together they form a circle.

Electrical Heating Apparatus.

4672.—1909. A. F. Berry, Ealing. The heating winding, which is in the form of a spiral, has its several convolutions free to be spaced over a flat surface on the underside of the hot-plate in such a manner as may be found requisite to secure the uniformity of temperature aimed at. Blocks of insulating material are placed between the various convolutions to hold them in position.

Watertight Electric Switch.

3106.—1909. Simplex Conduits, Ltd., Birmingham. This switch comprises a water-tight casing, a switch centrally located in the casing and an operating handle, which passes centrally through the casing. The handle has an L-shaped cam comprising opening and closing sides, which directly operate the dolly head of the switch so as to permit limited and free movement of the switch and ensure a quick break.

Electrically Igniting Miners' Safety Lamps.

8112.—1909. P. Buckley, Batley. A gas tight box contains the accumulators and source of electricity. On the top of the box is fixed a raised circular flange, to which is attached an upstanding cylindrical casing closed at its upper part but with a frontal aperture of a size suitable for admitting a miner's safety lamp. Within this casing is a second casing made to angularly turn within the outer casing, and provided with a revolvable bottom plate, and a central spindle at its upper part which passes through the outer casing. The outer case has a handle by which it can be turned upon its axis. The inner case has a frontal aperture. When the lamp is inserted, the casings are turned so as to bring the electrical contacts in connection with a source of electricity into engagement with the lamp while the lamp is effectually cut off from the outer air. The first reverse movement breaks the electrical connections. Further movements expose the lighted lamp and enable it to be removed from the casings.

Phase Displaced Electro-Magnetic Oscillations.

9427.—1909. M. Monasch, Vienna. This improved method of producing phase displaced electro-magnetic oscillations consists in bringing two or more sources of undamped or slightly damped oscillations into connection with one another in such manner as to cause a control or continuous influence to be established between them.

Determining Bearings and Distances by Electric Waves.

10876.—1909. J. H. M. Valoris, Angers. This is a receiving apparatus for use in wireless telegraphy for determining the distance of a transmitting station by the amount of energy received from the station, and combines an ordinary receiving post for wireless telegraphy and an electrolytic detector; an energy integrator constituted by a bolometer having an adjustable rheocord, the galvanometer of which serves as a precise indicator for the energy received and which may be graduated direct for distances. Telephone receivers shunted by a variable resistance for stifling the sound allow an approximation of the distance to be obtained. A relay actuates a chronograph to measure the duration of the series of waves and interruptions between the series.

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PATENTS.

Tumbler Switches

27446—1909. J. J. Rawlings, S. Kensington. This is an improvement in the portion of tumbler electric switches that forms the joint of the lever or dolly in the case of the switch and comprises the use of a flexible washer interposed between the spherical ball of the dolly lever and the circular cap fitting over its support. It has already been proposed in connection with an auxiliary lever for working the dolly of a tumbler switch, to mount the lever by a ball and socket joint and to render the joint water-tight by means of a flexible washer placed under the ball of such auxiliary lever. Figs. 1 and 3 are vertical sections of the upper portions of a tumbler switch taken across the pivot pin A, upon which the dolly B oscillates. Fig. 1 illustrates the arrangement of suitable switches that rely upon the switch cap C holding

FIG. 1

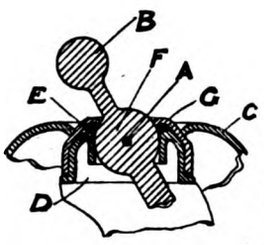


FIG. 3

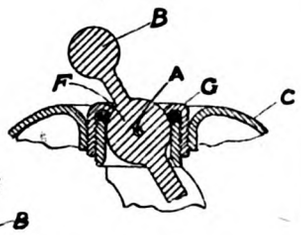
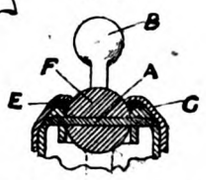


FIG 2



down the switch by clamping action and that shown at Fig. 3 is for that class of switch where the switch case is held in position by the dolly joint support. Fig. 2 is a cross section of Fig. 1, the switch case C being omitted. D, Fig. 1, is the metal support which carries the dolly pin A, a circular cap G fits over the support D in such manner so as to leave an annular space at E between the ball and the top of the support and into this space is compressed a flexible washer, which may be formed of felt impregnated with graphite and wax. It will be obvious that upon oscillating the dolly, the ball F will turn upon its centre pin A and make water-tight movable joint by reason of the flexible packing joint at E.

Controllers for Electric Motors

2715—1909. R. F. Baerlocker, Old Trafford. This is an improvement in electric motors of the type in which spring mechanism is used to automatically return the moving element when the controller handle is released, and has for its object to construct the operating mechanism of the controller so that when the controller handle is released during its movement through one portion of its range of travel, it will automatically return to a predetermined position whereas in a further portion of its range of travel the handle may be left in any desired position. The spring return mechanism is connected to the handle of the controller through a device which at any desired position during

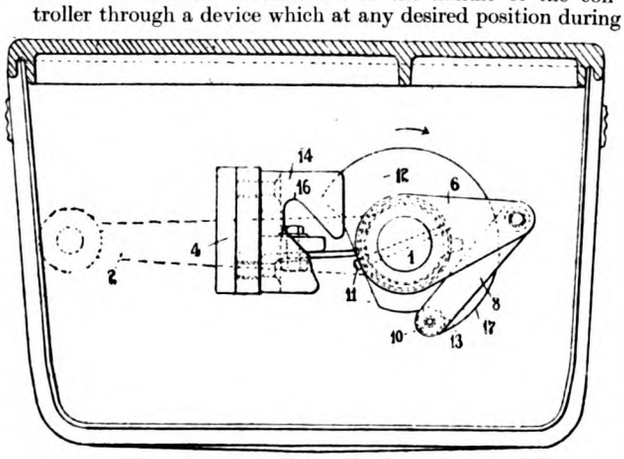
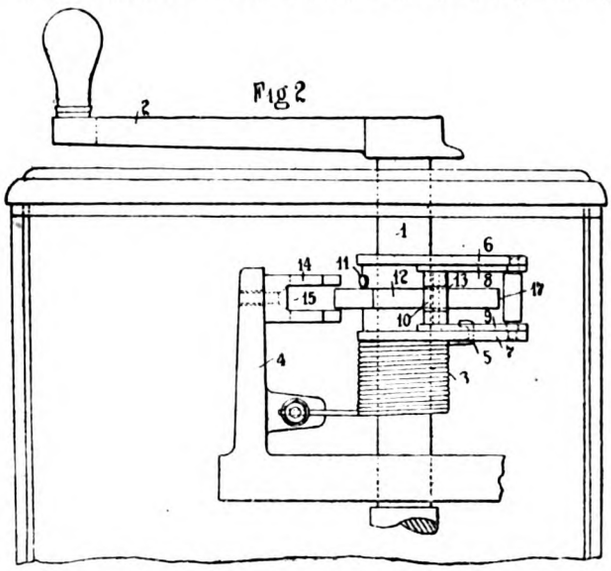


Fig 1

the range of travel of the controller handle acts to disconnect the latter from the spring return mechanism so that during the further portion of its travel the controller handle is no longer controlled by the spring. Fig. 1 is a plan of a controller partly sectional, and Fig. 2 is a vertical section showing the upper part. The shaft 1 of the controller, which carries the controller drum, is provided with the usual handle 2, and is surrounded by a helical spring 3, one end of which is attached to a bracket 4 mounted on a stationary part of the controller, the other end 5 of the spring is connected to the lower one of a pair of links, 6, 7, which are loosely mounted on the controller shaft 1. These links have pivoted to them at their outer ends a second pair of links, 8, 9, which are provided with a roller 10. Rigidly attached to the shaft 1 by means of the pin 11 is a cam disc 12, having a notch 13 in its periphery adapted to engage with the roller 10 in certain positions of the shaft. 14 is a plate secured to the bracket 4 having a recess 15 to permit the passage of the cam disc 12 and provided with notches. The roller 10 is divided, as shown in Fig. 2, into three portions, so that after it has entered the notches 16 the middle portion can readily revolve in contact with the cam disc and in opposite directions to the top and bottom portions, thus providing an easy movement. The operation of the device is as follows: When the controller handle 2 is rotated in the direction of the arrow, Fig. 1, the notch 13 in the cam disc 12 engages the roller 10 and the links, 6, 7, 8 and 9 are moved round the controller shaft, thereby winding

Fig 2



up the spring 3. After the shaft has been rotated through a certain range of movement, the roller 10 will be brought by the cam disc into the notches 16 in the fixed part 14, and if the shaft be further rotated this roller will be held in these notches by the periphery 17 of the cam disc. It will be clear, therefore, that during the first part of the movement of the shaft, the handle if released, will be returned by the spring 3 to its initial position owing to the engagement of the roller 10 with the notch 13 of the cam disc, while, during the second part of the movement of the shaft, that is to say while the roller 10 is retained in the notches 16 the handle may be released and will remain in any desired position, since the shaft 1 is no longer in operative connection with the spring 3. The device is particularly applicable to controllers for variable speed motors. In this case during the first part of the movement of the shaft, the resistance in series with the motor armature is varied for the purpose of starting, it being desirable, as well known, not to leave the controller in one of these positions; while during the second part of the movement of the shaft, that is after the roller has been engaged by the notched plate, the resistance in circuit with the field of the motor is varied in order to give the desired variation in speed.

Telephone Transmitters.

25028.—1909. M. Moloney, New Zealand. The object is to enable persons to speak over longer distances with an increased volume of sound. For this purpose the transmitter contains a metal cylinder, insulated from the casing and having within it a similarly shaped carbon cup, carrying radially arranged carbon pencils with pointed ends fitting in a groove in a carbon centre stud. The stud has a point which passes through the centre of two carbon washers, having between them a number of small shots. The washers are kept in position by a carbon recessed ring, within which are a number of carbon pellets arranged around the point of the carbon stud. To secure the best effect the centre stud, washers and carbon pencils must all be highly polished.

Electric Power Transmission.

25217.—1909. C. E. Tuch, Honolulu. This is an apparatus for converting electrical into mechanical power. Revolving motors, mounted on a frame, impart rotation to a shaft from which power can be utilised for any desired purpose. The power transmitting mechanism consists of a rotary element, carrying one or more motors, which reacts on

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a stationary element for causing rotation of the first rotating element. The stationary element has gear teeth co-operating with a number of electric motors mounted on a rotary element, which have pinions meshing with the gear teeth. The rotation of the armatures thus causes the rotary element to be revolved, current being supplied to the motors by means of a circular trolley wire, over which run trolleys carried by the motors.

Thermo Electric Devices.

24389.—1909. SIEMENS BROS. & Co., London. This is an improved thermometer for indicating the temperature of the super-heated steam on a locomotive. It consists of a thermo-electric couple, the junction of which is exposed to the steam, while the other couple is connected with an indicator constructed on the principle of the voltmeter in the locomotive cab. If the indicator be fixed to the end of the boiler it remains undisturbed by the general vibration, and is, therefore, sufficiently sensitive to be used for the requisite purposes.

Electric Insulators.

25259.—1909. E. BURTON, Ansley, U.S. The insulator comprises a braket formed of a single strip of material of uniform size throughout its length and bent to from an inverted T-shaped lower supporting portion, with spaced parallel yieldable ears rising therefrom. A vertically split insulator block forming separable sections is mounted between the ears. The inner faces of the sections contain registering grooves to receive a conductor element. These sections have channels in their outer side and bottom faces and are shaped to snugly engage with the ears.

Telephone Exchanges.

25882.—1909. SIEMENS BROS. & Co., London. In a telephone exchange of the kind wherein, when the connecting plug is inserted, processes occur automatically for making the necessary connection and can be reversed for disconnection by an operation performed at another panel, two relays are arranged for effecting these processes. Only one of the relays is returned to its normal condition by the operation at the second panel following.

Dynamo Electric Machine.

26146.—1909. ALLGEMEINE-ELEKTRICITATS GESELLSCHAFT. Berlin. In a dynamo electric machine having chord windings and reversing poles, it has hitherto been found necessary to employ two reversing poles per main pole. The object of the invention is to reduce the number of the reversing poles, and consists in arranging the reversing coils in machines with uniformly distributed field iron and chord windings or brushes arranged in chords so that for each two reversing points a single reversing coil is provided, extending from one reversing point to the other and co-operating with the stator working winding, which is strengthened at these points.

Electric Transformers.

6313.—1909. ALLGEMEINE ELECTRICITATS GESELLSCHAFT, Berlin. In the method of preventing idle losses in transformers, as patented by the above firm (92—1909), the connection and disconnection of the transformers is effected by a relay, the windings of which are connected to the secondary windings of two current transformers, one of which is in the circuit of the constantly connected transformers and the other in the circuit of the transformer to be connected.

Apparatus for Discharging Liquids.

3070.—1909. W. H. & R. THOMPSON, London, E.C. This electrically operated apparatus for discharging liquids for flushing purposes comprises a cistern adapted to contain and be filled with liquid to be discharged, an outlet from the cistern controlled by an electrically operated valve, a switch arranged in circuit with means for operating the valve and a make and break device operated by the rise and fall of the liquid within the cistern. The arrangement is such that on establishing an electrical circuit by the switch the circuit is kept automatically closed and the discharge valve of the cistern open until it is emptied, when the circuit is broken, the valve closed, and the switch put into condition for further operation.

Electric Motors.

2383.—1909. H. J. READ, St. Albans. The switch and resistance for starting and controlling the motor is arranged in a metal box fixed to the floor near the operator of the machine to be controlled. The switch arm extends through the casing and is connected to a pedal. A spring takes off the strain on the switch arm due to the weight of the pedal so that in the event of failure of the spring the weight of the pedal shall not pull over the arm and so start the motor. The foot operating gear is fixed to the same base as that on which the box is fixed. The whole operating apparatus is thus rendered compact, admits of being totally enclosed, and the frame and case can be easily earthed.

Controlling Electro Magnetic Clutches.

20413.—1909. D. DUSSERIS, Paris. This improved means for controlling electric clutches comprises a commutator containing two independent series of contacts insulated from each other, each series being connected to a pole of suitable electrical source; a third series of insulated contacts and a handle enabling communication to be made between the first or second and the last series of contacts.

Dynamo Brush Holders.

24276—1909. O. HÖHME, Radebeul. The brush holder comprises two parts arranged telescopically, and a carrier, provided with pins pivoted to it. The brush box is suspended by slanting slots on the pins, and a spring mounted in the box presses on the brush for the purpose of enabling the carbon to contact constantly with the box. The box is capable of receiving carbons of various size.

Regenerating Electric Accumulators.

19111.—1909. J. FRIEDRICH, Cologne. This is a process for regenerating electric accumulators which show a decrease in their capacity owing to contamination or shrinking of their active materials. The process consists in carrying out the regeneration before charging, and with the working electrolyte withdrawn, in a slightly acid aqueous electrolyte without addition of solid electrolytic substances.

Electric Cables.

6151.—1909. J. STRATTON AND E. A. CLAREMONT, Manchester. The cable has two conductors, each of which are embedded in a separate bed of vulcanised bitumen of cross section shape, so that when laid up together they form a circle.

Electrical Heating Apparatus.

4672.—1909. A. F. BERRY, Ealing. The heating winding, which is in the form of a spiral, has its several convolutions free to be spaced over a flat surface on the underside of the hot-plate in such a manner as may be found requisite to secure the uniformity of temperature aimed at. Blocks of insulating material are placed between the various convolutions to hold them in position.

Watertight Electric Switch.

3106.—1909. SIMPLEX CONDUITS, LTD., Birmingham. This switch comprises a water-tight casing, a switch centrally located in the casing and an operating handle, which passes centrally through the casing. The handle has an L-shaped cam comprising opening and closing sides, which directly operate the dolly head of the switch so as to permit limited and free movement of the switch and ensure a quick break.

Electrically Igniting Miners' Safety Lamps.

8112.—1909. P. BUCKLEY, Batley. A gas tight box contains the accumulators and source of electricity. On the top of the box is fixed a raised circular flange, to which is attached an upstanding cylindrical casing closed at its upper part but with a frontal aperture of a size suitable for admitting a miner's safety lamp. Within this casing is a second casing made to angularly turn within the outer casing, and provided with a revolvable bottom plate, and a central spindle at its upper part which passes through the outer casing. The outer case has a handle by which it can be turned upon its axis. The inner case has a frontal aperture. When the lamp is inserted, the casings are turned so as to bring the electrical contacts in connection with a source of electricity into engagement with the lamp while the lamp is effectually cut off from the outer air. The first reverse movement breaks the electrical connections. Further movements expose the lighted lamp and enable it to be removed from the casings.

Phase Displaced Electro-Magnetic Oscillations.

9427.—1909. M. MONASCH, Vienna. This improved method of producing phase displaced electro-magnetic oscillations consists in bringing two or more sources of undamped or slightly damped oscillations into connection with one another in such manner as to cause a control or continuous influence to be established between them.

Determining Bearings and Distances by Electric Waves.

10876.—1909. J. H. M. VALORIS, Angers. This is a receiving apparatus for use in wireless telegraphy for determining the distance of a transmitting station by the amount of energy received from the station, and combines an ordinary receiving post for wireless telegraphy and an electrolytic detector; an energy integrator constituted by a bolometer having an adjustable rheocord, the galvanometer of which serves as a precise indicator for the energy received and which may be graduated direct for distances. Telephone receivers shunted by a variable resistance for stifling the sound allow an approximation of the distance to be obtained. A relay actuates a chronograph to measure the duration of the series of waves and interruptions between the series.

TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns per week.			Increase or decrease.		Miles of track open.		Accounts for past year.							Cost per car mile.
	Ending	1909-10.	1908-9.	Week.	Current year.	1909.	1908.	Ending	Total receipts.	Passengers carried.	Car miles run.	Receipts per Passenger.	Receipts per Car mile.	Receipts per Mile of track.	
		£	£	£	£				£						
Aberdeen Corporation	Mar. 9	1,225	1,100	+ 125	— 704	27½	27½	May 31	71,930	17,517,304	1,566,119	·98	11·02	4,940	5·93
Ayr Corporation	Sept. 18	671	562	+ 108	—	8	8	—	—	—	—	—	—	—	—
Baker Street and Waterloo Ry.	Nov.	8,141	6,070	+2,071	—	4·25	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	Mar. 6	1,099	962	— 197	+ 231	24·003	13·52	—	—	—	—	—	—	—	—
Birmingham Corporation	Mar. 5	6,835	5,861	+ 974	—	56·792	58·52	—	—	—	—	—	—	—	—
Blackburn Corporation	Oct. 6	1,100	1,293	— 173	— 1,036	24·53	28·3	—	—	—	—	—	—	—	—
Blackpool Corporation	Aug. 26	2,152	2,050	+ 102	+ 732	—	—	—	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams	,, 8	2,304	2,309	— 24	—	—	—	—	—	—	—	—	—	—	—
Bolton Corporation	Oct. 10	2,416	2,337	+ 79	— 259	42	42	Mar. 31	117,799	25,492,902	2,492,147	1·1	11·34	2,804	6·50
Bournemouth Corporation	July 21	1,681	1,723	— 42	— 23	29½	29½	,, 31	86,225	13,991,328	1,766,068	1·47	11·71	2,912	7·22
Bradford Corporation	M r. 5	4,730	3,593	+ 1,137	+ 10,513	98	54·81	,, 31	235,258	47,839,569	5,331,007	1·17	10·59	2,378	—
Brighton Corporation	M r. 13	787	632	+ 155	+ 2,644	9·5	—	—	—	—	—	—	—	—	—
Bristol Tramway Company	Mar. 11	5,402	4,627	+ 775	—	57	51½	Dec. 31	265,362	46,652,389	5,756,842	—	—	—	—
Burnley Corporation	Mar. 12	1,179	1,069	+ 110	—	19½	19½	Mar. 31	64,261	12,355,958	1,202,330	1·23	12·83	5,971	7·92
Burton Corporation	Mar. 6	247	228	+ 19	— 38	6½	6½	,, 31	14,918	3,221,595	430,913	1·04	8·30	1,460	5·85
Cardiff Corporation	April 3	2,000	1,957	+ 43	—	—	—	,, 31	109,979	25,058,146	2,497,169	—	10·57	—	—
Carlisle Tramways Company	June 19	170	175	— 5	— 89	—	—	—	—	—	—	—	—	—	—
Central London Railway	Mar. 12	5,693	5,541	+ 152	— 407	6·32	6·32	Dec. 31	350,150	41,898,373	1,456,781	2·01	5·769	55,404	30·27a
Charing X, Euston, & Hamp. Ry.	Nov.	6,822	6,092	+ 730	—	7·75	—	—	—	—	—	—	—	—	—
City and South London Railway	Mar. 13	3,307	3,373	— 66	— 701	7·26	7·26	—	—	—	—	—	—	—	—
Colchester Corporation	July 14	200	219	— 39	—	8	—	Mar. 31	10,983	2,308,721	349,539	1·09	7·74	1,477	9·56
Cork E. T. and L. Company	Mar. 10	433	356	+ 76	+ 176	9·89	9·89	Dec. 31	24,044	5,737,478	896,945	—	6·43	—	4·43
Croydon Corporation	Feb. 25	1,449	1,177	+ 272	+ 8,514	11½	—	Mar. 31	74,132	16,277,418	1,884,137	1·06	9·56	3,703	7·109
Darwen Corporation	Oct. 1	239	256	— 17	— 201	7·23	7·23	,, 31	13,899	2,557,654	245,584	1·30	13·68	1,922	9·40
Dover Corporation	Sept. 18	230	252	— 22	— 395	7	—	,, 31	11,593	2,697,672	316,754	·98	8·78	—	—
Dublin and Lucan Electric Ry.	Mar. 11	110	91	+ 19	— 46	7	7	—	—	—	—	—	—	—	—
Dublin U.T.	Mar. 11	4,983	4,450	+ 532	+ 1,976	54½	54½	—	—	—	—	—	—	—	—
Dundee City Tramways	Oct. 6	1,332	1,305	— 27	— 569	—	26½	May 15	60,573	16,367,911	1,281,552	·875	1·9	2,371	7·46
East Ham Corporation	Mar. 12	974	866	+ 108	+ 5,763	15	15	Mar. 31	47,430	15,355,703	1,091,586	·73	10·26	—	6·96
Glasgow Corporation	M r. 5	17,360	15,247	+ 2,113	— 4,454	189	185	May 31	907,494	226,948,290	20,766,722	·96	10·49	5,080	5·89
Gloucester Corporation	Oct. 6	395	425	— 30	+ 535	15	—	—	—	—	—	—	—	—	—
G.N., Piccadilly and Brompton	Nov.	13,429	9,354	+ 4,075	—	9·25	—	—	—	—	—	—	—	—	—
Halifax Corporation	—	—	—	—	—	52·574	37	Mar. 31	81,872	20,378,672	1,786,390	11·40	11·18	1,528	8·40
Huddersfield Corporation	Dec. 4	1,613	1,357	+ 256	+ 2,663	28	28½	,, 31	84,704	16,200,020	1,960,329	1·29	10·37	2,421	5·10
Hull Corporation	Mar. 12	2,743	2,403	+ 339	+ 7,354	29	26	,, 31	128,722	30,964,254	3,022,844	1·	10·22	—	6·04
Ilford Corporation	Feb. 12	451	391	+ 60	+ 1,969	10	10½	,, 31	25,328	6,385,466	634,446	·87	9·58	2,066	6·42
Ilkeston Corporation	Mar. 10	133	126	+ 7	— 232	4	4	,, 31	7,214	1,968,850	198,415	9·1	7·9	1,803	7·04
Kirkcaldy Corporation	Sept. 8	259	266	— 7	—	7½	7½	May 15	14,993	4,874,199	459,066	·711	7·838	1,856	5·28
Lancashire United Tramways	M r. 9	1,234	1,080	+ 154	+ 242	39	39	Dec. 31	68,904	12,554,593	2,244,344	—	—	—	—
Leeds Corporation	Sept. 18	6,896	6,624	+ 272	+ 3,662	108	96½	Mar. 31	340,368	75,734,083	7,694,989	1·06	10·62	3,527	5·51
Leicester Corporation	Sept. 11	2,162	2,130	+ 32	—	—	—	—	—	—	—	—	—	—	—
Liverpool Corporation	N v. 6	10,803	10,687	+ 116	— 1,977	109	104	Dec. 31	572,822	124,043,239	12,231,799	1·108	11·24	5,508	7·04
Liverpool Overhead Railway	Mar. 6	1,310	1,210	+ 100	— 189	6·65	2·40	June 30	79,004	11,171,515	1,106,386	—	—	—	—
London County Council	Feb. 19	38,431	32,846	+ 5,585	+ 119924	129½	122½	Mar. 31	1,274,660	279 166,461	25,591,028	1·08	11·74	—	6·79
Lowestoft Corporation	D c. 11	155	150	+ 5	+ 30	3½	—	Sept. 30	11,399	2,645,206	370,320	1·03	7·36	2,279	6·12
Maidstone Corporation	Mar. 6	157	100	+ 57	—	7·4	—	—	—	—	—	—	—	—	—
Manchester Corporation	Sept. 11	15,631	15,297	+ 334	— 2,871	183	181	—	—	—	—	—	—	—	—
Metropolitan District Railway	Mar. 12	11,003	9,512	+ 1,491	+ 10,564	24	24	—	—	—	—	—	—	—	—
Metropolitan Railway	M r. 13	16,213	15,395	+ 818	+ 5,874	24½	24½	June 30	680,357	99,846,735	—	1·46	—	—	—
Nelson Corporation	Oct. 16	151	131	+ 20	+ 7	2½	2½	Mar. 31	7,362	2,060,712	204,740	·85	8·63	1,907	—
Newcastle-on-Tyne Corporation	M r. 5	3,815	3,659	+ 156	— 1,302	60½	59½	,, 31	211,085	46,203,164	4,411,745	1·10	11·48	3,504	6·36
Newport (Mon.) Corporation	Oct. 9	663	638	+ 25	— 311	14½	14½	,, 31	35,531	8,174,003	798,029	1·04	9·89	2,450	7·21
Oldham Corporation	Jan. 24	1,778	1,516	+ 262	— 386	—	—	—	—	—	—	—	—	—	—
Portsmouth Corporation	Oct. 10	2,046	1,809	+ 237	—	28½	28½	Mar. 31	97,741	21,247,048	2,309,439	1·10	10·15	—	—
Reading Corporation	Mar. 10	556	507	+ 49	+ 170	13½	13½	,, 31	32,769	7,933,572	915,481	—	8·93	—	4·46
Rochdale Corporation	Dec. 26	1,240	1,126	+ 114	+ 746	20·9	20·93	,, 31	56,558	10,196,148	1,252,925	1·32	10·83	2,693	9·47
Rotherham Corporation	Feb. 4	555	587	— 32	—	—	—	—	—	—	—	—	—	—	—
Salford Corporation	Sept. 27	4,096	4,662	— 66	— 3,326	78	74½	Mar. 31	244,065	45,771,611	5,486,150	1·25	10·67	3,185	—
Scarborough Tramways Co.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Sheffield Corporation	Mar. 6	5,788	4,749	+ 1,039	+ 8 043	39½	37	Mar. 25	289,745	17,568,686	7,065,380	·896	9·842	4,225	5·04
Southampton Corporation	Mar. 2	961	808	+ 152	+ 513	18	18	,, 25	52,647	10,121,887	1,157,451	1·25	11·33	—	7·30
Southend-on-Sea Corporation	Aug 21	995	557	+ 438	+ 1,483	—	—	—	—	—	—	—	—	—	—
Stockport Corporation	—	—	—	—	—	25	25	Mar. 31	52,004	9,155,172	1,335,911	1·34	9·342	1,830	6·73
Sunderland Corporation	Jan. 27	1,310	1,336	— 26	— 7,984	—	—	—	—	—	—	—	—	—	—
Swindon Corporation	Dec. 11	126	114	+ 12	—	—	—	—	—	—	—	—	—	—	—
Torquay Tramways	Aug. 26	630	647	— 30	—	8·41	—	Dec. 31	15,065	2,880,420	353,297	1·40	1·023	—	—
Wallasey U.D.C.	Mar. 12	804	762	+ 42	+ 951	12·68	12·45	Mar. 31	43,823	8,331,038	891,540	1·2	11·79	3,453	7·72
Warrington Corporation	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
West Ham Corporation	Mar. 3	2,351	1,812	+ 539	+ 8,034	27	14·7	Mar. 31	122,881	35,502,836	2,556,854	·789	10·95	4,417	6·79
Wolverhampton Corporation	Nov. 3	841	823	+ 18	— 206	21½	—	,, 31	44,432	9,440,369	975,714	—	10·929	2,190	6·509

a Train Miles. h Half-year's figures.

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NOTES.

SOUTH AFRICAN ELECTRICAL ENGINEERS.

At various times we have referred to that "young hopeful," the South African Institute of Electrical Engineers. It has been holding its first general meeting at Johannesburg, and all the Rand big-wigs were there to pat the vigorous infant on the back. Probably the occasion was specially noteworthy on account of the remarks made by Professor J. H. Dobson, the town electrical engineer of Johannesburg. He suggested that the three local engineering societies—civil, mechanical and electrical—might do well to consider some scheme which would co-ordinate the operations of all and yet leave freedom to each to live its own life. He instanced such items as a joint secretary, offices in common, and a joint journal. Everybody seemed to be pleased with the idea, and officers of the other societies pointed out how each might help the other, and Mr. C. W. R. Campbell, the president, was also quite agreeable, though firm on the question of the perfect autonomy of the different branches. There is much to be said in favour of such a plan. Something of the kind, at all events as far as regards offices in a common building, has been carried out successfully in America.

"ENCOURAGEMENT" TARIFF.

When meeting his shareholders, Mr. H. R. Beeton, chairman of the Brompton & Kensington Electricity Supply Co., told them all about the new tariff—what one might well call an "encouragement" tariff—which the company are introducing to consumers. It is, of course, the result of the metallic filament scare, an effort being made to induce consumers to avail themselves of the higher illumination without reducing the number of lamps, in which efforts the company was fairly successful. But with a view to further increase demand an offer is now made to supply current at a uniform charge of 2d. per unit for lighting, heating, cooking and small power, and at 1d. per unit above a certain quantity. In this way there would be no need of double wiring and two meters, while the economy on the lighting would more than compensate for the increase on heating rate. Of course, consumers preferring the old arrangement of separate wiring and measuring with dual rating, can remain "as they were." Any move to promote sale of current is interesting, and certainly Mr. Beeton's plan offers advantages likely to attract the public.

RUSSIA'S AWAKENING.

There appears to be a distinct awakening to the uses of electricity in Russia. Much lee-way has to be made up, for both electric lighting and traction is in a very backward state in the Czar's dominions. However, as we pointed out recently, both the German and Belgian financial-technical combinations are making vigorous efforts to introduce electrification for all departments of life in Russia. A correspondent of our contemporary, *The Financier*, states that the Tiflis Town Council have instructed their engineer to study the river Kure with a view to the establishment of a hydro-electrical scheme which would probably involve an expenditure of some half a million roubles. Tiflis possesses a funicular railway, and the company are seeking powers to extend along the crest of Mount St. David, while another project is to connect Tiflis and Baku with a telephone system, an aluminium cable being specified. The town of Piatigorsk, it seems, is ambitious to have electric light and power, and the contract was, it is said, offered to Messrs. Siemens & Halske, the project falling through owing to disagreement as to periods of payment. Now a local landowner, a Mr. S. T. Titz, has offered to undertake the supply and distribution of electricity if granted a 37½ years' concession, while a second contractor, a Mr. E. A. Tzart, is also in the field. A contract for the equipment of a 5,000 h.p. electricity establishment on the Romaninsk estate in the Caucasus has been given to the firm of Erikson. While Poltava is negotiating for the electrification of its tramways, the electrification of the tramway system at Krementchug is already begun. At Warsaw the merits of electricity for small power users is being so generally recognised that it is causing alarm among large manufacturers, who find home workers competing against them most successfully owing to the installation of small motors. This is merely the beginning. Quite apart from public lighting and traction, there are immense possibilities in the way of electrification of flour and saw mills, factories, mines, and so on.

MINE SAFETY DEVICE.

Mr. R. A. Copeland, of the New Modderfontein Gold Mine, in discussing the electrical underground winding plant at his mine before the South African Institute of Electrical Engineers, described a safety device of his own in connection with the switching off of the motors. Owing to the poor insulation of the cables he felt that precautions were necessary. So a bank of lamps 16 c.p. 120 volts, four rows of 12 in multiple series, was installed, which took the back kick satisfactorily, the lamps burning very dimly during working, and when switching-off with the main switch (having discarded the field switch) they simply rise to normal c.p. and then die out. As an extra precaution, a carbon sparking gap set at 3-32 of an in. was inserted.

IRON IN GOLD PULP.

By the way, members of the South African Institute of Electrical Engineers have been invited to solve the difficult problem of removing iron in the gold pulp coming from the stamps. The iron interferes with the cyanide process by absorbing oxygen. It was separated with the heavier bodies, and returned over and over again to the tube-mills to be re-ground until it is fine enough to be passed on to the cyanide works. The quantity of iron present in the pulp is approximately 4 lb. per ton. Treating 30,000 tons per month therefore meant that 60 tons of iron has to be ground down to a fine powder in the tube-mills before it can be got rid of. This means money, and any simple device to remove the iron from the pulp would be welcomed. Several schemes had been tried, but with no great measure of success. The most favoured idea seemed to be a magnetic separator, but it has not been an entire success.

ELECTRICITY v. STEAM.

The other day Mr. Roles, the City Electrical Engineer of Bradford, was entering the field on behalf of electricity in textile factories against the rather disparaging remarks of Professor Charnock, and within 24 hours or so he had the good luck of practically demonstrating its utility in overcoming the shortcomings of steam in a large factory. It appears that there was a bad breakdown at a packing case factory in Wakefield-road, a breakdown which caused a great deal of damage, and brought everything to a standstill. Thereupon the proprietors called upon the Corporation's Electricity Department. It was promptly agreed to put down a 45 h.p. electric motor, as being the quickest way

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of getting the premises running once more. To obtain the necessary supply a cable trench 86 yards long had to be excavated across the road under the tram lines, at which point the digging reached a depth of 5 ft. The motor was got ready and taken to the side of the breakdown, where it was fixed. Within 36 hours of the mishap the premises were running as if nothing had happened, the whole of the work being done by men in the electricity department.

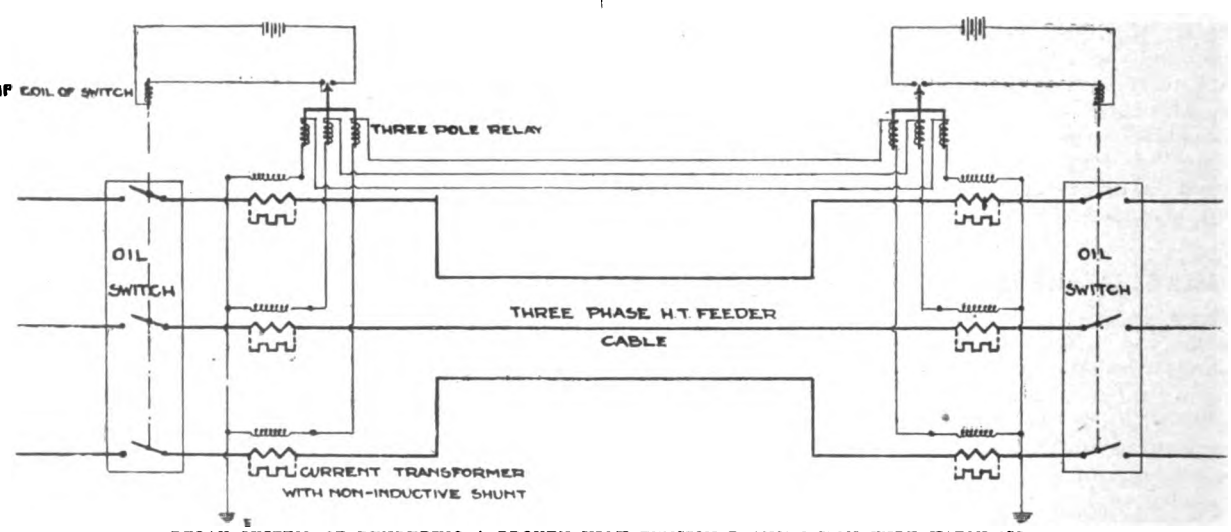
HOW PROFITS VANISH.

A lively breeze which flustered the Barrow Town Council last week is worth considering. The Electricity Committee asked that a debit balance of £440 on the year should be met out of the rates. Thereupon there was a tremendous hub-bub, and the Electricity Department was compared most unfavourably with the Gas Department, which made a profit of £6,000. But what are the real facts? The gross profits out of electricity were £6,615, or 7¾% on the capital expenditure. Out of this interest on the loans had to be met, and £3,374 paid away in reduction of the loans, and so there was a loss. But, it is argued, the enforced payments in reduction of capital are excessive. And so they are, if we are to compare the Electricity Department with the Gas Department. The electricity undertaking has only been in existence for 10 years, and has paid off £22,000, or 19·5% of its debts. The gas works, which have been in existence for 34 years, have only paid off £25,000, or 22% of its total capital. The repayments on capital account for 1909 by the Electricity Department was £3,757, or 3·3% on a capital of £113,000; the gas works only repaid £2,625, or 1·1% on a capital of £143,000. Obviously, therefore, if electricity had been placed on the same financial footing as gas, the department would have made a net profit of amounting to close upon 2% on its total capital. The rigorous treatment meted out to electricity by the Local Government Board in matters concerning repayment of loans is only too generally overlooked by captious critics; and, as a matter of fact, this rigour acts to the disadvantage of the undertaking, for by crippling the financial resources, progress and necessary development are retarded.

HANDLING BROKEN HIGH TENSION TRANSMISSION CABLES.

The Canadian Hydro-Electric Power Commission, a Government body, have devised a plan whereby high tension transmission wire is rendered harmless if it should break at any point between stations and the loose ends should fall to the ground. The diagram given herewith represents two consecutive stations, connected by three high tension transmission cables. Running parallel with these cables on a separate pole line (in actual fact the telephone poles are used) are three smaller wires, each of which is supplied with a weak current by small capacity transformers, one at either station, these being fed by one or other of the three main transmission cables, as shown. Each of these small circuits operates, at either station, one pole of a three-pole relay used on occasion to close a short, strong, local battery circuit. In case of accident to one of the main lines, which will produce a marked change in the strength of the current through the small-capacity transformers on that particular line, a large momentary current is induced in the corresponding relay line which operates the relay at both ends and closes the two local battery circuits; these, in turn, excite powerful electro-magnets which open the main line oil switches at the two terminal stations. The relay lines, as will be seen, are star connected at each station and earthed.

It will be seen further, that this scheme of installation is a safeguard not only against breakages in the transmission cables, but also equally against short circuits. If two wires should by chance become crossed or otherwise short-circuited, the result would be a sudden increase in current strength which would produce a corresponding instantaneous increase in the relay, so that the local circuits and the electro-magnates would operate as before.



RELAY SYSTEM OF RENDERING A BROKEN HIGH TENSION TRANSMISSION WIRE HARMLESS.

ENGINEERING STANDARDS COMMITTEE.

With a view of assisting the Committee to meet the heavy expenses incurred in the preparation of their reports, it has been decided to make certain alterations in the Committee's price list after March 31 next. The prices of 21 of the reports will be raised, the prices of 28 will remain unaltered, and the price of one report, namely, that dealing with the Properties of British Standard Sections (Report No. 6) has been reduced with a view to its more readily finding its way into the hands of draughtsmen and others engaged in constructional work. Copies of the revised price list can be obtained upon application to the Secretary of the Engineering Standards Committee, 28, Victoria-street, Westminster, S.W.; or to Messrs. Crosby Lockwood & Son, 7, Stationers' Hall-court, E.C., the official publishers to the Committee.

CANAL AS GENERATOR OF ELECTRICAL ENERGY.

An important installation has been recently completed in France to supply Bordeaux, Angouleme and Perigeux with electric power. In the installation under notice advantage has been taken of the difference in level between the river Dordogne and the Lalinde canal which runs parallel with it. By this means 18,000 kw. are obtained, and utilised for the production of two sets of currents, one of 50,000 volts, the other of 13,000 volts. The power station is at Tulliere, 70 miles from Bordeaux, to which the current is conveyed, as well as to Angouleme and Perigueux by overhead wires, after transformation on the way at Cenon. The 50,000-volt current is carried on steel masts 50 ft. high, but the reduced current is carried on wooden masts. The power station contains nine vertical Francis turbines of 9,000 h.p. each, at 107 r.p.m. At the Cenon transforming station there are nine transformers, which reduce the voltage to 13,500. The installation is of interest as showing that the high voltage is necessary, for cheap transmission must be reduced step by step before reaching street and house lamps.

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TATE BIFUNCTIONAL CELL.

A CHAT WITH THE INVENTOR.

A distinct revival of interest and hope in the electrical propulsion of vehicles—heavy trams and light cars—by means of storage batteries is evident. No doubt Edison's latest battery, recently described in these columns by our New York correspondent, has done much to concentrate the question on heavy vehicles, but the published details inspire certain misgivings, both on account of cost and durability, for the batteries are still too heavy, it would seem, to withstand vibration. For our part, we are inclined to attach far greater importance to the Tate bifunctional accumulator, which was fully described and illustrated in our columns of February 18 and 25. This Tate cell has most remarkable properties, and appears to be, both structurally and functionally, far superior to Mr. Edison's latest.

Mr. Alfred O. Tate has been over to London on business, and when calling upon us, explained that steps are being taken to manufacture his accumulator plates on a large scale. It is proposed at first to supply the British market from Toronto, but eventually it is hoped that the plates will be manufactured over here. Meanwhile, Mr. Tate, after a visit to Canada and the States, will return here with his private motor car, fitted with his batteries, which have been subjected to prolonged and severe strain without mishap.

We may be permitted to briefly recapitulate the main features of this very original invention. We have:

(a) An open insulating sectional frame, one end of which, and the three lateral supports, being milled to half their depth, and the internal vertical edges grooved to receive the lead conducting strip. When this strip is drawn into the frame, five pockets are formed for the reception of the active materials, each about one thirty-second of an inch deep, representing the distance between the surface of the metallic conductor and the outside faces of the frame itself. On one side of the frame the pocket is continuous; on the other it is interrupted by the lateral supports which break the channel into four pockets, and it is provided with a hole at each end to receive the assembling rods.

(b) A lead conducting strip provided with a relatively heavy-holed end to correspond with the hole at the milled end of the insulating frame.

(c) Two perforated insulating and separating shields, one equipped with a series of interrupted, staggered bearings along its internal vertical edges which hold the bars about one thirty-second of an inch apart, provide openings for the admission of the electrolyte, and form a continuous vertical channel from bottom to top for the free circulation of the fluid and the escape of nascent gases. They have end holes to receive the assembling rods.

(d) Two assembling rods on which the constituent parts are threaded top and bottom.

(e) Two side binders made of hard non-conducting substance.

Now let us consider the assembling. The heavy ends of the lead conducting strips project about ½ in. beyond the sectional frame. In assembling a unit, these frames, carrying the conducting strips and applied oxide, are reversed alternately, so that one series of projections appear at the top and the other at the bottom of the unit. A pair of perforated insulating shields (c) are threaded between the sectional frames, and the top and bottom metallic projections of the latter are turned down in contact and leadburned after the assembling rods (d) have been headed on the outside of the binders (e). Thus one alternate series forms the positive and the other the negative sections of the plate. A unit may consist of two or more sections.

The standard adopted for all purposes other than work of a very light nature, is a unit consisting of 57 sections —28 positive and 29 negative (one split negative). The dimensions are: Height $8\frac{5}{8}$ in., width across the face $9\frac{3}{4}$ in., thickness 9-16 in., and the weight of the unit 4 lbs. The capacity on 8-hour discharge rate is 36 ampere hours, and the average voltage for eight hours 1·94. The total watt-hour efficiency is 70 watt-hour efficiency per lb. weight of unit $17\frac{1}{2}$, and total weight efficiency 40 lbs. per h.p. hour.

This method ensures equal distribution of current density, arrests sulphating and retards oxidisation of the active materials. The current finds entrance at the top and exit at the bottom, or *vice versa*, of a finely sub-divided multiple assembled unit, having conductors only 8 in. in length, with the result that the line of potential equalisation follows the horizontal centre of the plate, and there is no appreciable variation of current density above or below this line; the distance from end to centre of the metallic strips being only 4 in., the drop in potential is practically *nil*. Owing to the restricted width of the metallic conducting media and the active columns, the vertical central regions are permanently fixed in close relation to the vertical edge areas of the media, and the current is again equalised in a horizontal direction. Every part of the cell is, therefore, active, and high efficiency is attained up to the last.

Mr. Tate informs us that he has repeatedly exhausted cells to zero and then suddenly re-charged at high speed, without any untoward result. This treatment, too, has been meted out to a unit repeatedly. This is a severe test, which is bound to appeal to users, so too is the curious phenomenon that oxidisation of the anode through the process of charging increases energy until the point of loss of metallic conductivity is reached. But, Mr. Tate says, he has succeeded by reversing the method of charging to de-oxidise the anode, restoring its metallic form, and so practically doubling the life of the cell. It may be well to say here that the inventor has not approximately approached a solution of the perpetual motion problem, because he can only revitalise the cell once. For which mercy, all things being considered, the industry will be devoutly thankful.

While laying particular stress on the utility of the Tate bifunctional plate for tram and other self-propelling vehicles, we recognise that it has the whole field of battery practice before it.

Its combined lightness and strength, ease of charging and general manipulation, even working and high efficiency are points singularly attractive for traffic equipments, but appeal likewise to all classes of battery users. We shall hear more of Mr. Tate's activities in the near future.

CARDIFF HYDRO ELECTRIC SCHEME.

The Cardiff City Council have adopted Dr. J. J. E. Biggs's proposal that the electrical engineer and waterworks engineer be instructed to report on the feasibility of a scheme for establishing somewhere on the line of conduit from the Taff Vawr Reservoirs to the city of Cardiff a hydraulic power station for the generation of electric current in order to supplement the existing power stations, and thus provide for any further extensions that might be required—the water so used not to be run to waste, but to be sent forward for waterworks purposes, such report to furnish an estimate of the cost of production by the suggested hydraulic power station as compared with the existing power station at Roath.

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LARGE UNITS AT HIGH SPEEDS.

DISCUSSION ON MR. WALKER'S PAPERS.

The discussion on the two papers, "Short-circuiting of large electric generators and the resulting forces on armature windings," and "The design of turbo field magnets for alternate-current generators, with special reference to large units at high speeds," read by Mr. Miles Walker, M.I.E.E., on the 10th inst., was resumed at the meeting of the Institution of Electrical Engineers, London, on the 17th inst.

Mr. A. H. Law (Newcastle): The barrel type of rotor mentioned by the author was originally introduced by Mr. Charles Brown and patented in 1901. A rotor of this type built about that time is still in operation at a station of the Newcastle Electric Supply Co., and has run ever since it was started without giving any trouble whatever. This type of rotor is really an adaptation of the old single-phase two-pole or four-pole armature—the revolving armature—as it used to be constructed. Continuing, Mr. Law showed a slide, illustrating a short circuit current of a 4,000 kw. alternator, shortcircuiting when excited for its full voltage 5,800. The displacement of the windings was measured by means of lead wires and showed that the windings only moved about 1-32 in. In addition, cast iron clamps were used on the test with the intention of replacing them with cast steel in order to secure the factor of safety. The importance of keeping down the short circuit current was touched upon, Mr. Law referring to such a method as Mr. Walker's alternating system of compounding. It was stated that with Messrs. Parsons compounding, a 1,500 kw. alternator could be built to have a momentary short circuit current not exceeding 12 to 14 times the normal, and extremely good regulation could still be obtained even with a heavy power factor.

Dr. M. Kahn: I must congratulate Mr. Miles Walker on his paper, in which the main difficulties met with in the design and construction of large turbo alternators have been treated in a most excellent and complete manner. The problem offered by short circuits in large turbo alternator units is a particularly difficult one, as the coils, which have to be rigidly clamped on, consist largely of insulating material, which is mechanically very weak. There is only one way out of the difficulty, and that is to attack the problem thoroughly, to employ really very heavy clamping arrangements, and not be afraid of getting the clamps close up to the winding. The most suitable windings for fixing are the windings similar to those used on direct current armatures, either an ordinary barrel winding or an end winding corresponding to the so-called butterfly connections. A method of supporting a barrel winding is shown by Mr. Miles Walker, but this method requires bolts going right through the winding, which has the disadvantage that the most valuable feature of the barrel winding (namely, all the bars lie close to one another and form one compact mass) is lost where the bolts pass through the winding. I would call your attention to a method of fixing this winding that avoids this disadvantage. The winding is stayed against movement outwards in a similar way by a supporting ring while a wrought iron flanged ring with pure mica insulation, is forced inside, and wedged to the other ring by bolts outside the winding. This type of construction has been used on a number of machines for some years and has never given the slightest trouble. I think it is the strongest winding that can be imagined, as all the bars lie flat against one another, so that the attraction between bars cannot produce any deformation of the winding, and in addition the current in one layer flows in an opposite direction to the current in the other layer, which has a neutralising effect, as Mr. Miles Walker has already stated. If the end connections are bent round at an angle of 90° we get a similar winding lying flat against the stator face, which has already been shown by Mr. Cooper. A third form of winding—(shown in the paper)—which is very often adopted is that called "winding in three tiers." This winding is used very largely, and has the advantage that there is only a comparatively small voltage between adjacent strips, whereas in the case of the barrel winding the full voltage exists between the adjacent top and bottom layers. This merit from the point of view of electrical breakdown is, however, its weakness from the mechanical point of view. There are large spaces between the conductors, and if these conductors attract one another due to the action of a short circuit, they may easily be displaced. It is, therefore, very important that the conductors be not only very well fixed and stayed to the core by clamps, but also that they be stayed very well against one another by packing pieces at short intervals. This latter is specially necessary between the mica tubes on the straight part of the coils of the outer tier where the coils leave the slots, as there is here a very large overhang, and in the case of short circuits, the winding would otherwise be bent together and the mica tubes damaged. I should also like to mention a simple method of construction of distance pieces for this part of the winding. The distance pieces are made in halves, both halves being screwed together so that they grip the tubes well at each end and cannot shift. It may be worth mentioning in connection with this type of winding it is advisable to make the inner bolts of non-magnetic material, as otherwise they are liable to get hot. In the case of machines of large output one has usually to deal with fairly large currents, which require conductors of considerable cross section. If these conductors are made of solid copper, they themselves offer a certain resistance against deformation. Such conductors can, however, only be used on former-wound machines, and for this reason former-wound machines have an advantage over machines hand-wound with flexible cable. Professor Thompson has already indicated that such former-wound machines with open slots can be used without fear of deformation of the current wave if the slots are inclined at an angle to the axis of the machine. Mr. Miles Walker has only treated the problem offered by synchronous machines. For large turbo alternators, the use of asynchronous machines has certain advantages, and one of them is that if an asynchronous machine is short circuited, the total impressed volts are counterbalanced by the reactance voltage, and, therefore, we do not get the big difference between the momentary and permanent short circuit currents. As the short circuit current of asynchronous machines is usually about six times the full load current, the current to be dealt with in the case of these machines is smaller than in the case of synchronous machines of normal design. In addition, the short circuit automatically cuts off the magnetising current of the machine so that the flux will begin to die away instantaneously.

Mr. J. H. Rider: Having had two examples of the effect of short circuits on large alternators, my experience may be interesting. We had a bad short circuit on a slow speed three-phase generator of 3,500 kw., due to bad parallelling. The whole of the end winding of the coils collapsed inwards from the frame of the machine. Every single coil went in and damaged the mica tubes and broke the machine down. The other short circuit happened on a 5,000 kw. turbo alternator. The alternator was coupled to the turbine in the usual way, and had 16 bolts 1 in. in diameter, holding the two halves of the coupling together. At the instant the short circuit took place the whole of the bolts were cut through as with a knife. So far as we know not a single coil, not a single clamp, was disturbed, and the machine was on load again as soon as we put in new bolts. Nothing has been done to the machine from that day to this. I think it is a splendid testimonial to the character of the work, particularly when you consider the apparent simplicity of the clamps. It is not in the number of clamps that safety is obtained, but in the placing of the clamps in the right positions. Mr. Miles Walker refers to the compensating feature which he has adopted with great success on many of his machines. It is one thing to use a single machine with compounding effect, but how will a machine with a large compounding effect work in parallel with a number of other machines all of large size which have not got this compounding effect.

Mr. E. H. Rayner: I have here several lantern views showing oscillograph records taken by Mr. David, at the Laboratory Central, Paris. The curves show during the first moments of switching on high tension transformers a pulsating current, mostly situated on one side of the zero line. The heating per c.f. of iron and the stator must, I think, be much greater in high speed machines than in slow speed machines. I imagine that the great trouble now in front of designers is to get rid of the heat from the windings.

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Mr. G. Stoney: Mr. Walker points out that in a large station with a number of turbo-alternators running you may get double the ordinary short circuit current where one machine is put in out of phase. Instead of having 20 times the normal full load current you have something like 40 times the normal full load current. A short circuit test at full voltage is hardly a sufficient test on the windings. You ought really to throw the machine out of phase when all the others are running parallel. I think, however, this probably is rather an excessive test, but this I understand from Mr. Walker, is the worst that could take place.

Mr. P. W. Turner: Regarding the design of field magnets, it is the rotor of a generator and not so much the turbine itself which limits the capacity of a turbo set for a given speed. For this reason the A.E.G. have evolved a unique design of rotor with which they are able to attain very high peripheral velocity—no less than 110 meters per sec. Turbo-generators of 3,000 kw. capacity are made in the A.E.G. Co.'s works to run at 3,000 r.p.m. The centre portion of the rotor core is made of a solid forging of steel in one piece with the shaft. The coils are placed in slots, and above them steel or gun-metal wedges are pressed in. The teeth, of steel plates, are in short lengths of about 6 in. The coils are of strip copper encased in brass castings, and are built up externally to the core. The whole thing—teeth and conductors—is then slid on the core. Consulting engineers in their specifications in connection to turbo-generators, frequently put a limitation as to the number of r.p.m., but I think that is detrimental, as it is the peripheral speed which counts.

Mr. G. W. Partridge: There is no doubt that the forces which are exerted on the windings of large alternators are enormous at the time of short circuit, in some cases, I believe, going up to almost 7 or 8 tons on each coil. It is difficult to even suggest a method of getting over this difficulty, except, in first instance, as Mr. Walker suggests, in clamping or holding the coils. But there is a second point, which, I think, is worth consideration, viz., that consulting engineers should in the future alter their specifications and allow an even greater drop on load than they do now. Instead of allowing a drop of from 16% to 18%, I should not hesitate to allow from 25% to even 30%, as we now have automatic regulation instead of the old hand regulation. If this drop were allowed I think we should not have the enormous rush of currents which take place on short circuiting of an alternator. With regard to the use of choke coils, does the author think the use of iron in the choke coil would act quick enough. I rather think that he would get better results with an ordinary resistance—I would not say whether used inductively or not.

Mr. J. T. Irwin: The author, in considering the forces that act on the coils has, I believe, not taken into account at all the stray fields that might be present in the linking of the coils.

Mr. Percy R. Allen: May I suggest that the views of those engineers who have had experience with large continuous current circuits would be interesting. The author might reply to any observations that may be sent in so that the record in our proceedings will be as complete as possible.

Mr. Miles Walker (replying to the discussion): Since these experiments were made, a number of more modern machines have been short-circuited at full voltage and stood it fairly well. Some consulting engineers include in specifications a clause that as part of the test the machine must be short-circuited. Although that has been in the past difficult to live up to, you can now get machines of modern construction, which withstand it perfectly well. I still think that two-pole winding is more difficult to construct than four-pole winding. Mr. Law's method of compounding is an exceedingly beautiful one, and it is understood he has recently beaten me in some guarantees. I congratulate him on that. Dr. Kahn has spoken about mica tubes. The forces are so great that if big clamps are put on you may have a certain amount of movement between the clamps. We must have fairly flexible insulation as well as very strong clamps. The distance pieces Dr. Kahn mentioned are used by a number of firms, and really are necessary in protecting parts of the winding which project from the slots. It is just possible that a machine which has stood a short circuit once will not stand it again. The coils do not always go inwards, it depends upon the direction of the currents flowing. The salient pole field has a much less mean turn than the cylindrical field. Other things being equal on a salient pole you will have less loss than in a cylindrical field. When you consider that the exciting energy is only about ½%, what does it matter whether it is ½ or ¼% if you are getting very much better regulation? I might say that the question whether a compensated machine will work in parallel with a non-compensated machine can be answered satisfactorily. Experiments have actually been tried in Glasgow on a 4,000 kw. machine, running in parallel with uncompensated machinery, and it runs perfectly well. The reason is that a compensated machine is not compensated for wattless current. It is the wattless current which helps in parallel running. If you have a compensated machine running with an uncompensated machine, it tends to hold its volts up better than the other machine. I was very interested in Mr. Turner's pictures of the A.E.G. rotor, which, from the theoretical point of view, stands in the front rank. As soon as it is shown that you can get large powers at high speeds the consulting engineers, who are always cautious at first, will be reasonable. A suggestion by Mr. Partridge as to putting in choke coils at the instant of parallelling might be quite useful, and might certainly save machines if the operator made a bad parallel. I think it is impossible to make any kind of automatic switch which would put in a choke coil quick enough to save a machine.

The discussion then closed, and the President, Dr. Gisbert Kapp, on behalf of the Institution, thanked the author for his valuable contribution. It was intimated that Mr. Miles Walker would give a more detailed reply for inclusion in the proceedings.

THE ELECTRIC MOTOR FOR MARINE PROPULSION.*

By WILLIAM P. DURTNALL.

One of the burning questions of the day is that of the generation and utilisation of power for marine propulsion and efficiency, which affects so directly the design, construction, and ultimate operating cost of all classes of vessels. Consequently, all designers are striving to get the very best results in the matter of maximum thrust per horse-power delivered to propeller shafts, and at the same time the lowest fuel consumption per horse-power so delivered. To design and construct a vessel which shall afford wholesome living accommodation, and also provide sufficient warehouse-room for merchandise, and be equipped with means of propulsion to get from place to place, and be as safe against the perils of accident and tempest as human foresight can make it, is a problem which, if there were no experience to guide one, would present as great difficulties and complexities as one would care to attack; but, with past experience to guide him, such is the work of the naval architect, and the special character of this Institution is a sufficient justification for bringing the subject of this paper before its members.

Electrical ship propulsion was a problem that had to await for its solution the means of generating electrical energy cheaply. The advent, in quite recent years, of those very interesting and efficient prime movers the steam turbine and the internal combustion engine, together with the enormous advance in design and manufacture of heavy electrical plant, has made the possibilities of electrically driven vessels of large power appear within sight, and such a question can now be profitably considered and discussed.

This is especially so now that we have very accurate instruments of precision, devised to facilitate the study of the numerous problems which arise in connection with prime movers, and power transmission systems, such as the various torsionmeters by which the actual shaft horse power can be recorded, and the difference ascertained between the towing resistance (or thrust horse-power) and the shaft horse-power.

The practical application of the steam turbine for marine propulsion by the Hon. Charles A. Parsons, has led to a close investigation of the propeller problem, as regards its efficiency when coupled direct to such high-speed machinery. No doubt some improvement in the

* Read at the Spring Meetings of the fifty-first Session of the Institution of Naval Architects, March 17.

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design and construction of screw propellers has taken place, as the result, during the last few years, of research work by investigators. This is especially welcome, as it tends to raise the revolution speed for a given propulsive efficiency or to improve such efficiency for a given revolution speed, or power.

The object of this paper is to bring before this Institution the great potentialities of electrical power generation and transmission and the means of regulating propeller speed in steam vessels of various types; to consider this question also from the commercial aspect, pointing out the low operating costs that are possible, and to promote a good discussion on the subject, which may go to show that such developments are well within the present range of practice.

Until the internal combustion engine is so developed that it can be constructed in the very large power units required by modern marine practice, there is not the least doubt that steam will be retained as the means of generating power, and while the great advantage of superheated steam is possible, there is not much fear that the steam turbine, with its high revolutions, small diameter, and great mechanical efficiency, will hold the field as being the most suitable prime-mover and producer of mechanical power. It is a most ideal prime-mover, with its one moving part, of light weight, low cost, occupying a small amount of space, easy to open up for inspection or repair, and if designed to run at high revolution speed for a given power and therefore constructed of very small parts, it allows the safe use of superheated steam without risk of distortion of its parts; it gives a uniform torque, has an absence of parts requiring lubrication, and is, at least in some cases, highly efficient under great variation of load, as shown by its successful application in important generating stations on shore, working with very heavy loads for railway and electric lighting service.

Its direct application for marine propulsion has secured for it a very strong position, and it has in many cases been successful in competing with the reciprocating marine engine, on the basis of results given out in fuel used per shaft horse-power. But in this case it labours under a few but very important disadvantages, when viewed from the commercial standpoint. First, it is essentially a piece of mechanism which, to be efficient in steam, must be run at high blade speed, and in order to meet the requirements of the propeller (which has diametrically opposite speed characteristics) marine turbines must be of great length and diameter, so that the economical use of superheated steam is precluded.

Further, the steam turbine in its most simple form is not reversible; therefore separate sets of "Astern" turbines have to be installed and carried, which, owing to the greater clearance that has to be arranged for in such large diameter turbines to meet the requirements of expansion and contraction, tends to increase the steam consumption per horse-power developed. The manœuvring qualities demanded for sea-going conditions, and also the astern steaming, are not economical conditions under which the steam turbine can be worked, and this is especially so at low vessel speeds. That inconvenience is, perhaps, of little importance in vessels that make long, continuous voyages in good weather; it is, however, very important in vessels that travel at low speeds, or for short voyages, starting, stopping, and manœuvring, in and out of harbour several times a day (especially during boisterous weather), whilst the reverse power is only applied usually on two out of three or four shafts, as the case may be, so that the time taken to pull up a vessel at high speed is considerable. For, besides having the actual reversing of the propeller to do, the reverse turbines have to break down the momentum of the "Ahead" turbine rotors that are mounted on the same shaft. Although much credit is due to those who have applied these very important prime movers to the propulsion of vessels at sea, such a combination plant cannot be ideal, from many points of view, as part of the total machinery is running idle when the vessel is steaming ahead, and the ahead turbines are idle when running astern. In order to get the maximum reverse power on all propellers, it would be necessary to instal reverse turbines on all shafts, and if this were done the weight would be considerable, and in many cases prohibitive.

Designers of propellers claim that screw propellers are now procurable that will produce the same thrust per horse-power, when run at the high revolution speeds suitable for the marine type of turbine as may be got with low-speed propellers such as are used with the reciprocating marine engines generally, but it is very doubtful if, with a given draught and other conditions, this is the case in practice. It has been generally admitted that if steam turbines are to be used direct-coupled for propulsion a compromise must be made, the propeller brought up and the turbine brought down from their most efficient speeds, in relation to the minimum expenditure of fuel required at various vessel speeds. If this compromise be effected, it is certain that the turbine must use more steam per horse-power developed at the propeller, and that the propeller cannot produce the maximum thrust per horse-power so delivered.

This has been realised in many countries, and various suggestions have from time to time been made to enable the steam turbine to be used to the best advantage for ship propulsion, so that it shall run at high revolution speed, and thus be efficient in steam per unit of weight and power developed. Also, to allow the propeller to run at a lower revolution speed and with large area propeller blades to produce the maximum thrust per unit of power delivered to it, and to provide better control at lower speed manœuvring, and so to reduce the cost in fuel under various speed conditions.

There may at first be some hesitation as to *why* we should introduce electrical power generation and transmission between the turbine and the propeller, because to that point we all wish to get the mechanical power from the steam, with the minimum of losses. On the face of it, it does at first sight appear that with efficient prime-movers, such as reciprocating steam engines, which usually run at a speed that is in every way suitable for coupling to propellers, the introduction of electricity or any other intermediary than the steel shaft would be a wasteful and unnecessary process.

But the steam turbine and the internal combustion engine, as already stated, have only one efficient critical speed, and unfortunately this speed is in many cases much above that best suited for propeller efficiency. Various schemes have been suggested in the past for meeting the case, and among others may be mentioned compressed air, hydraulic power, mechanical gearing, etc., but in the author's opinion none of these will be able to show general, all-round, and lasting efficiency.

Electricity for ship propulsion is not a new idea, but the methods proposed from time to time have been improved on since Professor Jacobi, of St. Petersburg, made the first experiments in electrical ship propulsion on the Neva in 1838, with a small boat 28 ft. long, 7 ft. wide, and a draught of 2 ft. 8 in. He employed a type of electric motor which had already attracted considerable attention, having been shown before the Académie des Sciences, of Paris, in 1834.

The Jacobi boat on the Neva derived its current from primary batteries, and the motor propelled it at a speed of about three miles per hour, and was geared to paddle-wheels. She carried as many as fourteen passengers, and was able to run for several hours, but the power was never more than about 1 h.p. supplied from no less than 128 cells. Such a small amount of power from such a large source of energy was not commercially sound, and the matter was given up as impossible for industrial purposes.

Since that time there have been many attempts to apply batteries as primary energy producers, with electric motors for the propulsion of ships, but the experiments have nowhere resulted in lasting commercial success, and the problem of electrical propulsion remained therefore unsolved until the introduction of light, high-speed, efficient prime-movers. The advent of steam turbines and internal combustion engines, together with the advance in electric dynamo machinery construction, rendered possible the application of the electric motor as a means of driving a ship's propeller.

In 1903, Messrs. Nobel Bros. constructed a tank vessel of 1,150 tons displacement, intended to carry oil on the Volga and the Caspian Sea. The plant consisted of three sets of Diesel crude oil engines, driving dynamos which

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supplied current to three electric motors, each serving to drive one of the vessel's three propellers. The regulation was carried out from the bridge, the total power being 360 b.h.p., and the vessel's speed (loaded) 7·14 knots. The generating plant was situated about amidships, while the electric motors were placed right aft, in a separate motor-room. The complete control of the drive was carried out by the engineer from the bridge, and the ship was steered and manœuvred thus, without the intervention of either the engine or motor-room staffs.

With the development of the steam turbine the successful application of the electric motor in very large units of power has become possible, and some very interesting propositions have been made recently, with a view of doing away with the reversing and cruising turbines usually carried on certain vessels, and to obtain economy in steam per shaft horse-power developed. (*Some of these systems are described in the Appendix, and illustrated on Plate I.*) Most of the schemes put forward have been either on the continuous or single-phase alternating current methods. The author was at first inclined to the continuous current method, with "all series" control, but on going into the question, and also on account of the running characteristics of the propeller, he soon came across difficulties as regards commutation of the heavy current necessary for reversing. He therefore proceeded with a method in which the simple "squirrel cage" type of polyphase alternating current induction motor was used, as this motor has only one moving part, and requires no rubbing contacts for the purpose of the working current. The current in the secondary winding produces the poles on the rotor, and is the result of magnetic induction across the air gap of the motor, no mechanical connection being therefore necessary.

There are many other features in connection with this type of motor that make it ideal for the work of propeller driving; some of the most noticeable are the following. It is the most simple and also the most efficient motor made; it has only two parts, the stator and the rotor, and is consequently the cheapest to manufacture. It has the greatest output per unit weight, it is therefore the lightest, for a given horse-power developed, of any other type of electric motor yet devised; it has the maximum structural and mechanical strength, and its running characteristics are suitable to propeller driving in that its torque increases with its speed.

It was found, however, that this type of motor, in large powers, with squirrel cage windings, had very little or no starting torque, especially in cases where high power transmission efficiency is required when the motor is working at highest speed and power. These conditions had to be met by the employment of a winding on the secondary or rotor, having a very low electrical resistance, and if the maximum efficiency as regards weight per unit output is required, only one winding can be placed on the stator if the motor is to be of the small diameter necessary to go into the narrow after lines of certain types of vessel. Such a motor, however, would only run at one speed, whereas propeller driving requires a variable speed; it was also found that when reversing, a high starting torque was absolutely necessary, and means had to be devised to ensure that these essential qualities should be satisfactorily met.

Various methods were tried by constructing the motor with slip-rings in connection with the secondary winding, and resistances were used to absorb the energy above that required for actual work when starting, and when running at speeds below the maximum. This method of getting the starting torque and speed regulation, however, introduced other and important difficulties, as, apart from the loss of energy by the use of the resistances, the mechanical efficiency was found to be so low that the design of the motor was affected, making it prohibitive as regards weight per horse-power developed, besides adding to the parts, and to the attention that they would entail. The amount of heat generated was such that its disposal was a large question, and became a matter that involved considerable work and cost.

Another method was then gone into, which consisted in winding the stator of the motor with several windings, and so connecting the windings with the current supply that several speeds were attained. By connecting the winding with the largest number of poles to the supply, the necessary starting torque was obtained, and by changing the windings to the supply terminals the variation in rotor speed was attained. This method was very satisfactory on two 40 b.h.p. motor omnibuses that the author constructed. On designing the motor, however, for the large powers required for marine propulsion, even this construction proved unsatisfactory, as the different windings took up considerable space in the stator slots so that extra depth had to be given to them, thus increasing the length of teeth. This reduced the magnetic circuit efficiency to such an extent that it involved widening the teeth and thickening the back iron of both stator and rotor, so that in order to get a motor of good efficiency the weight, diameter, and cost were increased to such an extent that its application to marine propulsion was dropped, being unsuitable for commercial purposes.

It was then suggested that a motor should be designed with only one winding on the stator, in the usual way, and, by utilising a separately excited generator, to start the motor by having its terminals permanently coupled to the generator terminals, except when reversing, etc. This method was analogous to the mechanical method of power transmission (which has of late received so much attention in engineering circles), as the prime mover could be run at a high speed and the propeller run at a lower speed. Although full speed "ahead" and "reverse" could be got by suitably changing two of the phases leading from the generator to the motor, it entailed certain uneconomical conditions. If any intermediate speed was required, it was necessary to slow the turbine or other prime mover, which raised the question of fuel economy, and it was seen that this method was not the most desirable for the purpose. It involved the expenditure of much energy when reversing, etc., created heating troubles, and was not considered elastic enough for the important duty of propeller driving. Moreover, it did not supply the means of running several motors at abnormally low speeds, such as are required in foggy weather, etc., from one generator running at the top revolution speed, with a view of getting economy in fuel, at such low vessel speeds.

The author then came to the conclusion that, if electrical power generation and transmission were to be practicable for marine propulsion, and the simple squirrel-cage motor was to be retained for this duty, the only real and efficient way to do so was to provide that the motor should be supplied with current at various frequencies, thus arranging for the variable speed required. By arranging that the voltage also varied with the frequency supplied, the iron losses were reduced, thus avoiding wasteful resistances and other means of disposing of energy for speed regulation.

The author designed all kinds of contrivances to attain this object, including generators arranged so that both members could revolve, if desired, thus providing for a low frequency by letting the generator armature slip after the field, so that the difference in speed between the generator field and the armature decided the frequency of the supply to the motors, and consequently the motor speed. But this design, although in many ways reasonably good from the speed regulation point of view, involved having two powerful members of the generating plant revolving at different speeds. In spite of the fact that it was the generator, so that a considerable air gap could be arranged for, the energy loss and the expense of suitable braking, and disposing of the heat so generated, made an expensive and un-mechanical type of machine, which did not lend itself to distant control from the bridge, which can be so readily provided for by other methods.

In order to reduce this braking effect as far as possible, it was decided to arrange that the winding of the stator of the motor could be changed, as regards polarity, and by feeding the current into the centre of each phase of the motor winding, the number of poles produced in the iron was increased 100% (or, say, from 20 poles to 40 poles). But on testing this type of motor it was found that certain losses were taking place in the iron of the stator, and that the efficiency of the motor for a given output fell. This also made complications in having to bring out so many connections from the motor stator windings to

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suitable switch gear, thus increasing the price, the number of parts, and, consequently, the liability to break-down. It was therefore discarded as impracticable.

In the latter part of 1908, however, the author introduced a system that is now well known, not only for marine propulsion, but also for traction purposes in association with the internal combustion engine, as the prime mover. In the "Paragon" system of power transmission, illustrated in Figs. 8 and 9 (Plate I.) and in Plate II., all the essential features that are wanted in order to utilise the simple squirrel-cage induction motor for propeller driving are embodied.

Current at various selected frequencies can be arranged for and the voltage can be made to vary with the frequency, thus avoiding iron and other losses. The only moving parts in the system are the exciting magnet, which is driven with the primary member of one or more transformers and the rotor of the motor, according to the lay-out proposed, and also according as one or more prime movers are to be utilised for driving any one propeller.

By this arrangement several prime movers of comparatively small power, such as the internal-combustion engine in its present form, can be used to generate electrical energy, and the aggregate of this power, *minus* generating losses, can be delivered to, say, one or more motors driving propellers. When intermediate speeds are required, the frequency and voltage best suited for the selected speed may be very economically given to the motor or motors It is a system that embodies the characteristics of polyphase alternating current practice, and the machines that embody this are well tried and reliable. By means of simple control gear the prime mover can always run in one direction and at one speed, independently of the direction and speed of the vessel, within the particular speed that the system may be designed for (three speeds are usually taken as sufficient for ordinary commercial vessels, but in large ships five or more speeds may be given, according to the particular design, power, and prime mover proposed).

The necessary starting torque is obtained with the low-resistance secondary motor, and the voltage is increased with the frequency, so that the plant is self-regulating as regards input and output energy, thus avoiding the usual heavy losses. Every watt generated is utilised for actual work in the motor, the over-all transmission efficiency is high, especially in large powers, with the consequence that the deadweight of the electrical plant is low per horse-power delivered to the propeller at various speeds, and the heat to be disposed of by radiation or by other means is, therefore, a minimum (and the disposal of heat is no inconsiderable item to deal with in any large scheme of electrical marine propulsion). The cost of the plant, owing to its light weight and high efficiency, is low, and the cost of maintenance, it can be fairly anticipated, will also prove small, while the life of polyphase alternating current machinery has been proved without doubt to be at least equal to any other class of mechanical moving masses. The distance that the power has to be transmitted is small, so that the voltage used need not be high; in fact, it is preferred to have a low voltage, as this will enable the motor and generator windings to be of strictly mechanical design. In large powers these will be composed of heavy copper bars, with mechanically made joints, so arranged that repairs can be made at sea with despatch and efficiency. In designs for large vessels the voltage will hardly ever be above 1,000 or 1,500, whilst for small vessels from 100 to 500 volts is sufficient in fact, the voltage is generally controlled by the current capacities of the control gear and other current-carrying parts, windings, etc., in various designs.

The motors that are proposed in this system have some noticeable features, amongst which are simplicity of structure, combined with great mechanical strength. The absence of commutators and slip-rings is an immense advantage, and since there is no sparking limit to the output, as in continuous current and other types of commutator or slip-ring motors, the output per unit weight is much greater in this type of motor than in any other type of electrical power machine. It is not difficult to construct large motors running at low speed with a minimum of weight, without sacrifice of efficiency, and, unless considerably over-loaded (which is not likely to happen at sea), such motors will run quite cool, compared with continuous current machines of the same weight and output. This is partly due to the large section that can be given to the conductors, consisting of the various windings, and to the fact that the windings are so arranged that the losses are not localised, whilst to a certain extent the necessarily laminated character of the live iron in the stator and rotor facilitates good and easy ventilation.

A point that will interest those experienced in sea-going conditions is the reversing of the propellers, and a few remarks on this question will possibly be of service in showing the value of the squirrel-cage motor for this important and exacting duty. Assume that the vessel is proceeding at full speed ahead, and that it is suddenly desired to stop the ship; the excitation is immediately taken off the generator, and two of the three leads to the motor are reversed (under no-voltage conditions). The connections between the generator and the motor are then made at the same time by means of the controller, so that the low-frequency current is sent into the motor in such a direction that the magnetic flux produced in the iron of the motor stator, revolves at low speed in the counter direction to that in which the rotor is being driven by the propeller. The effect of this is that the heavy bars forming the winding of the rotor, generate a certain amount of current, and, being short circuited on themselves, produce a very powerful magnetic braking effect between the stator and the rotor, tending to reverse or to hold the propeller momentarily still, thus forming a good retarder to the vessel's progress, until in a few seconds the torque of the propeller in the ahead direction of rotation is overcome by the high torque in the astern direction by means of the low-frequency current of the motor. This propeller torque will fall very rapidly with the vessel's speed, and the actual reversing of the propeller takes place, accelerating in speed in that direction as the vessel's speed still comes down, and stops, then proceeding in the astern direction, when a change in the frequency can be given to the current sent to the motor, and further acceleration in a stern speed can be given, if so desired.

As the motor will run in the reverse direction with the same high efficiency as in the ahead direction, it will be observed that only the momentum of the rotor has to be broken down, which is, comparatively speaking, a light affair.

There is no doubt that considerable racing and slowing of prime movers and propellers takes place on various types of vessels at sea, when under unequal immersion conditions, such as when heavily rolling or pitching. As it may be assumed that there is then a loss of headway, it is perhaps, interesting to note what effect this will have on a vessel fitted with the "Paragon" system of propulsion, say, on a vessel with twin or more screws. We will assume conditions of heavy rolling; the lightly immersed propeller will then run a little further into synchronism, therefore drawing less current from the generating plant, but not racing, as the frequency of the current is set by the generating plant, the deeply immersed propeller having momentarily more work to do, as it can slow but very little, but it draws, automatically, more current from the generating plant, say, the amount that the lightly immersed motor does not require. The consequence is that the generating plant is kept approximately evenly loaded, using steam to the best advantage as regards power developed. The propeller immersed deepest, getting a better grip of the water, has an increased thrust, thus making it possible to make better headway and a greater distance traversed by the vessel per unit of fuel burnt. Fig. 2 shows a vessel with four crews rolling 10 degrees, and it will be evident that there is a considerable difference in the work done by the wing propellers when under heavy rolling conditions. When under severe pitching conditions, and with the propellers possibly out of the water at times, no racing can take place, as the reduction in load can be anticipated, for immediately the propellers start coming nearer the surface, the resistance to rotation decreases, the rotor gets closer into synchronism, the current falls, and the electrically operated steam governor valves at the turbine arrest its speed. The frequency and power of the current (which is then only what

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is necessary for running the rotors, shafting, and propellers, and the magnetising current for the stator iron) are constant, therefore, also, the speed of the motors, and that fact should be of assistance in reducing the losses by racing, and the resultant mechanical vibration which is noticeable on most vessels when under such conditions.

As regards the efficiency in the design of hulls and propellers in connection with this problem, that matter can be safely left to the members of this Institution to deal with. The question which this paper is intended to consider is how to transmit the necessary horse-power in a better way than at present.

It may, in conclusion, be interesting to take the published figures that have been given for various well-known vessels over, say, a 100-hour run under full speed and power, giving the amount of steam used, and the shaft horse-power for propulsion only in each case, and compare this with what is possible with the electric motor under as nearly equal conditions as possible both as regards power and revolutions. Although there is a certain loss in the double transformation of mechanical energy delivered by the modern and efficient prime movers already mentioned, we may show that even then the amount of fuel burnt per shaft horse-power hour will compare favourably with the existing conditions of so doing, and the difference must be placed to the credit of the cost of propulsion. This is quite apart from the fact that, in many cases, the revolution speed of the propellers may with advantage be lowered, and with coarser pitch blades a higher speed obtained for the same shaft horse-power on the same draught, and with a lower fuel consumption. Or, advantage can be taken of the extra efficiency for such lower speed propellers, so that for the same vessel, speed, and draught conditions less power will be required.

Example No. 1.

In a small single-screw tramp steamer, 1,000 i.h.p., with triple-expansion engines, with a mechanical efficiency of 83%, this set of engines will deliver 830 s.h.p., at a revolution speed of 81 r.p.m., it is well within the present range of practice to assume that, with steam at 160 lbs. at the stop valve and with 26 in. vacuum, such engines would consume 16·5 lbs. of steam per indicated horse-power hour, or 19·88 lbs. per shaft horse-power hour. So that during a voyage of 100 hours there would have been developed 83,000 s.h.p. hours, and during the journey 1,650,000 lbs. of steam would have been used. Assuming the boat has a speed of 10 knots per hour, the radius of steaming is 1,000 knots, so that per knot traversed there would be, say, 1,650 lbs. of steam used. Such a vessel could have its propeller driven by an induction motor running at the same revolution speed, and performing the same work of 830 brake or shaft horse-power, for an expenditure of steam as follows: using saturated steam in each case and at the same working pressure, but on the electrically driven ship a better vacuum, say, 28 in., would be carried owing to the use of the turbine, etc. After allowing for generation, transmission, and motor losses, the steam used per brake or shaft horse-power given off by the motor would be 17 lbs. per hour, or a saving of 14·5% in fuel and steam, and only 1,411,000 lbs. steam used for propulsion purposes. The steam used per knot is therefore, say, 1,411 lbs., so that for the same steam consumption as with the direct-driven boat, the electrically driven boat will cover 1,169·41 knots. Fig. 11, Plate II. (reciprocating engine and turbine combination) shows the proposed lay-out for this electrical plant. With superheat of 150° Fahr., there would be a saving of, say, 10%, so that the steam consumption would be reduced to 15·3 lbs. per shaft horse-power hour, and the steaming radius would be increased to 1,297 knots, so that the extra steaming radius is increased for the same steam capacity by 14·5% by using saturated steam, and in the case of using superheat by no less than 22·8%.

Example No. 2.

In a twin-screw cargo boat, fitted with triple-expansion engines, each of 2,000 i.h.p., it is well within the preent range of practice to assume that such engines when running at full speed of, say, 100 r.p.m., would consume 15 lbs. of steam per indicated horse-power hour, or, assuming an engine mechanical efficiency of 85%, 17·65 lbs. per shaft horse-power hour. Therefore, provided that a good head of steam is kept up, we should get 1,700 s.h.p. on each shaft, or 3,400 s.h.p. in all, which would mean a steam consumption of 60,000 lbs. per hour, or 6,000,000 lbs. over a run of 100 hours, for propulsion only. Assuming that the ship has a fair weather speed of 12 knots per hour, then she covers 1,200 knots with this consumption of steam, or 5,000 lbs. of steam per knot traversed.

With electrical propulsion installed in such a vessel, and with the propellers driven at exactly the same revolution speed, namely, 100 r.p.m., the same brake or shaft horse-power may be obtained by the use of high-speed steam turbines, as the prime movers, with saturated steam the amount used per shaft horse-power delivered will not exceed (and will probably be less than) 15 lbs., or, if superheat is used, 13·9 lbs. per hour, which represents a saving of 15 and 21·3% respectively. Assuming the same vessel speed, then we have an increased steaming radius for the same steam consumption from 1,200 to 1,412 knots without the use of superheat, or, if superheat is used, the vessel will traverse a distance of 1,523·86 knots with the same steam and coal consumption.

Example No. 3.

In a twin-screw Atlantic liner fitted with quadruple-expansion engines each indicating 5,000 h.p., running at 100 r.p.m. at full speed, if such engines had an engine efficiency of 87%, a shaft horse-power would be developed on each shaft of 4,350, or 8,700 in all. Such a vessel, it may be assumed, would have a registered tonnage of about 14,000, and would have a speed of 16 knots per hour. The steam used per indicated horse-power hour would be 13·4 lbs., or 15·4 lbs. per shaft horse-power hour. Over a voyage of 100 hours' duration, she would consume for propulsion purposes 13,400,000 lbs. of steam, or 8,375 lbs. of steam per knot traversed. Assuming that for every ton weight of boiler-room equipment with cylindrical boilers without water, with large and small mountings, pipe work, funnels and auxiliary machinery in the boiler-room, 180 lbs. of steam can be produced per hour, then we have a total boiler-room weight of 744·4 tons, and, assuming that for every indicated horse-power the weight of engines (without condensers) will be 120 lbs., so that the engine-room weight will be 535·7 tons. We have a total boiler and engine weight (for propulsion purposes) of 1,280 tons. Take the evaporation of the boilers as 10 lbs. of water per hour per lb. of coal burnt, then the fuel consumption for propulsion will be 13,400 lbs. per hour, or for the 100 hours' run, 598·6 tons.

An electrical equipment for such a vessel could be arranged as follows:—Two squirrel-caged induction motors, each capable of giving off continuously 4,350 brake or shaft horse-power, weight 80 lbs. per brake horse-power, developed efficiency 93·5%, 100 r.p.m., total weight of both motors 310·7 tons.

Two steam turbine generators, complete with bedplates, steam-pipe connections, and control gear, for port and starboard operation, set running at about 800 r.p.m., using (without superheat) 11·5 lbs. of steam per brake horse-power on the turbine shaft, when exhausting into 28 in. vacuum, and under the same conditions, or with 120° superheat, 10·2 lbs. steam per turbine shaft horse-power hour. At full load and speed the power transmission efficiency would be 86%, so that the steam used per propeller shaft horse-power would be (with dry steam) 13·37 or 11·75 lbs. of steam respectively. This represents a saving in steam used per shaft horse-power delivered of 13·2 and 23·7%. Taking the same amount of steam used for the 100 hours' run, namely, 13,400,000 lbs., and 1,600 knots, with saturated steam, the electrically driven boat would use 7,270 lbs. of steam per knot, or would traverse 1,843·19 knots, or with superheated steam she would only use 6,389 lbs. of steam per knot, or would traverse 2,097·3 knots.

The weight of the turbine generator plant, as given above, can be put down as equal to 208 tons, so that the total engine-room weight will be approximately 518·7 tons, which is a saving in engine-room weight (without taking condensers into account) of, say, 17 tons, or 3%.

Assuming that the same amount of steam can be got per ton of boiler-room weight, namely, 180 lbs. per hour, the weight of the electrically driven ship's boiler-room

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will be, with saturated steam, 646·2 tons, or, if superheat be used, under the conditions stated, the boiler-room weight will be reduced to 567·9 tons. To this should be added, say, 50 tons for superheaters, so that the boiler-room weight will be approximately 617·9 tons, which is an estimated saving in boiler-room weight of 13%, or 98·2 tons, or, in the case of superheat being used, 17%, or 126·5 tons. The figures given do not take into account the reduction in weight of the water in the boilers, or condenser capacity not required, or the smaller steam pipes necessary, but they show that with reciprocating engines the shaft horse-power developed per total ton weight of boilers and propulsive machinery is 6·8, while in the electrically driven ship the shaft horse-power is with saturated steam 7·46, whilst with superheat this can be raised to 7·65 shaft horse-power developed per ton of total weight.

As compared with the reciprocating engined boat, the deadweight on starting the voyage on the electrically driven boat with saturated steam, taking the saving in machinery weight and the coal, would be 263·2 tons. The electrical boat fitted with superheat would have a

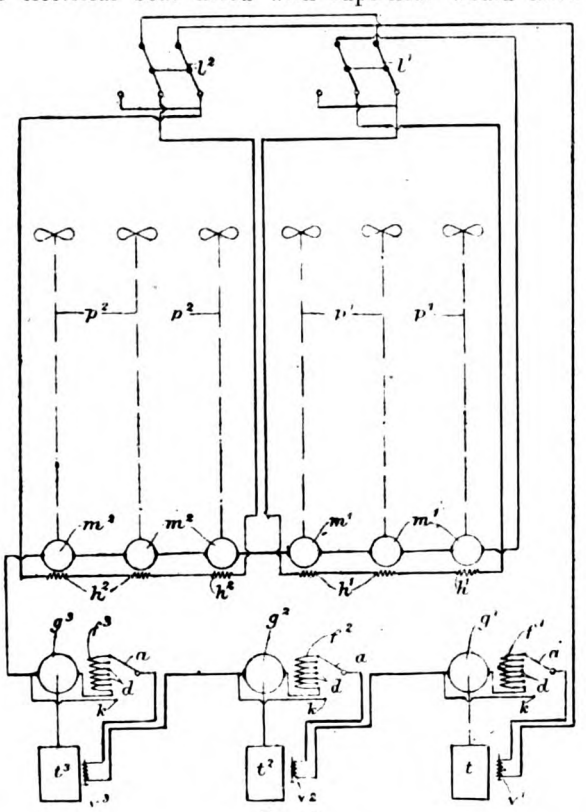

FIG. 1.

reduction of deadweight at the start of the voyage of 409·5 tons, which for a given cargo or passenger weight would consequently require less draught, and for the same shaft horse-power would have a somewhat higher speed, or it would be found that for the same speed conditions less shaft horse-power would be required for the same vessel speed, and this fact would further reduce the actual coal consumption, unless the saving in deadweight is made up of extra cargo or passengers to bring the draught up.

Thus it will be seen that, with the adoption of electric motors for propeller-driving, some important improvements may yet be made in the cost of propulsion for various classes of ships. The figures given above are, of course, only approximate, as the data for large ships at the disposal of the author are somewhat limited at present.

The adaptation of electrical driving to existing vessels may mean that they can be made faster vessels with the same boiler capacity, or that a lower fuel consumption can be obtained for the same vessel speed.

There are not lacking signs that British shipping is feeling the competition of other countries who are looking into the merits of more efficient means of ship propulsion. Recent papers before American and Continental Institutions of Naval Architects and Marine Engineers show that the electrically driven vessel has now become a subject of more than passing interest, and it behoves naval architects and steamship owners to make themselves *au fait* with all the potentialities of this twentieth century invasion of the orthodox methods of steam propulsion.

APPENDIX.

Fig. 1 shows a continuous current system that the author designed in 1905, for a private yacht, in which it is shown that six propellers were proposed. The system is what is known as the "all-series" system, and the speed regulation for the motors was proposed to be got by means of regulating the voltage to the motors. The reversing was to be got by means of reversing the fields of the motors on either port or starboard sides, as might be desired, from the bridge. Three turbines are shown as prime movers, driving three main generators

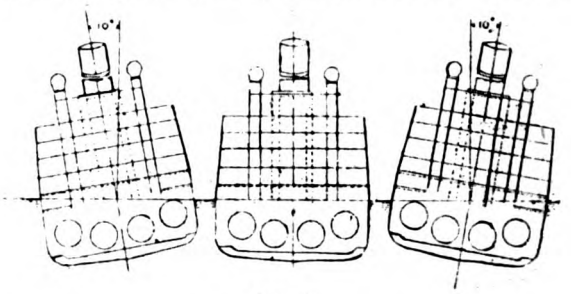

FIG. 2.

to supply the current. On going into this scheme for large powers, it was found that the system of commutation for the current, both on the motors and the generators, was of such a nature that it precluded such a system being put forward as practical, because the propellers would race on leaving the water, etc.

Fig. 3 illustrates a Swiss system, using the direct-coupled turbines at top vessel speed, and a separate turbine driving an electric generator, supplying current to electric motors mounted on the main turbine shafts for low vessel speeds or reverse.

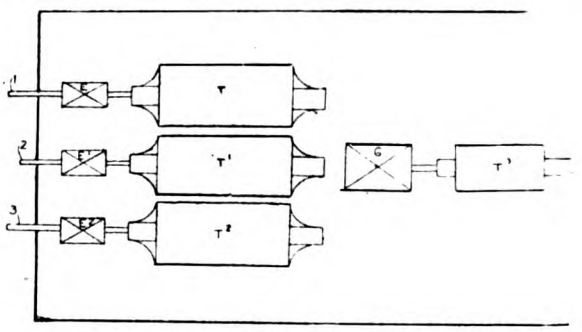

FIG. 3.

A SWISS SYSTEM USING THE DIRECT COUPLED TURBINES AT TOP VESSEL SPEED, AND A SEPARATE TURBINE DRIVING AN ELECTRIC GENERATOR SUPPLYING CURRENT TO ELECTRIC MOTORS MOUNTED ON THE MAIN TURBINE SHAFTS FOR LOW VESSEL SPEEDS OR REVERSE, ETC.

The lay-out is fairly clear, and is of special interest, insomuch as it shows a very interesting attempt to avoid the great waste of steam that takes place in direct-coupled turbine-driven boats when running at low vessel speeds. The propeller shafts are shown at 1, 2, and 3, coupled direct to the three main turbines (ahead), T, T_1 and T_2. It will be observed that on the propeller shafts are mounted three electric motors, E, E_1 and E_2, which can be supplied with current from the high-speed turbo-generator G and T_3.

(*To be concluded*).

The motor car as an adjunct to the locomotive-drawn train is growing in favour with American managers rapidly. The good service given by the run on the Erie between Salamanca and Bradford already has been told, together with the fact that the Buffalo, Rochester, and Pittsburg is investigating the merits of several different types. It is now announced that the Pennsylvania Railroad has been making investigations in the same direction for a long time, and has definitely decided not only to acquire such cars, but has determined upon the gasoline-electric type, and has contracted with the Allegheny Foundry Company of Warren, Pa., to build them.

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ALUMINIUM AND ITS USES.

I. CABLES.

The vagaries of the copper market, which are all the more disconcerting owing to the large measure of artificiality about the high prices and tendency to rise, is doing much to bring forward aluminium. So far as electricity is concerned, the chief use of the white metal has been for wires and ribbon cables, and these gained considerable favour abroad, especially where high tension distribution from central stations prevails, as in America, Italy and France. Attempts have, however, also been made to use aluminium in the construction of apparatus, mainly, of course, for windings. It will be well to give a brief review of the present conditions of affairs, confining ourselves in this article to cable practice. Even this is comparatively a thing of yesterday, for the conductivity of copper is so high—surpassing any metal with the exception of the out-of-the-question silver—that it long remained supreme for all purposes of transmission. But after all, aluminium, though inferior, is fairly efficient, and thanks to its low specific gravity (rather less than one-third that of copper), the extra volume of metal required presents no difficulty so far as weight is concerned. Its bulk may become an inconvenience, but in practice this is found to be negliable, even as regards the extra surface presented to wind. In foreign experience, however, it has been found advisable to substitute wood poles for metal supports when aluminium cables are used, because the poles have greater elasticity to transversal pressure. It had been predicted that trouble would arise from the fact that the bulkier aluminium cables would accumulate more hoar-frost and snow than copper. This, however, has been proved not to be a fact. In very severe weather there is little to choose between the two varieties of wires, whether because snow and frost will not accumulate on a round wire above a certain thickness owing to physical con-

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ditions, or because of the higher heat conductivity of aluminium, it is difficult to say; the net result is that the extra weight arising from an accumulation of condensed water is a mere theory-bred difficulty. Bulk tells against aluminium in ordinary cases when insulation is necessary, because about 30% more insulation is required. Even so, the low price of the white metal allows of such a wide margin for economy that the extra cost for insulation still leaves a considerable advantage to users of aluminium. Moreover, for high tension purposes this extra insulation is not needed. Herr Apt, speaking before the German Electro-technical Society, has shown that it is possible to diminish the thickness of insulation in ratio with the increase of the section of the cable, while retaining the same co-efficient of safety. Apart from this general law, Apt found, in testing cables with currents of from 20,000 to 40,000 volts, that aluminium, owing to its lower conductivity being less subject to rise of temperature under operation, can be safely guarded with a thinner layer of insulation than copper. Coming to the physical and chemical peculiarities of the metal. We find that owing to the greater volume of aluminium when we assume equal distance apart of wires in overhead practice, the inductance is diminished by about 5% as the self induction is lowered. Moreover, loss is lessened as compared with copper, even if we assume equality of self-induction, because the distance between each conductor will be from 30 to 35% greater in the white as against the yellow metal. Reverting to atmospheric influence, it was long assumed that when certain constituents were found present in the air aluminium would quickly suffer, and it was said that this was peculiarly true of ozone and salt, therefore that aluminium was unfit for coastal practice. Here, again, experience has falsified theory. In America, high tension overhead wires have been extensively used on the coast and over saline plains and swamps. We gave a brief account of experiences in France (ELECTRICAL ENGINEER, Vol. XLV, page 141), where a cable of comparatively small section was set up near the coast and over salt pans, no inconvenience being experienced, which would certainly not have been the case with copper under similar conditions. The reduced weight of aluminium cables makes handling easier, and it is found that the setting up of a line can be accomplished at an appreciable saving of time. Difficulties there have been in the matter of repairs. But these are being overcome with practice. For certain purposes, one or other of the aluminium solders now on the market serve well enough. Then we have the special joints, of which MacIntire's sleeve joint is a type. As a rule, careful splicing is all that is required. So far we have little data to go upon as regards the relative duration of efficient service of aluminium as against copper cables. Taking everything into consideration it would seem to be chiefly a question of price. While the cost of copper continues to grow and that of aluminium steadily falls, the advantage will be with the latter metal, for most cable work, and this may help to relieve the situation as regards the use of copper for other purposes.

SUPPLY OF ELECTRICAL POWER FOR INDUSTRIAL ESTABLISHMENTS FROM CENTRAL STATIONS.

By R. S. HALE.

[Somewhat in the nature of a counterblast to Mr. Charles T. Main's paper, published in our last issue, on "Central Stations *v.* Isolated Plants for Textile Mills," was the paper presented at a joint meeting of the American Institute of Electrical Engineers and the American Society of Mechanical Engineers, Boston, Mass., by Mr. Hale, which we print below.—ED.]

We have heard an account of electric power plants planned for each mill to have its own plant. Now, even if the 2,000 h.p. plant is of a size greater than the majority of electric central stations, nevertheless the question at once arises why should we not have a central station larger than most of those of to-day and then let the very large station supply the comparatively small plants with all the possible advantages due to size and combination. This is the question on which I shall dwell.

I am interested in a great central station and this is a very immediate and almost personal question, but the form in which the question comes to a sales manager is always whether some particular owner of a mill or factory can be persuaded to buy electricity, while the American Institute of Electrical Engineers is interested in principles rather than in particular contracts.

The general question of whether a large station can supply power more cheaply than several small ones is, however, one that hardly admits of argument. Still, in order to satisfy myself as to whether 1,000 or 2,000 h.p. isolated power plants for mills diverge except in detail from the general principles that have produced our existing central station, I asked the engineers of the construction bureau of the company with which I am associated, these questions:

1. What would be the cost of power in a station that you would build to-day to supply about 2,000 h.p.

2. Suppose you had to supply the same at each of ten scattered points within a territory 100 square miles, what would the power cost from a big central station?

The point of asking for both figures from one office was to be sure that both were on the same basis: that, if the cost of turbines, for instance, should be taken too low, or too high, or if the cost of labour were taken too high, or too low, nevertheless the same basis would be used on both sized plants and would produce no error when comparing the two propositions.

There are, of course, two kinds of errors that we are subject to. If one man makes an estimate for both sets of conditions, then even if there are errors or omissions, as, for instance, if we have figured the price per ton of coal too high or too low, or if we have figured 10% depreciation against an actual 3%, or have omitted taxes altogether, still the comparison is, on the whole, correct even if both sets of figures themselves are a good deal out of the way, since they would be out of the way by the same proportion in each case.

On the other hand, if instead of comparative estimates we take actual results in plants that have run long enough to give results, we find that the comparison is never on the same basis. One man has bought turbines when the manufacturer was willing to cut prices; the other has run into quicksand in his foundations or unusual labour troubles; and, although the individual figures in each actual case must be much more correct than in the estimates, yet there is no question but what accidental items affect tremendously the actual costs in individual cases, so that the comparisons based on actual correct figures are often very erroneous comparisons.

For instance, published cost figures are sometimes what would be called the engineering costs, omitting several items that should be included in the real commercial costs before dividends would be declared, but if omitted items apply to both sets of figures, the comparisons are not seriously wrong. On the other hand, we know of hundreds of 2,000 h.p. plants when the actual figures over a term of years show results much higher than in Mr. Main's plants, and higher than in some 1,000 h.p. or even 500 h.p. plants. We cannot use such actual figures

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for comparison, no matter how correct each set of figures may be, because they are not on the same basis and we cannot take figures for a few well-designed plants as representing real average conditions any more than the average central stations can feel sure of operating at as low costs as the best central station.

Our engineers' figures, however, are on the same basis for both small and large plants. I will not take time to present their figures in detail but they figured that ten plants of 2,000 h.p. each cost £196,359 per year to deliver their power, and one large plant to deliver the same power, including distribution expenses, £147,916 per year —a saving of 25%.

No one should expect any other comparative results. When the Edison Electric Illuminating Co. of Boston, owned plants of from 100 to 2,000 h.p. capacity each in Somerville, Dedham, Milton, Newton, etc., it found it paid to abandon them and establish one big generating plant at L Street in Boston and distribute the power to outlying districts.

When the Pacific Mills in Lowell, or Swift & Co. in Chicago, concentrate all power in one large power house instead of one plant for each building, it is because central station power is cheaper than small scattered plants.

It is safe to say that a good engineer who has a chance to make a saving for his clients would seldom advise a dozen small plants as against one large one.

Apparently, there can be but one answer to the question as to whether a central station or scattered plants are cheapest and yet plants such as Mr. Main has installed in his practice and even smaller ones, are still being put in occasionally instead of the user buying power from existing central stations.

The real question is not whether large stations are cheaper than small ones, but the question is: Why do not the present central stations take all the present business when it can so surely be supplied at a less cost to the community if supplied from a central station?

The question is: Why are any small plants left? The real question is not as to the facts, but as to the reasons why we do not take advantages of the fact.

Now, the figures usually assumed as the cost of supplying power to the small plants from a large central station are somewhat different from the prices the central stations will actually quote. The question is, therefore, not whether central station power is cheaper than power of a private plant, but whose fault is it that there should be so much difference of opinion as to the actual cost in particular cases? In my opinion, both sides are to blame. The central station has, to a large extent, failed to realise its opportunity. Also, the builders, or rather promoters, of the small plants usually figure much too low for the real commercial cost, and all of us, even when we have thought clearly ourselves, have failed to get the exact knowledge sent home to the general public.

Now, why should the central stations, who are not making fabulous profits, insist on such high prices instead of giving the customer at least part of the advantage of the reductions in cost that everyone agrees ought to come with central supply.

The first thing is to analyse the actual central station figures and find where the money is going. We find on taking published figures of central stations certain large items that are nearly or entirely omitted by private plants. Billing and collecting is, for instance, a large item in central station costs.

The size of these items is obviously due to the number of small customers. On the other hand, with twenty large customers, or even one such customer, it would amount to something, yet it is practically negligible in comparison with the bills rendered. Again, for a few large plants we have figured 10% loss from the central station while the actual central station of to-day reports 30%. For a few large customers 10% is correct and again the high figure for the existing central station is due to the number of small customers who use transformers at a poor load-factor. For a few large plants, we figure only a small distribution expense, while the actual central station spends far more for distribution than for manufacturing, and as before stated, this is because the existing central station has a lot of small customers.

The combination of big with little does not necessarily add to the cost of either and more usually saves on both. The wholesale department of a firm of dry goods merchants is not handicapped by the retail store of the same company but the wholesale and retail departments complement each other. If a central station for a few large wholesale customers should add retail net-work and get enough income from the retail to pay all the additional costs, it would not add to the cost of supplying the wholesale, although the average cost per horse power delivered to all the customers might and would go up.

Up to within a very few years, central stations have had only a retail business, and have not realised that they did not increase distribution expenses proportionately by adding a few big customers. Up to within a few years central stations figured on their average costs of retail business and thought that the big business was a loss because it would not bring as much per kilowatt hour as their average costs. To-day, they are beginning to realise that it is per cent. on investment and not cents per kilowatt-hour that means profit; but business of to-day is the result of prices of three years ago; it takes time to develop. Even to-day, however, few central stations realise the field that they should cover. Unjust critics are to a certain extent responsible for this, as central stations depend on popularity. A central station making 5% on its investment from the proceeds of retail business, seeing that a low kilowatt hour price to a big mill means a 6% return on the investment for that customer and an accompanying later reduction in price to its small customers, hesitates to make the price necessary to secure the large customer because the big differential furnishes an apparent argument to those who claim that central stations are favouring large customers against the small, and 5% with popularity is better than 6% with unpopularity, even if in the latter case the small customer is getting his price actually lower.

Central stations have been weak in not analysing their expenses properly, but the owners of small plants have likewise failed to analyse their expenses as between their plants and the rest of their business.

When a central station figures that doubling its kilowatt hours by selling ten million more to a single customer will add to its distribution expenses as much as if it sold them to ten thousand customers, it makes a very serious error. On the other hand, it is sure that every additional piece of business added adds something to the expenses all along the line; in some cases more, in some cases less. There are a great many expenses of a business that must be paid but cannot be said to be part of the cost of any particular portion. These are what are sometimes called the general expenses, but they often have other names. For instance, the salary of the president's office boy is not obvouisly part of the cost of unloading coal, and yet we know pretty well that if we should unload five times as much coal as we do now, the expenses of the president's office would go up.

The cotton mill seldom figures any of the interest on its floating debt against cost of power, and yet the money tied up in the coal pile must be drawn from somewhere and must earn its interest somehow.

Each item is in itself usually small, but in some isolated cases there are often extra expenses that run into big figures.

Once I prepared some estimates for one of the best engineers we have, one of the men who is now doing things rather than engineering them. He said to me, "Hale, your estimated figures are all right so far as they go, but remember that the expenses that really count in business are those that you don't figure on." In my own department I am always tempted to figure that when I add another salesman at £20 a month, I am adding only £240 a year to my expenses. I have, however, taught myself to remember that he will need a desk, part of the office, rent, part time of a stenographer, office boy, etc., and these all cost money. A stock exchange broker once told me that when he hired a salesman, the commissions on the business the salesman brought in must be four times his salary, otherwise the salesman was really a loss.

Now, just as central stations have figured the costs of adding large customers to their retail business too high,

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so the mill in its analysis has failed to remember that its power plant involved other expenses besides those it figured on.

I am perfectly willing to agree that the figures which are presented in Mr. Main's paper are correct as far as they go. We have in Massachusetts 100 to 1,000 such plants as those of which Mr. Main has given an account. What has been the cost in others? The cost in a central station we *know*, and know for large stations and small stations. We have had bed-rock experiences for 20 years with no chance to draw on the general expenses of the rest of a mill. Any expenses which we forget to figure on come out of profits; but do you not suppose that if you got at a mill whose treasurer took a pride in his weaving-room and cared little about the expense of his engine-room that you would find a good deal more charged against cost of power than Mr. Main has given as the cost in the best plants?

To bring this out, take some of these estimates of cost and consider what a promoter says if he is asked to put in a plant and sell power at his estimates. Suppose he figured 6% on the money; 6% is a good return year in and year out and if the promoter's figures are for the actual costs, they should show profits that would give more than 6% just as often as they would show losses. But we all know what the promotor says: he is not in the business of selling power and would not want to risk his money. He knows that before the work is done there will be all sorts of extra expenses of the kind he has not figured on. He knows that if the plant is run in connection with a mill, or hotel, by anyone that is not in the power business, that all these extra expenses will come out of the general profits of the other business, while if the plant is run independently and on its own basis, it would have to stand its share. Still these other expenses must be paid before the dividends. The owner of the business usually realises this, though not in full degree. He always says, "I am perfectly willing to pay 10, 15 or 25% more for central station power that it would cost me to make it myself." If the costs he is thinking of were his real costs, this would be foolish, but what he really means is, "In addition to the costs that my engineer or book-keeper figures for me, I must add 10, 15 or 25% for what they do not figure on."

Now, if the engineer has included all the items, *viz.*, interest at the same rate of profit the owner wants on all his business depreciation figured not on the time the plant might last but on the date when he will scrap it, taxes, insurance, coal, water, labour, repairs, rent, removal of ashes, loss due to noise, loss due to vibration, loss due to dirt, loss due to non-flexibility, loss due to extra cost of running overtime, extra cost for superintendence including the time spent in hiring and discharging engineers, purchasing coal and supplies, checking records, etc., etc. (these all should be added), and if, after *all* the expenses are included the plant shows a less cost than purchased power, it should be put in. When an owner says he will pay 20% more for purchased power than it would cost him to generate it for himself, he is really saying, "My engineer is sure to omit 20% of the real costs"; and just as the actual central station of to-day has a tendency to figure costs of supplying big power too high, the actual isolated plant of to-day figures its costs too low.

The projectors of isolated plants often lay stress on the special advantages of a separate plant for some particular case. This is usually in connection with the use of exhaust steam. One of the isolated plant advocates told his client that he could use his steam three times; first, for power; second, for heating by exhaust steam; and get a third supply of heat for evaporating sugar or in chemical processes.

There is no question about the theoretical advantage of using the exhaust steam for heating, but if the practical advantage followed the theoretical then the central stations should be putting down small plants in the centres of cities and selling steam heat in local blocks. If the central stations find this does not pay, and practically every one of them has tried it at some time or other, then the chances are that it usually does not pay. The same idea applies to many of the other special cases.

A further difference between a small plant and a central station is that there is an actual difference in the thing supplied in two very important ways. One is quality of service. Theoretically, a small plant can often give as good service as a large one. Practically, the large one gives wool against cotton in many ways. The steadiness and reliability of the power in every way is, as a matter of fact, much greater for central station power. This costs more and is worth more and often the central station has not any poor service to sell at a low price. This is a special condition that is really more frequent than the question of steam heating. A business that is fully satisfied with cheap and irregular power at a low price can often make that quality of power itself better than to buy a good quality of power from the central station.

A second is that the isolated plant supply is inflexible but the central station supply is flexible. An isolated plant, if figured on depreciation of 3%, must be used a quarter of a century. Even at 10%, it must be used a long time; and, more than this, no plant is like the one horse shay, it can *never* be discontinued without a loss. On the other hand, central station supply in many cases can be discontinued at the will of a purchaser on a moment's notice. In other words, with central station supply, the purchaser is free; with a plant he is tied like a serf to the investment he has put in.

It is true that this freedom for the purchaser can only be given at an expense to the central station. When the central station must be prepared to lose a customer at a moment's notice, or a month's notice, it cannot make its arrangements as economically as if it counted on running along exactly the same year in, year out, as the mill that has its own plant must do in order to make the plant pay. Part of this condition can be and is taken care of by long-time contracts. If a central station can figure that its investment for a particular customer will be used for all time and will not be discontinued at some definite or indefinite date, it can supply power more cheaply. On very large business, it must get this assurance by long-time contracts; on small business by its own judgment of the future; but even with the longest and strongest contracts made with the central station, the mill is freer when purchasing power than with its own plant, since at the end of the contract it discontinues without loss, while with a plant of its own it can never discontinue without loss. Perhaps in special cases this freedom may not be worth anything, yet it is safe to say that in general the central station sells better power and allows more freedom than the isolated plant can give.

To summarise:

1. Central station power can, except in very unusual and special cases, be supplied more cheaply than when a man in another business attempts to make power as well as to carry on his own business.

2. Central station power is practically always better and gives the private owner more freedom and flexibility than when he ties himself to his plan.

3. The existing central stations have in the past figured the cost of their power supply in large lots too high, and have unconsciously hurt themselves and the public by attempting to charge large customers too much.

4. When central stations have made proper prices, the people who do other kinds of business have hurt themselves and the public by figuring their own costs of power too low and not charging their own time and general expense against the added business responsibility of the plant.

In future, the central stations will come closer to the other businesses; all will get together and pull together, and an isolated power plant will, before many years, be just as scarce as an isolated plant for making gas is to-day

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CALCUTTA ELECTRIC SUPPLY CORPORATION.—The number of units delivered to consumers during the four weeks ended January 28, 1910, were 482,672, compared with 400,279 units in the corresponding four weeks of 1909.

NAVAL AND ENGINEERING EXHIBITION.—Sir David Gill, K.C.B., F.R.S., President of the Institute of Marine Engineers, has accepted the Presidency of the Naval, Mercantile Marine & General Engineering Exhibition, Olympia, West Kensington, September 1–26.

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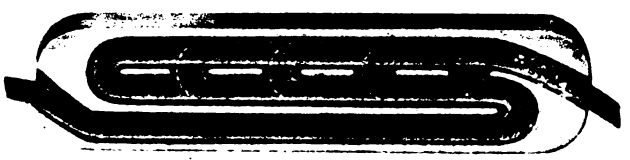
PUBLICITY.

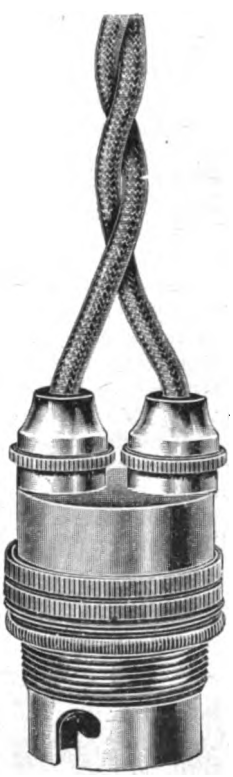
In this Section of "The Electrical Engineer" we give Publicity to New Inventions and Specialities.

A TELEPHONE DEVICE.

An invention, which we illustrate, is coming into wide use in the United States, much to the relief of telephone operators, who are considerably inconvenienced by the slack usually allowed on switchboard cords. These extra lengths of a foot or so are intended to permit of the cord being cut back as it becomes worn by wear at the plug end. But until the slack has been almost entirely used up, it proves a nuisance. In order to overcome this a Chicago firm are introducing the device depicted, which is made of aluminium. It is about 6 in. long and 1 in. wide, and has two slots running longitudinally its entire length. The cord,



in the form of a loop, is laid in the slots and adjusted to the proper length by means of the openings in the partition between the slots. It is held in place by the cover, which is attached by two screws, one at each end. As the cord is cut back, the slack is let out by changing the cord from one slot opening to the other, thus shortening the loop to the adjuster. When the slack has all been used, the adjuster is removed and ready for use on another cord. As there is practically no wear, it will outlast the switchboard. Adjusters in normal positions do not interfere with one another, and, being made of aluminium, do not add any appreciable weight to the cord. Apart from its convenience, it saves considerable time when adjusting has to be undertaken.



TWIN CORD GRIP LAMPHOLDER.

Wiring contractors as well as users will welcome the Evans twin cord grip lampholder, which we illustrate. It has been designed to overcome the frequent trouble arising from the two wires, insulated though they be, being jammed together at the top of the lamp. In the twin holder the two ends of the flexible cord are taken into separate grips. In this way a strong hold is secured without chance of abrasion or of breakdown, even under rough usage. The holder is easy to handle, easy to fix and has met with the cordial approval of fire insurance companies, so it should prove a good thing in the hands of enterprising wiring contractors. It is manufactured by Messrs. Bell Bros. & Co. (London), Ltd., 63, Bishopsgate-within, E.C.

SIGNALLING ON ELECTRIC RAILWAYS.

A paper on block signalling on electric railways, read at the March meeting of the Street Railway Association of the State of New York by Mr. Charles Barnes, Inspector of Electric Railways, with the Public Service Commission of New York, presents so many aspects of interest in connection with electric railway signalling in this country that we give below an abstract transmitted by our New York correspondent.

The definition of a "block signal system" as presented in the modern electric dictionary of the English language, said Mr. Barnes, is as follows: "A method of signalling especially designed to prevent collisions between trains travelling on the same line of rails." There is no block signal system in use on any of the railroads in this country which complies with the requirements mentioned in the foregoing definition, namely, "prevent collisions between trains travelling on the same line of rails." This statement needs no argument in its defence, as the records of collisions on roads equipped with the modern signal systems prove that they do occur in large numbers on some roads and that the possibility of such occurrence exists on all the roads so equipped. It is considered unnecessary in a paper to be presented to street railway men to describe the different kinds of signal systems in use on the various roads, both steam and electric in this country. It is, however, considered necessary to emphasise the foregoing remarks by stating that inherent defects which exist in all of them permit collisions.

The more important defects in signal systems as at present constructed and operated are:

First.—That all systems, manual or automatic, depend upon the co-operation of human elements to accomplish what they are designed to do, namely, prevent collisions.

Second.—Nearly all of the automatic signals in use are moved in one direction by motive power. The movement in the other direction is dependent upon the relationship existing between the signal engineers and Divine Providence. Under the present methods of automatic block signalling, an engineer entering a block has no positive knowledge that the signal at the outgoing end of that block is set at "danger." He has no positive knowledge when approaching a signal at "safety" whether such signal was set at "safety" for him to proceed or whether it remained at "safety" after its last operation.

Third.—There is no signal system in use on any of the railroads in this country which positively provides for emergencies which may result in collision, such as that engineers may disregard danger signals or become incapacitated.

Several attempts have been made to obviate the third defect. The most important device for that purpose is the track-trip used in the subway in New York City. By this means, the train line will be opened and an emergency stop made if the motorman attempts to pass a danger signal. To illustrate the defects of the system in use on this railroad and its unreliability, it need only be pointed out that the tripping devices can be broken in such a manner as to prevent their operation for the purpose intended. Such breakages could be discovered only by close observation.

The traffic on the steam railroads of this country has been steadily increasing for a number of years past with the result that at times their operating officials must strain

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every point to move the traffic. To accomplish this, safety of operation has been seriously impaired in some cases. This statement is not intended as a reflection upon the judgment or ability of railroad officials generally, but is presented as a fact and one which from the standpoint of operating officials no doubt is justified. That it is a fact is demonstrated by the modification of the "31" train order in use on many roads of the "19" order; also by the use of "permissive" block signalling on roads equipped with signal systems.

Discussion of the subject of block signals with signal engineers leads me to believe that the inventive genius of these men can and would develop a signal system which would absolutely prevent collisions on railroads under all conditions. Further discussion of the subject with railway operating officials develops the fact that they consider such a system among the future possibilities. They feel, however, that the companies would not adopt such a system, as it would become impossible from the present operating standpoint to move the trains on time, and public opinion would not endorse the adoption of any means which would increase the possibility of delay to train movement. I am firmly of the opinion that a signal system can be devised and maintained in such a manner as to interfere with train movement only when absolute safety requires. I am further of the opinion that the passenger would prefer to arrive at his destination an hour late than to be brought there on time in a box.

The Interstate Commerce Commission, realising the number of collisions occurring on the roads throughout this country, has appointed a committee of eminent experts to investigate this subject thoroughly, with authority to make such recommendations for improvement in the present block signal systems as in their judgment may be necessary. No doubt much benefit will be derived, both to the railways and to the general public, by this committee's researches and the ensuing recommendations. Reference is made to the work of this committee at this time only to show that the defects in the present block signal system are recognised and that the necessity for improvement exists.

At this point in the discussion it is pertinent to ask: "What has all this to do with the topic under which this paper is presented, namely, 'Block signalling on electric railroads?'" The foregoing has been presented because there is a tendency among some of the managers of the interurban electric railways literally to follow in the footsteps of their brothers—the operating officials of the steam railroads. In my judgment this practice is a mistake. The revenue of the interurban railway companies is in most cases confined to receipts from passenger earnings, so that the financial results of collisions to them are more serious than to the steam railroads, which have large additional revenue from freight business. In plain words, the steam railroads can afford to adopt certain methods of operation and pay the losses incident to them, whereas a collision occurring from the same method of operation on an interurban road might place the company in the hands of a receiver.

There is no intention to discourage the introduction of any of the present block signal systems on the electric railways of this State, as safety of operation would be increased on a number of them by the use of some of the devices now on the market. What is intended by this paper, however, is to impress on the minds of the electric railway men of this association that nothing should be left undone which will add in any way to the safety of passengers on the roads under their charge; also that the numerous fatal collisions occurring on steam railroads throughout the country and on some of the interurban electric railways outside the State of New York, will bring about the development of a block signal system which will absolutely prevent such occurrences. A crystallisation of public sentiment would compel the adoption of an improved system.

Having pointed to some of the defects of the present block signals, I feel it incumbent upon me to suggest some of the essential elements of a signal system which in my judgment would fill the requirement mentioned.

Briefly stated, such a system on a steam railroad should consist of home and distant signals, normally at danger and so constructed that when an engineer is approaching the distant signal and the block is clear, the signal at the outgoing end of the block would be locked in the danger position. The locking of this signal would be a means to cause the home and distant signals at the entering end of the block to go to safety. The system would include a tripping device arranged so as to operate the throttle and the air. This tripping device should form a part of the block signal system and be so interlocked with it that if it is not in the operative position at the outgoing end of the block, the home and distance signal at the approaching end could not be brought to "safety." All engines should be equipped with a device to be operated by the aforementioned trip, the operating device on the engine to be so constructed that if it is not in the operating position the engine cannot be started, and if after the engine is started it is broken or moved from the operating position, the steam will be shut off and the air applied. All of the signals should be controlled from a central office so that a train can be stopped at any point.

While the suggestions given above apply to the equipment of a steam railroad, the main principles of such a signal system are equally applicable to electric interurban railway work.

DRESDEN INTERNATIONAL HYGIENE EXHIBITION, 1911.

At a meeting of members of the British Executive Committee of this exhibition, held at the *Hotel Cecil*, Professor Dr. Pannwitz, the deputed representative of the Scientific Department of the Exhibition, delivered an address.

Among the ladies and gentlemen present were Mr. B. A. Whitelegge, H.M. Chief Inspector of Factories (Home Office); Mr. H. R. Kenwood, Professor of Hygiene at University College; Sir John Purley, of the St. John's Ambulance Association; Mr. J. Porter, Director General of the Medical Department of the Royal Navy; Sir William Church; Dr. Theodore Williams (Brompton Hospital and King Edward VII. Sanatorium); Major C. E. Pollock, R.A.M.C., of the War Office; Dr. W. Armit, of the Lister Institute; Miss A. M. Anderson, H.M. Principal Lady Inspector of Factories; Dr. J. C. Thresh (London Hospital Medical College); Mr. Arthur G. Gagshawe, Director of the Sleeping Sickness Bureau; Professor W. H. Smith, Principal of the Royal Institute of Public Health; Professor Eyre, Director of the Bacteriological Department, Guy's Hospital; Sir David Bruce, Dr. E. Bashford, of the Imperial Cancer Research Fund, etc.

Dr. Pannwitz said he felt it a privilege to address at that preliminary stage such a number of eminent British men of science and members of the medical profession as were there assembled. Speaking to them as the professional descendants of the great Englishmen who were the acknowledged fathers of hygiene, he invited their earnest co-operation in the important project upon which they had entered. The great charm of the science of hygiene was that it was the most unselfish of sciences, not pursued for mere personal profit, but for the good of the community. It was hardly 200 years since sanitary science had its birth in certain efforts made by British doctors to arrest the progress of virulent epidemics, and in the time that had since elapsed such splendid results had been obtained that it was not too much to say that epidemics had been almost killed while the average span of life had been lengthened by many years. He then proceeded to explain the objects and aims of the exhibition, what the German Imperial and State Governments were doing to aid the enterprises, how every civilised country was making vigorous efforts for an effective representation, and concluded by expressing his confidence that the British committee in their collective wisdom would make the British representation something for the world to talk about—something that would add fresh laurels to the brows of British workers in the cause of hygiene.

It was stated that offices were to be opened in Victoria-street, S.W., for the accommodation of the British Executive and for the general working of the undertaking in this country.

FARADAY HOUSE OLD STUDENTS' ASSOCIATION. The annual dinner of the Faraday House Old Students' Association has been postponed until Friday, April 29.

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Electrical Contractors' Section.

A Survey of New Things and Business Prospects.

NOTICE.

Contract and Miscellaneous Advertisements should reach this Office by Mid-day on Wednesday. For rates apply to the Manager, 149, Fleet Street, London, E.C.

CONTRACTS.

GLOUCESTERSHIRE COUNTY COUNCIL.

EXTENSIONS TO SHIRE HALL, GLOUCESTER.

The Committee of the Gloucestershire County Council are prepared to receive TENDERS for the ELECTRIC LIGHTING OF THE EXTENSIONS TO THE SHIRE HALL, GLOUCESTER.

General Conditions, Specification, Plans, etc., may be seen and Forms of Tender obtained at the Office of the Consulting Surveyor in the Shire Hall.

Sealed Tenders, endorsed "Electric Lighting," must be addressed to me and delivered not later than the 2nd day of April, 1910.

The Council do not bind themselves to accept the lowest or any Tender.

EDWD. T. GARDOM,
Clerk to the Council.

Shire Hall, Gloucester.

CORPORATION OF SUNDERLAND.

STORES.

The Corporation are desirous of receiving TENDERS for the various kinds of STORES used in connection with the Electric Tramways, viz.: Paint and Oil, General Electrical and Car Supplies, Ironmongery, Wrought Iron and Steel, Timber, and Overhead Line Materials.

Further particulars, with form of tender, may be had, and samples inspected, on application to the General Manager, Mr. A. R. Dayson, Tramways Offices, Sunderland.

Tenders, in sealed envelopes, endorsed "Tender for Tramway Stores," must be delivered at my office not later than 12 o'clock noon on Thursday, March 31, 1910.

The Corporation do not bind themselves to accept the lowest or any tender.

FRAS. M. BOWEY,
Town Clerk.

Town Hall, Sunderland,
February 28, 1910.

BURGH OF GOVAN.

ELECTRICITY DEPARTMENT.

The ELECTRICITY COMMITTEE of the BURGH of GOVAN are prepared to receive TENDERS for the Supply of the following STORES for Twelve Months from 16th May, 1910:—

1. ENGINE-ROOM STORES, OILS, Etc.
2. CABLES.
3. CABLE ACCESSORIES.
4. BITUMEN and JOINT BOX COMPOUND.
5. METERS.
6. FUSE BOXES.
7. WROUGHT IRON TUBES and FITTINGS.
8. CAST IRON PIPES.
9. CEMENT.
10. IRONMONGERY, BRUSHES, Etc.
11. PAINTS, VARNISHES, Etc.
12. TIMBER.
13. ARC LAMP CARBONS.
14. COAL.
15. JOINT BOXES.

Forms of Tender to be obtained from Mr. T. C. Parsons, Burgh Electrical Engineer, Helen-street, Govan.

Tenders endorsed "Tender for Stores Contract No. ....." and addressed to the Town Clerk, Town Hall, Govan, must be delivered not later than Tuesday, March 29, 1910.

J. A. HOUSTON,
Town Clerk.

Town Hall, Govan,
March 7, 1910.

VULCANITE
ALL SPECIAL ARTICLES QUOTED FOR ON RECEIPT OF SAMPLE, SKETCH, OR SPECIFICATION.
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EBONITE

CONTRACTS OPEN.

HOME.

ABERDARE.—Urban Council invite tenders for: (*a*) Generating station buildings; (*b*) two high-speed reciprocating engines, direct coupled to direct current generators (200 kw. and 100 kw.), balancer, booster, switchboard, steam and exhaust piping; (*c*, battery of accumulators (500 amp. hour capacity); (*d*) cables) sheet work, junction boxes, switch pillars, etc. (Particulars from Clerk to the Council, Aberdare). April 9.

BEDFORD.—Corporation invite tenders for one 750 kw. direct coupled steam driven single-phase alternator and exciter. (Particulars from Mr. R. W. L. Phillips, Borough Electrical Engineer). March 28.

BOLTON.—Borough Council.—Electricity Department.—Annual supplies. (Particulars, Borough Electrical Engineer, Spa-road). March 31.

BRAY (Ireland).—Council invite tenders for annual supplies of stores for electricity department. Particulars from Mr. P. MacDonnell, Town Clerk. April 5.

COLINTON.—The Colinton Tramways Co. invite tenders for the excavation and banking for formation of roadway. Note: This contract is mainly for earthwork, and does not include track laying or electrical equipment. (Particulars from J. & A. Leslie & Reid, engineers, 72a, George-street, Edinburgh). March 23.

DUNDEE.—Town Council invite tenders for the supply of: (*b*) General stores; (*c*) meters to be delivered over a period of 6, 9, or 12 months as required, and (*d*) for the insurance for the next year of the boilers at the Carolina Port Generating Station. (Particulars from the City Electrical and Tramways Engineer). Tenders by March 31.

GLASGOW.—Corporation Electricity Department.—Cables, meters, carbons, gas and steam tubes and fittings. (Specification £2, W. W. Lackie, 75, Waterloo-street). March 29.

GOVAN.—Burgh invite tenders for (1) engine room stores, oils, etc., (2) cables, (3) cable accessories, (4) bitumen and joint box compound, (5) meters, (6) fuse boxes, (7) wrought iron tubes and fittings, (8) cast iron pipes, (9) cement, (10) ironmongery, brushes, etc., (11) paints, varnishes, etc., (12) timber, (13) arc lamp carbons, (14) joint boxes. Particulars from J. C. Parsons, Burgh Electrical Engineer. March 29.

NEWPORT.—Tenders invited for second-hand material. (Particulars from Borough Electrical Engineer). March 26.

ROSSLYNLEE.—Mid-Lothian and Peebles District Asylum Board. Supply for six months April 15 to October 14 of electric fittings; fittings and materials for machinery and boilers Particulars from Treasurer, 19, Heriot-row, Edinburgh, March 28.

SALFORD.—Education Committee invite tenders for the electric wiring of the Wellington-street Boys' School, Pendleton. (Particulars from Borough Electrical Engineer). March 31.

SUNDERLAND.—Borough Council.—General electrical supplies. (Particulars from Borough Electrical Engineer). March 31.

WARRINGTON.—Borough Electricity Department invite tenders for: (1) 1,000 k.w turbo alternator; (2) 750 kw. rotary converter; (3) switchgear. (Particulars from F. V. L. Mathias, borough electrical and tramway engineer, Horley, Warrington). March 22.

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55, CHANCERY LANE, LONDON, W.C.

THE PROPRIETORS OF THE PATENTS Nos. 7637 of 1907, 7642 of 1907, for "Improvements in and relating to Filaments for Incandescent Electric Lamps," are desirous of entering into arrangements by way of license and otherwise on reasonable terms for the purpose of exploiting the same and ensuring their full development and practical working in this country. All communications should be addressed in the first instance to HASELTINE, LAKE & Co., Chartered Patent Agents and Consulting Engineers, 7 and 8, Southampton Buildings, Chancery Lane, London, W.C.

PLANT FOR SALE.

Advertisements under this heading: Twenty-four words, 1s. per insertion; three insertions for 2s. 6d.; or each additional line of eight words. 4d.

HORIZONTAL HIGH PRESS CONDENSING ENGINE for sale by Woodhouse & Mitchell, capable of developing 20 to 30 h.p., first rate order. Selling as more power is wanted. —For particulars apply Box O, c/o THE ELECTRICAL ENGINEER, 149, Fleet Street, E.C.

FOR SALE, 25 b.h.p. MOTOR, built by the Electric Construction Co., Ltd., Wolverhampton, with spare armature, extended shaft, and extra wide pulley, pedestal and plate, coupling, starting switch, and resistance, 200 volts, 102 amps., at 830 revs.—Box S.H.P., THE ELECTRICAL ENGINEER, 149, Fleet-street, London, E.C.

FOR SALE, 20 h.p. Suction Gas Plant and 14 b.h.p. Engine; also 10 h.p. Vertical Boiler and 6 h.p. Vertical Steam Engine.—Box C.E., c/o THE ELECTRICAL ENGINEER, 149, Fleet-street, London, E.C.

LANGDON DAVIES ELECTRIC MOTOR; alternating current, 16 h.p.; 100 volts.—Box G.S., c/o THE ELECTRICAL ENGINEER, 149, Fleet-street, London, E.C.

ELECTRIC MOTORS.—Two 15 h.p., 500 volts; one 20 h.p., 100 volts; one 10 h.p., 460 volts; tramway controllers.—Box W.G., c/o THE ELECTRICAL ENGINEER, 149, Fleet-street, London, E.C.

CONTRACTS OPEN.

OVERSEAS.

ANTWERP.—Lower Scheldt Works.—Electric lift for vehicles on floating pier. Dep., £320. (Specification No. 19, 2d., plans 1s. 5d., Direction du Service Spécial de l'Escaut Maritime). June 16.

BUKAREST.—War Office.—Incandescent lamps, Edison globes, projectors, etc. (Particulars, Direction de la 7me Intendance Militaire). April 1.

GHENT (Belgium).—Municipal authorities invite tenders for the supply of three electric cranes. Tenders, accompanied by a deposit of 2,000 francs (£80), should be addressed to "Monsieur le Maire, l'Hotel de Ville," Ghent, and should reach their destination not later than April 2.

MADRID.—Tenders are invited for a concession for the construction and working of an electric tramway in Madrid, viz., from the Calle de Alcala by way of the Calle de Velasquez to the Calle de Diego de Leon. Tenders, which should be accompanied by a deposit of 2,480 pesetas (about £90) and enclosed in sealed envelopes, must be addressed to the "Direccion General de Obras Publicas, Ministerio de Fomento," Madrid, where they will be opened at noon on May 9. Local representation is necessary. An application respecting this concession has already been lodged by the "Sociedad Tranvia del Este de Madrid," who have certain preferential rights in the competition.

TENDERS ACCEPTED—Home.

LONDON.—County Council Tramways Department. For supply of 27 tons of fishplates, Walter Scott, Ltd., Leeds, £10 10s. per ton (accepted); P. & W. Maclellan, Ltd., Glasgow, £13 13s.9d. per ton. Chief Officer's estimate £300.

SOUTHEND-ON-SEA.—The following tenders have been accepted: (*a*) The tender of the Electric Apparatus Co., of Battersea, for the supply of 50 meters at prices varying from 19s. 6d. to 42s. each; (*b*) the tender of Ferranti, Ltd., of Hollinwood, Lancashire, for the supply of 250 meters at prices varying from 36s. to 50s. each; and (*c*) the tender of the British Insulated Wire and Helsby Cable Co., of Prescot, Lancashire, for the supply of 300 single pole fuse boxes at 3s. 6d. each; (*d*) the tender of the Electrical Co., 101, Charing Cross-road, W.C., for the supply of such prepayment meters as may be required at 52s. 6d. per 2½ amps. size, and 55s. for the 5 amps. size; and for the supply of 100 current limiters at 9s. 3d each, be accepted.

OVERSEAS.

WINNIPEG, MANITOBA.—Board of Control of City Council. Tenders for equipment of electric power terminal station: Canadian General Electric Co., $138,250; Canadian Westinghouse Co. (accepted), $116,500; Siemens Bros., England, $111,725; Ferranti, Ltd., England, $89,850; Kolben & Co., Austria (not including testing transformers), $72,100; Brown Boveri, Switzerland (for power transformers only), $39,700. In regard to the tenders for the supply and erection of light, heat and power systems for the terminal station, the engineers recommended that of Chapman & Walker, Toronto, at $8,225. There were three Winnipeg tenders, as follows: Canadian General Electric Co., $11,000; Shipman Electric Co., $11,715; and Reese Engineering Co., $15,064. Only one tender was

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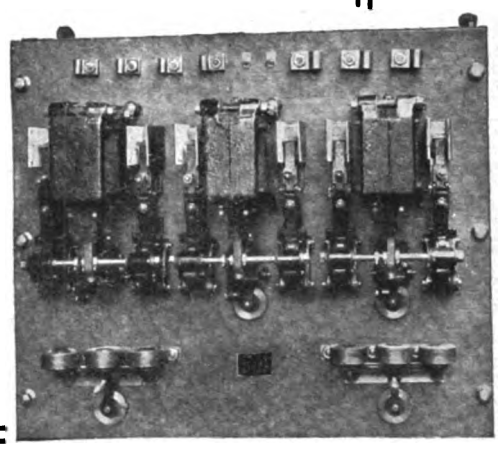

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PLATINUM UTENSILS, SCRAP, LAMP TOPS.—Best prices given by DERBY AND CO., LTD, 44, Clerkenwell Road, London, E.C. N.B.—Platinum Sold.

DYNAMO (modern) Wanted, about 100 volts and 60 to 80 amps. Lowest price, and where it can be seen.—Box D.N., c/o THE ELECTRICAL ENGINEER, 149, Fleet-street, London, E.C.

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WIREMAN, Experienced in all branches, requires situation —Box A., c/o THE ELECTRICAL ENGINEER, 149, Fleet-street, London, E.C.

ELECTRICAL ENGINEER desires berth in Central Station, or charge of private installation.—Box C., c/o THE ELECTRICAL ENGINEER, 149, Fleet-street, London, E.C.

ELECTRICIAN, young, requires situation; could take charge of small plant.—Box H., c/o THE ELECTRICAL ENGINEER, 149, Fleet-street, London, E.C.

MEN OUT OF EMPLOYMENT in all branches of the Electrical Trade should write to Box No. 20, c/o THE ELECTRICAL ENGINEER, 149, Fleet-street, London, E.C.

THE ELECTRICAL ENGINEER REPRINTS.

New Series No. 1.

JUST PUBLISHED.

"LIGHTNING CONDUCTORS,"

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received for the supply and erection of the oil and water system for the terminal station, that of Canadian Fairbanks Co. for $6,482, which was recommended. No tenders were received for the water cooling tower and accessories, the specifications being general in character. Detailed designs will be prepared and tenders again called. The Jens Orten Boving Co., of London, England, have been given a contract for seven turbine governors for the new Point Bois plant, at $23,000, while Glenfield & Kennedy, Kilmarnock, Scotland, were awarded the contract for valves at $2,852.

LIGHTS AND LIGHTING.

The discussion by the Illuminating Engineering Society on "glare," serves as a reminder of the prominence which scientific methods now hold in the work of the electrical contractor instead of the old-fashioned rule of thumb methods which characterised electric lighting work until within a comparatively recent time. No contractor can now afford to be merely a purveyor of lighting accessories, for the public are being educated to expect higher standards of illumination than they were wont to be satisfied with some time ago, and unless the electrical contractor is really capable of satisfying these demands, he will see loom over him still another expert in the shape of an "illuminating engineer," who will secure the better and more lucrative classes of work. It is significant of the slow but nevertheless sure change which is taking place in the attitude of the public towards illumination that various electric lighting accessories are now designed to give better concentration of light, and to eliminate glare. The effect on the sight, especially since the introduction of more intensely dazzling points of light, is undoubtedly a question of sufficient seriousness, and posterity will probably refuse to tolerate such points and will obtain all artificial illumination indirectly. Yet even then there is much danger from reflected glare as thrown off by the shining surface of paper and other materials. There is promise of rapid improvement, however, in these matters now that such a wealth of scientific ability is concentrated on the benefits of gentler methods of diffusion of light. Few firms have done more towards helping the trade of the public to scientific illumination than the Holophane Glass Co., of 12, Cartaret-street, Westminster, London, S.W. The Holophane system of illumination is a strictly scientific illuminating engineering system by which the direction, distribution and diffusion of light rays are put under perfect control. The Holophane system of illumination is generally carried out with specially designed Holophane glass, made in hundreds of shapes of globes and reflectors, constructed to give the most efficient light distribution with the best type of illumination. The following suggestions may be of assistance in selecting the right globe or reflector. Never use a pendant Holophane globe for an upright or *vice versa*, for when the wrong globe is used it throws the light towards the ceiling, thus giving the reverse of the desired distribution. In all cases, it is advisable to use lamps recommended by the company, for lamps of smaller candle-power give a dim and unsatisfactory light. If it is planned to use small lamps, the globes or reflectors selected should be designed for such lamps. Mr. John Walsh Walsh of the Soho and Vesta Glass Works, Lodge-road, Birmingham, has introduced some new patterns of electric shades which can be recommended. These include an entirely new series of designs, decorated in the modern taste, *i.e.*, in the Georgian, Adam, Chippendale, and other styles, and enriched with intaglio effects. The combination is novel and attractive, besides being decidedly effective. The new shades are made in two sizes to suit respectively the ordinary carbon-filament and the larger metallic filament electric lamps.

FOSTER Metal Lamps

Are made from start to finish in our own Works, and the most stringents tests are enforced. The tungsten filament is securely anchored, hence FOSTER METAL LAMPS have a long and useful life. Special attention is paid to packing, consequently breakages are at a minimum.

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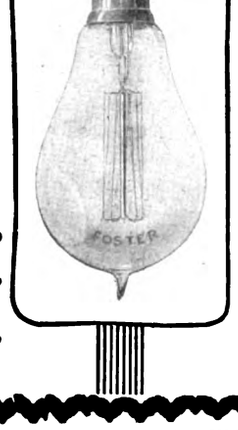
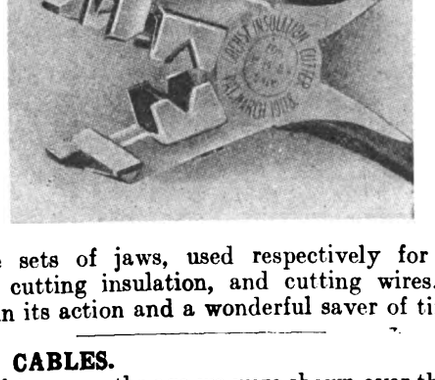


INSULATION CUTTER.

A clever little device of American origin has come under our notice. This is the Goehst insulation cutter and wire plier, manufactured at Chicago. These pliers are provided



with three sets of jaws, used respectively for slitting insulation, cutting insulation, and cutting wires. It is very neat in its action and a wonderful saver of time.

IGNITION CABLES.

Some eighteen months ago we were shown over the works of the Liverpool Electric Cable Co., which were then working at high pressure to execute the numerous orders which the company had in hand. Since then there has been no slackening in the quantity of orders which the company have been entrusted with, and this, together with the fact that works extensions have been necessitated, proves that the enterprise of the Liverpool Electric Cable Co. has been fully justified. We have on previous occasions referred to the standard productions of this company, and it will suffice now to make brief reference to the "Multicore" ignition cable system which they have just introduced, and which possesses several obvious advantages for motor-ignition purposes. With the advent of four and six-cylinder engines for motor car work, the question of suitably placing the ignition wiring assumes considerabls importance, as on this wiring depends the satisfactory operation of the car. The Liverpool "Multicore" ignition cable system is a most effective remedy for wiring troubles, being a thoroughly mechanical adaptation of an electrical system. In the "Multicore" system, short flexible leads run from brass connectors on the cable to the magneto, while solid connections, hinged at the cable and forming insulating switches, connect the cable on to the sparking plugs. The ebonite cable is oil and waterproof and is finished off with a polished surface. This cable is unaffected by the heat of the engine, and it is tested before leaving the works with pressure from a 7 h.p. transformer, sufficient to give a spark of 2 in. in air, or four times the usual working spark. The system has been in use some time and has given highly satisfactory results.

THE "CINECONVERTER."

The Phœnix Dynamo Manufacturing Co., Ltd., of Thornbury Works, Bradford, have brought out under the above name, a special single armature double commutator continuous current converter, which, as the name implies, is intended to meet the requirements of arc lamps for cinematograph work, and should find a good opening in the "electric" theatres, which are now so popular in this country. The "Cineconverter" is of the semi-enclosed type, and is designed to run without sparking, even under the heaviest fluctuations of load. The brush gear is exceedingly simple and requires little or no attention, while the great distance between the adjacent brushes obviates any risk of flash-over. The Phœnix Co. list three stock sizes for 3½, 5 and 9½ kw., the last of which is intended to run stage side and at the same time as a cinematograph.

CONTRACTS WORTH WATCHING:—

Below we present a list of building contracts which have recently been placed or for which tenders are invited. We have no means of ascertaining whether electricity will be used at all; but it is evident that in the majority of cases electricity will be used either for lighting or for power, or for both. Where names of firms are mentioned, and unless otherwise stated, they are those of the builders or contractors who have the work in hand, and it will repay electricians to keep in touch with these jobs.

Bromgrove.—Director of Education, 37, Foregate-street, Worcester. Secondary school.

Cardiff.—Messrs. Dunbar Smith & Cecil Brewer, Gray's Inn-square, London, W.C., architects. Welsh National Museum, Cathay's Park, Cardiff, at cost of £240,000.

Dublin.—M. T. J. Byrne, architect, 11, James's-street, Dublin. Library at Ballyboden, Rathfarnham, for South Dublin Rural District.

Dunoon, N.B.—Mr. W. W. Morton. Erection of skating rink in Castle Gardens.

Exeter.—Salter & Son, Exeter. Additions to St. Luke's College.

Gateshead.—R. T. Edington, Secretary of Education Committee. New school.

Leyton.—J. D. Butler, surveyor to the Metropolitan Police, New Scotland Yard, London, S.W. Alterations to Police Station.

London, Soho.—Staines & Co., builders. Clergy house, choir room, etc., St. Anne's Church, Soho.

Lowestoft.—Youngs & Son, Norwich. Re-instatement of premises, 116, London-road.

Lowestoft.—Mr. R. Scott, Cockrile, architect, Lowestoft. Boarding house in Parade.

Norwich.—Hannant, Norwich. Erection of warehouse.

Norwich.—Morgan & Buckingham, architects, Norwich. Erection of warehouse.

Shadwell.—E. V. Wimpenny, architect, Basinghall-street, Leeds. Villa residence.

Shepshed.—A. Faulks, 4, Sparrow-hill, Loughborough. Handicraft centre. £1,238.

Shotley Bridge (Co. Durham).—D. M. Spence, architect, Shotley Bridge. Alterations to *King's Head Inn.*

Stoneaston.—W. A. Bird, architect, Stoneaston, near Bath. Cottages.

St. Helen's.—Mr. P. Sharp, Secretary of Education, St. Helen's. New school.

Swansea.—Mr. H. O. Schenk, engineer, Harbour Trust, Swansea. Extension of warehouse.

Tunstall.—Mr. H. Dain, architect, Tunstall. Extension of Church Schools and erection of Infants' School.

Wye.—Extensions at the South-Eastern Agricultural College, Wye.

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CHEAPER TELEPHONES.

At the Conference of the Association of Chambers of Commerce, Mr. A. J. Hobson presented the report of the Special Telephone Committee, and stated that as the National Telephone Co. would not meet their views in any respect in regard to cheapening the service up to the end of 1911, they could only postpone further consideration of the question until they were able to negotiate direct with the Postmaster-General as to the whole question of telephone administration after the transfer of the undertaking.

Mr. Hobson regretted that the Telephone Committee which approached the Association of Municipal Corporations was not able to induce the municipalities to take up the question of municipalising the telephone system, at the time of the transfer of the undertaking to the Government. He felt there was something in the view that unless they obtained competition they would have to wait a long time before they obtained cheaper and better telephones. The only competition they now had was provided by the Hull and Portsmouth undertakings, and they would throw valuable light on the matter when freed from the strong competition they had to face from the National Telephone Co., for it was evident that when the Post Office took over the National system they must have one price for all the country, and could not have special rates for these two towns. The view of the Telephone Committee was that it should continue as a watch-dog until the transfer of the National Telephone Co.'s system in 1912. There might be developments not now foreseen in regard to the transfer, and to the Hull and Portsmouth undertakings, on which it might be desirable to approach the Postmaster-General. The Telephone Committee was re-appointed, and the question will come up for further consideration in 1912.

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Electrical Progress at Home & Abroad.

A Review by our Special Correspondents.

TYNESIDE.

NEWCASTLE-ON-TYNE.

The Newcastle-upon-Tyne Association of Students of the Institution of Civil Engineers has during the present session inaugurated a series of lectures by appointment of the Institution by Mr. F. H. Donaldson, C.B., M.Inst.C.E., on "Mechanical Power in Engineering Construction," which are being attended with very great interest by the local members of the Institution. The lectures, which deal with the mechanical powers as used on constructional work, discuss the availability and advantages of man, animal, steam, electric, water, hydraulic, pneumatic, and other forms of energy, and examples of each type are being given by the lecturer. This series of lectures is being given in the Institute of Mining and Mechanical Engineers, Neville Hall, Newcastle-on-Tyne. Another new feature of the work of this Institution is that the Council of the Association of Students have arranged that a room in the Bolbeck Hall (a new building in Westgate-road, Newcastle-upon-Tyne), which is devoted to scientific and technical purposes, shall be open every Thursday evening from 5.30 to 10 p.m. for the use of members of the Association. The intention of the Council is to afford opportunity for members to meet and become more intimately acquainted with each other, and also to give opportunity for the discussion of engineering matters generally; professional literature is to be provided and refreshments will be obtainable at moderate charges. This is the first beginning of a species of professional club which is very badly required in this area, and it is to be hoped that the venture will meet with adequate encouragement.

West Stanley Colliery.

The West Stanley Colliery, closed last year on account of the lamentable accident occurring there, has now been taken over by the South Derwent Coal Co., which controls a group of important collieries in Durham. At the annual dinner to the officials, it was stated it was proposed to extend to other parts of the collieries the use of electricity as being the modern and economical motive power, and particularly at the West Stanley Colliery it was proposed to employ electric power as extensively as possible. Mr. Rutherford, the Manager of the group of collieries, stated that the directorate had shown considerable courage in taking over the operation of the West Stanley Colliery, which had a record the reverse of brilliant, both commercially and from a mining aspect, and he hoped very sincerely that the undertaking would, under this directorate, prove a success.

Electricity Supply to an Urban District.

It is to be presumed from reports which are current in this area concerning a certain amount of friction between the Northern Counties Electricity Supply Co. and the Shildon Urban District Council with regard to the price charged for electricity in that area, that in the case of supplies throughout an area by means of a private concern, it is unwise to fetter the conditions of supply with any restriction which may have, as an equivalent for their carrying out such restrictions, the raising of the price of electricity as charged to the consumer. It is obvious that any increase in the cost of generation or distribution is ultimately reflected in the price at which electricity can be provided, and for this reason in an area where competition is exceedingly keen in the matter of lighting and power, any increase of price over the general rating is quickly felt. This possibly explains the fact that the Supply Co. have apparently, in a reply to a letter of complaint from a consumer of electricity as regards price, stated that the Shildon Urban District Council, and not the company, are to blame in this matter, but there is no doubt that it will take a considerable amount of investigation to convince the members of the Council that any arbitrary restrictions have been placed.

Electricity in Shipbuilding.

During the last few days there has been quite a boom in the number of orders placed on the Tyneside and Wearside for shipbuilding, and although the effect of this will not be felt for some little time owing to the delay necessary in getting plans drawn up and approved, it is anticipated by electrical engineers in this area that there will be a very considerable amount of work during the next few months. The annual meeting of Messrs. Swan, Hunter & Wigham Richardson, Ltd., revealed a very pleasing amount of work now in hand, this work including not only Admiralty contracts, which have been previously mentioned in this column, but also a Cunarder and other fast passenger steamers, a floating dock for the west coast of Africa, and the finishing of the two ships for the Grand Trunk Pacific Railway Co., known as the *Prince Rupert* and *Prince George* respectively. Both these boats are now launched, and are being finished, with a view to their ultimate use in the development of the new terminus of the railway mentioned to the south of the Island of Vancouver. In the majority of these boats there will, of course, be a considerable amount of electrical work done. Another interesting item of news is that the Tyne-Tees Shipping Co. have placed an order with Messrs. Irvines Dry Dock Co., which order is now being executed, for a passenger steamer of luxurious finish, to be used for the Tyne and London route. This has accommodation for a large number of first and second-class passengers, and is equipped with electric light throughout. It is also satisfactory to note that Sir James Laing & Co, Ltd., of Sunderland, have now a clear course to proceed with their work, as the claim for electric power preferred by the Sunderland Corporation has been satisfactorily disposed of, and other creditors have been negotiated with. The liquidation of the company has, therefore, been stayed, and new capital is being provided. Work is already in hand, which it is believed is only a forerunner of several orders at a later date.

Electricity in Buildings.

Reference was made in last week's notes to the high speed change over of the White City lighting made by Messrs. Robson & Coleman, of this city. An error which should be corrected, however, is that the men were actually upon the work in 30 min., and not 3 hours after the placing of the order, as was stated. At Tynemouth there is also going to be a further application of electricity in the re-illumination of the Tynemouth Palace Skating Rink, which is now under a new manager. A considerable amount of changes are to be made at this place of amusement, including the provision of auxiliary rooms for reading and writing, and also reception and dining rooms, all of which will probably give an opportunity for further electric lighting. Another interesting equipment which has been recently carried out is at Alnwick, where Messrs. Lloyds' Bank have erected new premises of a very handsome appearance, to the designs of Mr. George Reavell, jun. In order to keep the lighting of the place in keeping with the general fine appearance of the building, electricity has been used, supplied from the mains of the Northern Counties Electricity Supply Co.

THE MIDLAND.

BIRMINGHAM.

The Birmingham Corporation Electrical Department will be putting in between Easter and Whitsuntide supplies to the amount of 2,500 h.p. on their high tension mains alone, this total being equal to the whole total of the new high tension supplies for last year, while the new connections for lighting and other purposes on the low tension

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mains keep quite up to the average of 1909. The new high tension supplies range from 300 h.p. downwards. Two of 300 h.p. are for rolling mills, and a third for a large firm of tool manufacturers. A supply of 200 h.p. has been taken by a firm which already has a large installation of electrical machines for dealing with scrap and other metallic waste, and a similar amount is being installed in the manufactory devoted to the production of various well-known cycle accessories. The new supplies of 150 h.p. include three for metal rolling and two for pen factories. Practically the whole of the pen factories in Birmingham have adopted or will shortly be adopting electrical power, and as Birmingham is the chief centre of production for the world, it will soon be possible to say that by far the greater proportion of the pens used by mankind are made by electricity.

Carbon and Metallic Filaments.

Some interesting observations with regard to the comparative economy of the carbon and the metallic filament lamp have been made at the Birmingham Exchange during the past year. The new lamps, which are of the Osram type, were put in by the Walsall Electrical Co., Ltd., about the middle of April last year. There are four ranks of 24 lights in the large hall of the Exchange arranged in series of two's and three's, and making a total, with those in the reading rooms, secretary's office, etc., of 110. Taking the period from June to September, 1909, and comparing it with the corresponding quarter of 1908, the consumption was 345 units against 610 units, a reduction of 43·44%. The net charge for the same period shows a reduction of 46·6%. This was partly due to an alteration in the rate of charge, but even on the old basis the saving in cost would have amounted to 38·73%. Taking the last quarter of the year, the consumption was for 1909, 1·386 units, as against 1·813 in the corresponding quarter of 1908, a saving of 23·55%. The reduction in cost was 28·6%, or, allowing for the alteration in prices, 21·98%. There was, however, an extra working day in last year's Christmas quarter, and after allowing for this, the comparison comes out still more favourably for the new form of light, while members and subscribers have also had the advantage of a greatly improved illumination. Until quite recently no breakages beyond accidental ones had occurred.

Medical Electricity.

Mr. J. Hall-Edwards, Surgeon-Radiographer to the Birmingham General Hospital, will be one of the British representatives at the Congress on Physical Therapeutics which will be held in Paris from March 29 to April 3. The other British representatives, as far as is known, will be Dr. Deane Butcher, editor of the "Archives" of the Röntgen Society, and Mr. Lewis Jones, who is in charge of the electrical department of St. Bartholomew's Hospital, London. The members of the Congress will be entertained at dinner by the President of the Republic, and there will be an exhibition of apparatus and other matters illustrative of the progress of electricity in its application to the treatment of injury and disease.

The Electric Club.

The Birmingham and District Electric Club arranged a successful social function—a ladies' evening. This took place at the *Colonnade Hotel* on Saturday evening last. Mr. G. O. Donovan, M.I.E.E., President of the Club, took the chair, and the proceedings commenced with a lecture by Mr. W. H. Whitehouse, M.I.E.E., on "The Pyramids of Egypt," a subject of which the lecturer has made a special study. His conclusion is that their original function were not that of a burial place, but that of an astronomical observatory. A concert followed, songs being given by Miss A. Bullock, Miss Leah Pinnick, Mr. F. G. Stephenson and Mr. H. Collings. Humorous selections were given by Mr. Will Kings and Mr. W. G. Proverbs, and Miss Elsie Proverbs contributed some charming whistling solos.

LANCASHIRE.

MANCHESTER.

The electrical exhibitors at the Building Trades' Exhibition here (which closed last Saturday) report a very good time, and express the opinion that they have made a good impression on a new set of people. It seems a decided pity that there were not a few more exhibitors to give prominence to systems of wiring for new property; to push in an effective manner the merits of electric heating and cooking, and the advantages of electricity as a motive power for the numerous domestic labour-saving appliances which are now flooding the market. All these things were on show certainly, but neither in positions sufficiently prominent nor in quantities sufficiently large to give the public any other impression than that these things are still "in their infancy;" an impression which is, of course, quite wrong and which should be corrected as soon as possible. It would undoubtedly have paid some of the large firms interested in the products I have mentioned to have made a prominent display of the goods.

A Missed Opportunity: A Suggestion.

Those interested in the supply of electrical energy for lighting or power applications also let slip a most valuable opportunity of bringing home to the general public the fact that electricity, while perhaps not always cheapest on a cost price basis alone, possesses such advantages as make whatever little extra cost there may be a really good paying investment. Before the house to house canvasser can begin talking strictly business, he has to teach his prospective customer the A B C of electricity. This he has to repeat on each occasion, thus losing valuable time and making the work costly. Why not teach the public this A B C "in class," all together? It is at shows and exhibitions, such as the one under discussion, that the public can be taught collectively those interesting facts about electricity and its advantages which make them interested, and prepare their minds to receive the direct and individual attention of the canvasser. The public is out to learn and be amused on such occasions, and anything electrical catches its fancy. Afternoon and evening lectures at such shows, giving accurately and in non-technical language some account of the element of practical electricity and of the working of the various appliances, would soon set the town talking "juice," with great benefit both to the supply authorities and to the contractors and the industry as a whole. It is, of course, very easy to be wise after the event, but it must be remembered that "after the event" is really "before the event" when speaking of exhibitions and shows, and I point out the missed opportunities here so that they may be made use of on the next occasion. From May 6 to June 11 next there is to be a great "Home Exhibition" here. This would certainly afford an opportunity for valuable propaganda work.

Some Exhibits.

In addition to those mentioned last week, the stand of "The Metal Jointing Co., Ltd.," London, had some interest from an electrical point of view. "Amalgaline"—which consists of a ribbon of pure tin ·05 mm. in thickness, and treated with a patent composition to prevent the formation of oxides during heating—is inserted between the two adjacent portions of the lead pieces to be joined. The tin melts rapidly on the application of heat, having a very low melting point, and in so melting causes the lead also to melt below its normal melting point. It renders the jointing of lead very easy, and has been applied with great success to the jointing of lead-covered cables of all kinds. I also saw some cast lead joint boxes made by these people. The ends of the lead-covered cables are brought into the ends, and after putting a layer of the "Amalgaline" round all joints, the cast lead lid is put on and heat applied round the edges, which are pressed together by working round after the blowpipe flame, with a pair of pliers. It is said to be quite easy to undo the joint on heating, and inserting a blade, when the two halves can be forced apart again. It certainly seems to simplify the old cast iron joint box with its glands. Another exhibit of interest to mains engineers was that of "The Duroline Wire Wove Roofing Co.," who showed some jointers' tents with "Duroline" windows, so that daylight can enter the closed tent. Duroline is simply special wire netting embedded in a transparent oil preparation. It is weatherproof and unbreakable, while it has the added advantage of cheapness.

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Students' Section Institution of Electrical Engineers.

At the last meeting a long and interesting paper on "A Modern Telephone Exchange," having special reference to the "City" Exchange recently opened in Manchester, was read by Messrs. J. P. Garner and R. L. Bell, B.Sc. Some of the advantages claimed for the C.B. system which is now universally adopted by up-to-date exchanges were, that it simplifies the subscribers' instruments and the operation of his instrument; that it enables by means of the double lamp arrangement the exchange operator to more effectually control the subscribers' lines; that the speaking current being supplied from a common central source, and not from a number of dry cells in the various subscribers' telephones, speaking is more uniformly distinct; faults on lines show up automatically; the concentration of the whole apparatus in one building simplifies repairs and reduces their cost. Its disadvantages are that the increase in the appliances necessitates an increased capital outlay at the start, since the whole of the ultimate capacity must be provided from the start. A higher standard of line insulation is also necessary. This section is holding its second supper and smoker this session on Tuesday, April 5. These functions are always highly successful, but it is hoped this will be exceptionally so.

SCOTLAND.

GLASGOW.

The Glasgow Chamber of Commerce have under consideration a scheme, emanating from one of their members, for the formation of a British Empire Trade Mark Association, the objects being: (1) to stop the foreigner from making further inroads into our home markets and by a gradual process to regain the share of our markets which he already has; (2) to divert to the Colonies our foreign source of food supplies; (3) to stop foreign manufacturers from placing names of British manufacturers or the names of British places upon goods which have not been manufactured within the United Kingdom, and at the same time to stop British traders from selling as British goods what are actually foreign manufacture; and (4) to provide a remedy for excessive unemployment. The matter was left in the hands of the Home Affairs Committee, and one may hazard the prophecy that it is likely to remain there! The intention is excellent, but is it practicable? *Io non credo.*

Glasgow Tramways.

The *Glasgow Herald* of March 15 contained a very interesting article from the pen of Mr. John Ferguson, of the Glasgow Corporation Tramways Department. Mr. Ferguson makes enthusiastic reference to the future of the steam turbine. "In its present state of development," he says, "it can successfully hold its own in the matter of reliability and steam consumption per h.p. with the reciprocating engines on the market, and in the matter of first cost, running expenses and maintenance, the advantages are decidedly in favour of the turbine." The car system in Glasgow now includes a total of 812 cars, 451 being already and 50 cars soon to be fitted with top roofs. But the Tramways Department is not allowed to go on its successful way untramelled. Just as in the case of a family, if one member, by dint of exceptional ability and application, succeeds in being a little more prosperous than the other members, he often becomes a sort of family leaning-post, so the Tramways Department have their revenues threatened, now from this side and now from that. Up to the present time the periodical cry has been for the application of tramway profits to the relief of city rates. This, of course, practically means subsidising the better class of taxpayer at the expense of the average man, who, by his constant use of the cars, is the principal contributor to the trams revenue. Now other suggestions are forthcoming to enable the Tramways Department to dispose of their surplus. One prominent citizen suggested in a letter to the Press the other day that the Tramways Department should be charged a rental for the use of the streets, and at a public function the other night an Ex-Lord Provost said that as the tramways dominated the streets and an undue amount of traffic was caused on the remaining two-fifths of the street, would it not be reasonable that with the abounding finances of the Tramways Department a contribution should be made towards the maintenance of the roadway for commerce? Bailie D. M. Stevenson replied that the Tramways Department paved the whole of the streets where the cars ran and 18 in. on each side, and it seemed they were doing far more than their fair share of the upkeep of the streets. . . . Surely the obvious thing for electric tramways is to use their surplus for their own development and efficiency to an ever fuller and more complete extent.

A Pioneering Company.

In the rapid development of the electrical industry, many men and many firms who were prominent in the earlier days have dropped out in the race owing to their devices and methods having become obsolescent or been entirely superseded. A striking exception to this is the Edison & Swan United Electric Co., who still hold their own in Scotland amid a host of competitors. The day was when this company had practically a monopoly in a number of their specialties, more especially the carbon filament lamp. In places where there is much vibration and the metal filament lamp is unsuitable the Ediswan carbon filament lamp still commands a large sale. As evidence of the company's ability to cope with new sets of circumstances, it is interesting to note that their metal filament lamp is being increasingly recognised as an efficient and reliable lamp. In various parts of the country the "Royal Ediswan Metfil" lamp is in use on railways, in Corporations, public institutions, and in public streets. The Ediswan "Metfil" lamp is produced entirely in Britain, even the filaments being manufactured at the company's own works.

Stair Lighting in Glasgow.

In the course of a report on Stair Lighting, Mr. S. B. Langlands, head of the Watching & Lighting Department of the Glasgow Corporation, says that to remedy the present inadequacy of stair-lighting further statutory powers are needed. In the meantime the only course open is private arrangement with owners. Of the total of 65,000 stair lights in Glasgow, 6,000 are incandescent gas and 2,000 are electric incandescent lamps. Pending further Parliamentary powers being obtained or a definite and permanent arrangement being come to with owners, it was decided to leave the matter in the hands of Mr. Langlands to extend and develop the lighting of common stairs with incandescent gas and electric lamps.

Caledonian Railway Co.

To meet the increased demand at the works of the Locomotive Works of the Caledonian Railway Co., the Glasgow Corporation decided the other day to accept the offer of the British Westinghouse Co. for providing and fitting up a rotary converter at a price of £780.

Trade Revival.

There are continued signs of reviving trade in the electrical industry. One firm in Glasgow of many years' standing who have suffered more from trade depression during the past two years than at any previous period of their history, find themselves with a considerable body of work on hand which has all been booked since the begnining of the present year. The firm in question have good reason to believe that some further orders will come to hand shortly. They are well known to the trade as a firm whose work is invariably of the highest class and commands a respectable price. Many of the orders that have gone past them during the past two years have been snapped up by second rate firms quoting ridiculously low prices.

GERMANY.

BERLIN.

A very able and exhaustive article has been published by H. Thurn in the *Elektrotechnische Zeitschrift* of February 24, 1910, on the international expansion of wireless telegraphy. Another noteworthy article in the same issue refers to the variations of arc lamps in their light giving power. Ernes Presser, of Pankow, near Berlin, proposes a system for automatic recording of the variations in

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illuminating power by means of a selenium cell. It is well known that arc lamps depend for their success in the main on uniformity of action, and Kuess's system of testing them seems to be better than any other yet proposed.

"Wireless."

The accident to the *Kentucky*, of the Eastern Steamship Co., has aroused great interest here as showing that the impossibility of directing wireless telegraphy has its advantages, and even that were it possible to telegraph wirelessly as we can telegraph wirely, useful results might be missed which are now possible as the case of the *Kentucky* proves. That steamer sprung a leak on February 14 last, on a voyage from New York to San Francisco. The whole Atlantic coast was at once informed of the fact by wireless signals, and also many United States warships and merchant ships. Signals were handed backwards and forwards continually between wireless ships and coast stations. But here the fact enforces itself that most of the wireless information was gathered by those so far off from the sinking ship that they heard the bad news without its being in their power to render assistance. As a matter of fact, however, the Mallory liner *Alamo* saved the whole crew of the *Kentucky*, 46 men, and we have not yet heard whether the *Alamo* had any wireless news of the danger or not.

Wireless Installation for Military Purposes.

Important experiments have recently been made with wireless installations at Tempelhof for military purposes. Half Berlin was there to look on and offer criticism. Further experiments on a larger scale are about to take place in places further removed from Berlin. The steel mast carrying the antennæ was carried on a waggon. It was of telescopic make, and could be drawn out to a height of 120 ft. It was found that the mast could be put up and down again, after receiving a message, inside of 10 minutes. Communication was made during the experiments with the fortresses of Strassburg and Metz, and the results were eminently satisfactory.

Rapid Forming of Positive Lead Accumulator Sheets.

M. Mitrofanoff has been studying the question as to the quick formation of lead accumulator plates, especially with reference to the use of nitric acid for that purpose. The results of his experiments are that no advantage is gained with the strong currents necessary for rapid charging in the case of flat plates, but that the case is somewhat different with rolled up or corrugated plates. Here, probably on account of the character of the surface, durable coatings can be obtained, so long, however, as the concentration of the acid used is not too great. Further experiment is badly wanted, but even what Mitrofanoff has done so far is exciting considerable attention in German electrical circles. When we consider that for self-propelled electric vehicles we have lead accumulators, and them only, and see no prospect of anything less dead-weight being invented, the question of making the best use of the lead we must carry is of the highest importance.

UNITED STATES.

NEW YORK.

A noteworthy contribution towards a history of electrical developments was made in an address delivered by Mr. Samuel Insull, president of the Edison Medal Association, at the recent annual dinner of the American Institute of Electrical Engineers. The occasion was the presentation to Professor Elihu Thomson, of the first Edison medal, and the gathering was from many points of view an extremely interesting one. Mr. Insull spoke in warm terms both of Mr. Edison, in honour of whom the Edison medal was founded, and of Professor Thomson, the first recipient of the distribution, and then reviewed briefly the progress of land and submarine telegraphy and the development of the telephone. He traced the achievements in electric lighting of Jablochkoff, Brush, Thompson and Houston, Edison, Zippernowski, Bradley, Tesla and others, and dwelt in detail upon the work of George Westinghouse, who by his development of the alternating current system has done so much towards the production of electricity on a large scale at low cost. He dealt also with the storage battery, wireless telegraphy, Tesla's work in alternating current apparatus, the achievements of the late Lord Kelvin, Professor Watson's measuring instruments, and the evolution of the turbo-generator. The address was full of interesting and suggestive material, and might well be expanded into an extremely fascinating volume.

One Fluid, or Two Fluids?

During the last few decades, says the *Electrical World* in an editorial comment on a paper read by Professor F. E. Nipher before the Academy of Science at St. Louis, we have been so busy putting electricity to use that we have had but little time or ardour for arguing about its real essence. Nevertheless, during the last few years, the discoveries of Röntgen rays, of radium, and of radioactivity have revived interest in Franklin's one-fluid theory from an entirely new and unexpected standpoint. When a long Geissler tube lights up on the passage of an electrical discharge, it is found that the glow commences at the anode, or positive pole, and advances toward the cathode or over negative electrons to the anode. These negative electrons are exceedingly minute and lively little particles, and can move, under favourable conditions, with a prodigious speed. The denuded air-molecules around the anode are now left positively charged. They virtually act as an extension of the anode into the gaseous space. The negative electrons in the next surrounding layer of air-molecules jump into these positive molecules and hand over their charges. In this way the action goes on from layer to layer at great speed until a stream of negative electrons flows all through the tube from the cathode toward the anode. The hypothesis is that only the negative electrons move, always from the negative pole toward the positive pole, the positive particles being too big to move to any great extent, and merely acting as centres of attraction for the tiny negative electrons to alight upon. Inside a copper wire the action is supposed by the hypothesis to be essentially the same. In the normal unelectrified state all the copper molecules are substantially neutral. When an electric potential difference, or voltage, is applied to the ends of the copper wire the negative electrons at the positive pole jump out of the adjacent molecules, leaving them positively electrified. These, in their turn, attract more negative electrons out of the next layer of neutrals beyond, and so on, back to the negative pole, until there is a complete bucket brigade formed by the molecules, the buckets being the negative electrons and the firemen being the nearly stationary molecules, which pass negative electricity all along the line.

A Noteworthy Conversion.

A remarkable engineering feat has been successfully accomplished on the Washington, Baltimore and Annapolis Electric Railway, the system of operation having been converted in a single night from 600 volts single-phase alternating current to 1,200 volts direct current without the least interference with the running of trains or the occurrence of the slightest accident of any kind. The railway had hitherto had one of the largest single-phase installations in the United States, and the fact that the change was made in so remarkably short a period and without a single hitch is naturally regarded as a highly creditable achievement. The conversion was made, according to a statement issued by the company's engineer, because the 60-ton cars, equipped for the single-phase system, could not enter Washington, as, owing to the limited strength of the yokes which support the city tracks, the maximum weight of the cars was restricted to 40 tons. As the railway company desired to run to the heart of Washington, it was confronted there with the problem of securing a car of this weight equipped with motors of sufficient size to provide the high speed and particularly high-class service required by the character of its patronage, and investigation of the engineering features involved showed that it was impossible to meet these requirements with the existing single-phase equipment. The company then made an investigation into the relative merits of the two direct-current systems, and found that a large saving in first cost and operating expenses would result from the adoption of the 1,200-volt system in preference to the 600-volt.

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Results amply justified the anticipations of the company's electrical staff. During the first day of operation the cars ran over 4,500 car-miles, and not a trip of the regular schedule was lost. Moreover, a saving of over 25% in energy is indicated by the watt-hour meter records of the first few days. The apparatus, which included many new designs, was constructed, delivered and installed in the short period of eight months.

The New Equipment.

For operation at 1,200 volts, energy is purchased from the Potomac Power Company, and is received, as formerly, at the Bennings sub-station, where it is transmitted three-phase to the sub-stations at Ardmore, Naval Academy Junction, Annapolis and Baltimore at a potential of 33,000 volts and a frequency of 25 cycles. The transformer primaries are Y-connected and the neutral point is grounded. The transmission line is in duplicate, the conductors being aluminum wire. The switchboard equipment at the Bennings sub-station controls two transformer panels and two 33,000-volt, three-phase outgoing lines. With the exception of Annapolis, the sub-station equipments consist of duplicate sets of rotary converters, each set consisting of two 300 kw. machines operating in series to supply energy at a potential of 1,200 volts. The Naval Academy Junction sub-station also has a spare converter. The switchboards of the Ardmore, Naval Academy Junction and Baltimore sub-stations have two 33,000-volt incoming line panels, two 33,000-volt rotary converter and transformer panels, and two 1,200-volt feeder panels, making it possible to supply energy to the three sections of the trolley line from this sub-station. The Ardmore and Baltimore sub-stations have two 1,200-volt feeder panels each; the Annapolis sub-station has one panel of each kind. In addition, the Naval Academy Junction sub-station has one 33,000-volt outgoing panel for the line running to Annapolis. The Naval Academy Junction sub-station has one 600-volt feeder panel controlling the energy for the operation of the motors which drive the repair-shop tools. For the protection of the sub-station apparatus, 33,000-volt aluminium lightning arresters are being installed in the sub-stations, and each transmission line is protected by an overhead ground wire. The Cleveland Construction Company supervised the changes, and all the electrical apparatus was furnished and installed by the General Electric Company.

Using the Night Wires.

It is announced by the management of the Bell telephone and Western Union Telegraph alliance that a "night letter" of 50 words may be filed before midnight for transmission, and will be telegraphed to the objective point and delivered with the early mail the next morning. The charge is to be the same as for the usual ten-word telegram. A greater part of the vast telegraph system, crowded to capacity during the day, lies idle at night. At small addition expense these idle wires can be made to earn something, and also accommodate the public. The new telephone-telegraph organization regards these night messages as "by-products," capable of being handled at very low rates so long as no noticeable increase in fixed charges is incurred. Telephone offices everywhere are ever open for business, and any one wishing to send a telegram after the Western Union office is closed can dictate it to the telephone company, which will transmit it to the nearest all-night telegraph office for transmission to the point of destination

Central Station Load Factor.

An interesting corollary to the articles you published a few months ago on the subject of central station business is to be found in an editorial in the current number of the *Electrical World*. The writer discusses the reasons why even the largest and best administered central stations usually fail to get more than 10 to 20% of the available power business within their respective territories, and expresses the conviction that the reason sometimes cited —that the cost of power is too high—is not the real one, since in any ordinary city distribution, the central station "can on general economic principles furnish energy to manufactories, small and large, at a price almost always lower than the cost for which it can be locally produced at the factories." The conclusion is finally arrived at that the real source of the failure to obtain this business is "an inflexible system of selling which prevents quoting prices which will get the business at a profit"; and that, in short, a hide-bound system of rates loses much valuable business which could be taken on to the great benefit of the community served.

The Diversity Factor.

The chief point which the writer desires to make is not one in favour of special contracts, as such, but in favour of a classified industrial service taking into consideration the kind, as well as the amount, of load requirement which, it is urged, would render it possible to deal with the question of prices in a much freer way than is now possible under systems of rates which usually take no account of the relation of the customers to the diversity factor of the station. A mere quantity discount, with or without a maximum demand requirement, does not give the central station manager free enough hand in dealing with his various classes of service. His problem is to sell as much product as possible at a fair profit. If he is to succeed in a large way he must continually get more and more load, and should not tie his own hands by any system of rates which interferes seriously with his power of selling his product. A uniform flat rate per kw.-hour without discount is, from the standpoint of business-getting, probably the worst system imaginable. At the other end of the line, a free hand at special contracts is almost equally objectionable from the standpoint of the public. The attention of the rate-maker ought to be directed, not so much to securing a consistent and universal system of charging every customer on an academic theory as to planning one which will help the central station to dispose of its product on a large scale and at prices which will interest all classes of consumers.

Cost of Power.

As you have already shown in THE ELECTRICAL ENGINEER the subject thus opened up is one of wide importance to central station managers all over the world. It is fairly obvious that central stations, by adopting a little elasticity in this matter of rates, can almost always supply energy at a cheaper rate than a factory owner can generate it with his isolated plant, but as the writer of the article referred to is keen to point out, the owners of these small factories are works managers primarily and not engineers, and while they can fathom the details of manufacturing processes to the minutest detail, they are apt to balk at the simplest engineering problem. "Their function is to get every cent out of the business that is possible; they are not wedded to any particular prime mover or to any special system of distribution; whatever embodies elements of cheapness and reliability carries to them a strong appeal, and it is the work of the central-station manager to present electric power propositions in such form as to excite their interest." What seems to be needed is something in the way of electrical missionary effort; a simple, concise statement setting forth in plain language just what can be done, how to do it, what it will cost, and what economies it can produce.

Electric Railway Progress.

As a sequel to the doubling of the capacity of the Ohio Steel Casting Company's plant, and the possible building of still additional facilities, the Lima-street railway lines will be extended in a loop for more than two miles encircling the new industrial section of the city to the southward. The Alabama Aerial Tramway Company has been organised to supply short-distance transportation by means of an aerial cable. It is claimed that by reason of loop-sections the tension is equalised, and the cables kept taut at all times. The new road which the Shore Line Electric Railway Company is building between Essex and Stony Creek, the most ambitious trolley project now under construction in Connecticut, will be completed this spring. Practically all of the roadway, for a distance of nearly 40 miles, has been finished, except a stretch in the town of Guilford. Work remains to be done on several small bridges owing to the delayed arrival of materials. The poles have been set and the wires strung for long distances. The big power

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house on the shores of the Connecticut river at Saybrook has been completed. The route runs through a series of populous communities that are now isolated from trolley facilities. Shore Line cars will be run from Stony Creek into New Haven over the tracks of the Connecticut company.

Hydroelectric Projects.

At the new hydroelectric undertaking at 'High Falls' New York, preliminary work has started, and the plant will be constructed during the spring. A fall of 50 feet, with a possible 72 from the top of the dam to the power house, will be secured, and the large volume of water from the drainage of 350 square miles of territory will make it possible to develop 4,000 h.p. Machinery will be bought at once for 1,000 h.p., and more will be installed as needed. The company recently purchased the water rights of Samuel Coykendall at the falls, so it now controls all the power there. The Cleveland Cliffs Iron Company has begun the construction of a dam at the head of the falls on Au Train river, to develop electric power for the operation of the paper mill at Munising, Mich. The dam will be 20 ft. high, 140 ft. in length, and 24 ft. thick at the base. It is planned to begin work on the power plant as early in the spring as the weather will permit. This plant will be located a quarter of a mile below the dam. From the power house, the current will be transmitted to the Munising Paper Mill over a pole line, 13 miles in length, which will be built along the line of the Munising Railway. Au Train will be the second of the streams in this part of the upper peninsula to be harnessed for commercial or industrial purposes, the other being Dead River, a small part of which is utilised for the Marquette City Light and Power Plant.

The Licensing of Wiremen.

The president of the Buffalo Electrical Association makes the startling announcement that fires which have caused an enormous loss of life and have wrought damage to the extent of upwards of $40,000,000, have been caused by the defective wiring of buildings. "We are against anything which retards the electrical business," he says in a report to the Legislative Committee, "and defective wiring certainly does retard it. There is no danger in electricity when the wiring is properly installed," and he makes a powerful plea in support of a Bill introduced by Mr. Macgregor, which proposes to create a Commission whose business it will be to license men engaged in the electrical business. The Commission, it is proposed, should consist of one electrical engineer with seven years' experience, one journeyman wireman with seven years' experience, one representative of the State Board of Fire Underwriters, and two master electricians. The Commission has the power to conduct examinations and issue licenses, the fee for which shall be $50 with $5 a year for a license.

Electric Drive for Factories.

A noteworthy paper on the applicability of electrical power to industrial establishments was read a few days ago by Mr. Dugald Jackson at a joint meeting at Boston of the American Institution of Electrical Engineers and the American Society of Mechanical Engineers. Mr. Jackson laid stress on the fact that the operating economies of large steam turbine plants, either in respect to the use of labour or the use of fuel, do not seem to be exhausted within the limits of capacity yet attained in even the largest generating plants now in commission. Moreover, the first cost per kilowatt of capacity of plant, including land, buildings, and machinery, falls off in an important degree for the larger steam turbine plants, until such a plant may nearly rival a hydroelectric plant in the gross cost per kilowatt-hour of energy delivered at the switchboard, through the fact that the fuel cost pertaining to the steam turbine plant has an offset in the charges caused by larger first cost per kilowatt of capacity of hydraulic plant. These considerations, he pointed out, indicate that concentration of steam electric generating plants will afford considerable economies when the concentration is carried much further than heretofore, provided large steam turbines are utilised as prime movers. The ultimate economy cannot be reached in a single factory plant, even when it comprises several thousand horse-power and logical development leads beyond the present practice of concentrating the power units of each manufacturing establishment into an individual power plant. Economy and reliability in power service are both to be obtained by further concentrating such individual power plants located in a compact industrial centre into one or more great central stations, each of which provides power for a number of establishments.

The Load Factor.

Mr. Jackson went on to point out that the mill using 10% more power at the maximum than is required on the average, and operating 313 days of 24 hours each in the year, gives substantially 78% annual load factor based on an installation of a rated capacity equal to the maximum load. If the 10% by which the maximum load exceeds the average is expected to be carried by the margin in the capacity of the machinery over regular rating, as it properly may be in cases where the extra load only occurs for brief periods when the mill is cold after having been shut down, or for some similar reason the annual load factor of the machinery is substantially 86%. With a load factor like this, a large turbine station can generate electrical power at a remarkably economical rate. It is three times the load factor ordinarily pertaining to electric lighting stations. "Electrical distribution of power," he adds, "has made its way in factories of all kinds of product on account of its adaptability to diverse requirements. It has proved particularly advantageous on account of its ready adaptation to delivering power wherever and in whatever position the best interests of getting out product demands; on account of its joint properties of steadiness of speed and controllability of speed, which have contributed to increasing both the quantity and quality of product; on account of cleanliness, reliability, and safety, which have also strongly commended its use."

Electric Welding in Repair Shops.

The Philadelphia Rapid Transit Company has perfected a number of interesting welding processes with an electric arc. All grades of wrought iron and steel are successfully welded with the electric arc, and even malleable iron gear cases have been repaired with this process. Current at from 14 to 20 volts is used to form the arc. The carbon pencil is secured in a wooden handle, and is connected to the positive lead of the water rheostat which regulates the voltage. The piece to be repaired is mounted on a bench, and is connected to the negative side of the rheostat. By playing the point of the carbon pencil over the surface to be welded the metal is brought up quickly to a full welding heat, which is localised at the break. The weld is finished on an anvil by hammering until cold in the usual manner. A special flux is necessary to secure satisfactory welds with steel. Among the many uses to which electric welding is put in these shops may be mentioned butt welding of motor armature shafts and building up shafts which have worn down in the bearings. A worn shaft can be built up with metal welded on to a thickness of $\frac{1}{4}$ in. or $\frac{3}{8}$ in., at a total cost for welding and machining to correct diameter of not to exceed $2. To tear down an armature and insert a new shaft would cost from $35 to $50. In building up a shaft, small pieces of $\frac{1}{2}$ in. round steel bars, containing 0·20% carbon, are melted down on the shaft by the electric arc. The completed weld is not hammered, but it is claimed that the metal welded on in this manner is as homogeneous as the shaft itself, and has quite as good wearing qualities.

NATIONAL PHYSICAL LABORATORY.

At the invitation of the President of the Royal Society, chairman of the General Board of the Laboratory, a visit was made to the National Physical Laboratory, Bushey House, Bushey Park, to meet the Board and inspect the premises.

The institution is splendidly equipped both for research work and testing, not least so in the electrical departments. We were conducted over the premises and taken in hand at each stage by the officials responsible for the various sections. Thus in Rooms 17 and 19, devoted to General Electrical Measurements, Mr. Campbell and Mr. H. C.

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Booth were in charge. This department is equipped as follows:

Iron Testing.—Apparatus for testing the magnetic properties of iron, including wattmeter method for total power loss; electrically heated oven for ageing tests; also a bifilar galvanometer free from zero creep.

Measurements of Capacity and Inductance.—The apparatus for measuring electrical capacity and inductance at various frequencies included: Monochord interrupter for frequencies up to 500 ~ per second. Microphone hummer giving alternating current at high frequency (*e.g.*, 1,000, 2,000, 4,000 ~ per second). Moving coil vibration galvanometer, which can be readily tuned to any frequency from 50 to 1,000 ~ per second. Variable mutual inductance and bridge by which self and mutual inductances from 0·1 microhenry to 2,000 microhenries can be read off directly. Variable mutual inductance from 0·001 microhenry to 20 microhenries. Wien variable self inductance with many ranges (0·6 to 150 millihenries). Set of standard mutual and self inductances wound with highly stranded wire. Mutual inductance standard (of 10 millihenries) accurately calculated from the dimensions.

The standard air condensers of the British Association (total capacity about 0·05 mfd.), with rotating commutator and bridge for Maxwell's method of test are also available.

High Frequency Measurements.—Rotating mirror and camera for photographing high-frequency sparks (up to 2,000,000 per second). Standard wavemeter for frequencies from 100,000 up to 1,000,000 ~ per second. These are supplemented by ring transformer of high ratio (1 : 800) for measuring small alternating currents and voltages, and apparatus for high insulation tests.

The Electrical Standards Department is in charge of Mr. F. E. Smith. In Rooms 63 and 64 we found:

Mercury Standard of Resistance.—The standard glass tube is terminated with spherical glass vessels provided with current and potential leads. When filled with mercury the apparatus is immersed in melting ice without fear of leakage of water into the tube. The insulation resistance between the mercury and the surrounding ice is easily measured.

Resistance Bridges.—One of which showed the arrangement adopted for comparing coils from 1 to 10,000 ohms, and the other was a special form of Kelvin bridge for the comparison of coils from 1 to 0·0001 ohm.

Standard Resistance Coils.—The original coils of the British Association are marked, A, B, C, D, G, and H; these date from 1864. Other old coils are marked E, F, and Flat. These are, of course, of historical interest, only more modern coils, dating from 1888, are of platinum-silver, and quite modern coils of platinum-silver and of manganin are shown.

Standard Cells.—There are over 300 of these available, of which more than 250 are Weston cells. Special 4-limb vessels with 2 or more kinds of depolarisers illustrated the method of research.

In Room 19 we saw the British Association Ayrton-Jones Current Weigher recently constructed at the Laboratory for the accurate determination of current in absolute measure. The coils consist of single layers of bare copper wire wound in screw thread grooves cut in marble cylinders. To avoid uncertainty as to leakage between adjacent turns of a coil, double-threaded screw grooves are cut and these are wound with different wires. The mean diameters of the coils are known to a few thousandths of a millimetre and the mutual induction of the suspended and fixed coils has been accurately calculated. The current is led into each suspended system by 80 silver wires, 0·025 mm. in diameter. A most interesting exhibit was the Lorenz Apparatus presented by the Drapers' Co., in memory of the late Professor J. Viriamu Jones, F.R.S., and constructed at Elswick, by the kindness of Sir Andrew Noble. It was designed at the Laboratory for the direct measurement of a resistance of $\frac{1}{360}$th of an ohm.

The Electrotechnics Division is placed in a separate building. Here the party was met by Mr. Paterson, Mr. Melsom, Mr. Rayner, Mr. Kinnes, Mr. H. C. Booth and Mr. Hutt.

The Heavy Test Room is arranged for tests on heavier apparatus, such as machines, transformers, etc. It is fitted with main switchboard for direct current side of machines. Life test alternator. Westinghouse machine (for 100,000 volt transformer). Siemens double alternator, arranged so that the field of one machine can be rotated in relation to the other, so giving facilities for testing instruments and making measurements at any desired power factor. Board for alternating current distribution. High tension transformer control board. In an adjacent transformer house there is a 100,000 volt 20 kw. transformer. Also electrically heated oven for breakdowns up to 100,000 volts; voltmeter, resistance and switch for measuring up to 100,000 volts; and wattmeter for high tension measurements. Returning to the main room we saw instruments and equipments for accurate alternating current measurements, including electrostatic voltmeters and wattmeters. Also standard balances and water-cooled standard resistances. The reflecting voltmeters have scales 8 metres long. Besides these there are test stations and equipment for the calibration of alternating and direct current ammeters, voltmeters, supply meters, etc. Battery paralleling board and water-tube regulating resistances for 8,000 amps. Potentiometer and shunts for heavy current measurement. Switchboard for 300 volt battery. Switchboard and arrangements for accumulator testing. Megger with two ranges, 250 and 1,000 volts, for testing the insulation of instruments, etc.

A Resistance Room has been designed to meet the requirements of constancy of temperature for commercial resistance measurements. It is fitted with large bridge and standard coils for testing resistance boxes and coils; arrangements for testing primary batteries; Kelvin double bridge for conductivity tests; potentiometer set; shunt potentiometer method for verifying low resistances; cable tank and arrangements for high insulation tests; apparatus for verifying insulation sets, including liquid resistances up to 1,000 megohms, and water tube regulating resistance for 6,000 amps.

Photometry is dealt with on the first floor. On the landing there is a 100 and 300 volt photometry battery distribution boards.

The Standards Room is equipped with a 4-metre photometer bench; standard lamps; 18 ft. electrostatic voltmeter scale and general electrical measuring apparatus.

In the Large Photometer Room there is the Gas Referee's photoped for pentane lamp comparisons. Long photometer track for arc lamp tests and bench for testing pentane lamps. Returning to the ground floor we found provided for life tests on Glow lamps, distributing board with Tyrrill automatic voltage regulator for maintaining constant pressure on life test racks, and special lamp frames, adjusting and measuring apparatus, for testing lamps to the Engineering Standards Committee's Glow Lamp Specification. Also a 3-metre photometer bench with lamp spinner and measuring table for candle power measurements of lamps under life test.

The Battery Room is approached by an outside staircase, and is fitted with a 600 amp.-hour battery for heavy discharges in parallel at 6 volts. Battery for machine driving and two 300 volt batteries.

We have no space to deal with the Thermometry, Metrology, Engineering, Metallurgical and Metallurgical Chemistry, or Experimental Tank Departments. The visit was certainly most impressive. Considering the wonderful equipment and the trained staff available it is a source of wonderment that the facilities for making tests and controlling results of experiments made by inventors and manufacturers are not more generally recognised. For instance, the equipment for research work (contained in rooms 36, 58 and 59 of Bushey House proper) includes various types of gas and electric furnaces for the determination of melting points and of cooling curves, muffles and other furnaces for annealing and heat-treatment experiments being also provided. A Rosenhain quenching apparatus, in which small specimens are heated in vacuo and are quenched without being removed from the furnace or exposed to air or other gases is installed. The pyrometric appliances for taking direct and differential cooling curves include a complete potentiometer set with electric chronograph, and also an equipment for portable use.

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The microscopic equipment includes, apart from cutting' grinding and polishing arrangements, two Rosenhain metallurgical microscopes for visual observation and photography, a Zeiss stereoscopic binocular microscope for the examination of fractures, a Zeiss photo-micrographic projection bench with powerful arc lamp by Leitz, and a Zeiss apparatus for photo-micrography of metals by the aid of ultra-violet light, the source of light for the latter being a spark-gap between magnesium electrodes, excited by a large induction coil fed from the lighting mains through a Wehnelt interruptor and charging a battery of Leyden jars. This recognition, however, is coming gradually. Meanwhile Government Departments are making considerable use of the Laboratory for testing purposes.

ODDITIES OF GOVERNMENT SPECIFICATIONS.

That people who live in glass houses must not throw stones we are taught by proverbial philosophy. Being painfully aware of what our own Government officials are capable if once they put their minds to it, we cannot afford to laugh at the oddity displayed by Uncle Sam's worthy servants when they are preparing specifications for electrical appliances. We will, therefore, soberly enough quote a few remarkable, if those whom it most concerns would only take it to heart, illuminating examples of American Federal officials' activities in this direction, brought forward by Mr. C. F. Scott when addressing the students of the United States Army Engineer School at Washington.

Outstanding in its fantastic glory is the case where three bureaus were represented in the specifications for apparatus which was to be operated in conjunction, and in which controlling panels for various motors were to be installed in a single room or compartment. One of the bureaus specified a watertight control panel; another, a switchboard enclosed in a non-watertight sheet iron case, and the third entirely open panels. Three types of control apparatus were, therefore, to be installed in conjunction, in the same compartment.

On the investigation of the specification for standard rubber covered wire, it was found that the Navy Department's Bureau of Equipment had one specification, the Navy Department's Bureau of Yards and Docks another, the Library of Congress another, the Treasury Department another, the Quartermaster's Department another, and there were perhaps one or two other peculiar specifications. On looking over these specifications, they ran a complete line from the poorest competition wire which would comply with the National Board of Fire Underwriters' manufacturing specifications, to the most elaborate specifications for 36% Para rubber insulation; notwithstanding the fact that the wire was to be used under virtually identical conditions. In investigating this matter the question of wire for ship-board purposes was taken into consideration and it was found that with few exceptions, all specifications for wire could be embodied under a few general heads.

A further instance which has been cited in the same connection is with regard to motors. When the question of specifications for motors was looked into, it was found that the same variance takes place in the specifications. For example, the temperature requirements of a motor covered the entire line from operation at full-load for an hour with a rise of 75° F., to operation continuously for 24 hours at 25% overload with a considerably less rise of only 63° F. Such variance in the requirements for motors would apparently cause the manufacturer to make up special apparatus to comply with each specification.

As regards lamps, it was found that the Treasury Department had one specification; the Bureau of Yards and Docks of the Navy another; the Bureau of Equipment of the Navy a third; the Quartermaster's Department a fourth; the Library of Congress a fifth; the Government printing office a sixth; the Post Office Department a seventh, and the Bureau of Engraving and Printing an eighth. While nearly all of the lamps were substantially the same and there were but few unusual requirements, yet no two of these specifications agreed and great difficulty was experienced by the manufacturers in understanding just what type of lamps should be furnished under any one of them.

To cap all, and bring our strange tale of woe to an end, we will mention that case where a certain specification for a machine for a special service contained a clause the meaning of which was not clear. Literally, it either meant nothing or specified a physical impossibility. A more liberal interpretation indicated a desirable and proper characteristic. The designer took the common-sense interpretation and did what was practical and useful. The machine met its acceptance test satisfactorily, except that it did not literally comply with the impossible requirements. The inspector declined to accept the machine. The matter was investigated. It was found that the original writer of the specification did not know what the particular paragraph meant, but he had seen an attractive phrase somewhere and had incorporated it. The machine was finally accepted, but the conference between the inspector and his superiors had caused a delay in shipment and for this a penalty was incurred, which the manufacturing company had to pay.

Someone, with a proper sense of humility, ought to gather together a few of our own curiosities to present as a friendly offering to our long-suffering Transatlantic cousins.

TRADE NOTES.

The partnership between Mr. Henry Tinsley and Mr. Arthur Snell has been dissolved, Mr. Tinsley continuing in business at the same address, and will trade as "H. Tinsley & Co." Additions are being made to the works and laboratory equipment, and in the future Mr. Tinsley will specialise in his well-known cadmium cells, potentiometers and high-class measuring instruments, including Dr. Drysdale's polyphase wattmeters, alternate current potentiometer and phase-shifting transformer, for which a special one, two and three-phase machine is being installed.

Messrs. Siemens Bros. Dynamo Works, Ltd., have secured a large contract for the General Post Office for Tantalum lamps for all voltages from 25 to 250.

The Marconi International Marine Communication Co., Ltd., have received instructions from the Peninsular and Oriental Steam Navigation Co., to equip the s.s. *Arabia*, s.s. *Moldavia* and s.s. *Macedonia* with the Marconi system of wireless telegraphy.

Messrs. D. H. Bonnella & Son, Ltd., manufacturers of electrical and motor car accessories, announce that owing to increase of business their works will be removed on and after March 25 to larger and more convenient premises situated at Newton Works, Whitfield-place, Tottenham Court-road, W.

Messrs. Siemens Bros. Dynamo Works, Ltd., have secured the contract for the supply of "Tantalum" lamps for station and sign lighting on the Metropolitan Railway. It way be taken that the extraordinary strength of the lamps has largely accounted for their success in this department of railway work. This is only one of the many large contracts for "Tantalum" lamps and fittings secured recently, and, naturally, there is a lively anticipation that further contracts will follow, where it is desirable to obtain the strongest lamps on the market.

The contract for the supply of the whole of the compressors for the construction of the main sewer from Battersea to Deptford has been awarded by Messrs. Griffiths & Co., the main contractors, to Messrs. Reavell & Co., Ltd., of Ipswich. There are in all 24 compressors to be installed at the various shafts and to be electrically driven, some by single-phase motors through automatic clutches of Messrs. Reavell's construction, some by two-phase motors through gears, and some by continuous-current motors, which are directly coupled to the crank shafts of the compressors.

We are informed by Messrs. Electrical Installations, Ltd., of Bassishaw House, Basinghall-street, that they have no connection whatsoever with a firm of similar name, who called a meeting of their creditors in Manchester last week. We may add that this firm, owing to increase of business, are moving from Basinghall-street, and will, next week, be installed at 27, Martin's-lane, Cannon-street, E.C.

Messrs. L. Andrew & Co. have removed to their new warehouse, 2, Whitworth-street West, Deansgate, Manchester.

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Business Notes and News.

LIGHTING AND GENERAL—Home.

ALLOA.—The Borough Council have decided to cancel the agreement with the British Electric Plant Co. to light the town with electricity, paying compensation, and to erect their own electricity generating station on a site near the gas-works. Mr. W. Arthur Ker, of Glasgow, is the consulting engineer.

BELFAST.—The Harbour Board are considering a scheme for establishing a wireless telegraph station. This is partly the result of the Midland Railway Co. having fitted all their boats running to Belfast with wireless apparatus.

DOWLAIS.—A Board of Trade inquiry has been held with reference to the proposed electric lighting of Dowlais, objection having been raised by the Dowlais Chamber of Trade, and also by petitions against overhead wires. Mr. Dixon, engineer to the Merthyr Electric Traction Co., said that in the lower portion of Dowlais, electric cables had already been put down, which would be used for lighting purposes. The streets in which there would be overhead wires were 22 ft. wide. The company, he said, intended to strictly carry out the regulations of the Board of Trade with regard to the scheme. The inquiry then closed.

DUNDALK.—An inquiry has been held by Mr. P. C. Cowan, Local Government Inspector, into a number of applications for loans by the Dundalk Urban Council, including one for £20,000 for an electric lighting scheme.

LLANELLY.—The Llanelly and District Electric Light & Traction Co. have given formal notice to the Urban District Council that they will, within nine months, supply electricity to the town for public and street lighting under the terms of their agreement. It is hoped that the tramway will also be run by electricity.

LONDON.—The London County Council have approved the laying of mains by the following companies: City of London Electric Lighting Co., in Gravel-lane and Union-street, Southwark; County of London Electric Supply Co., in Rectory-grove, Larkhall-rise, and Manor-street, Wandsworth, Amwell and Margaret-street, Sedgmoor-place, South and Havil-street, Camberwell, and Southwark Bridge-road; London Electric Supply Corporation, in Goodwood-road, in Raymouth-road, Aspinden-road, Nelldale-road, Mossington-road, Abbeyfield-road, Hawkstone-road, Dartmouth-road, Westlake-road, Oldfield-road, St. Helena-road, Eugenia-road, Pedworth-road, Fawcett-road, Cornbury-road, Reculver-road, Alpine-road, Braston-road, Rotherhithe new-road, Suffolk-street, Reed-street, Canute-street, Silverlock-street, Tissington-street, Silwood-street and Luxford-street (and to construct inspection boxes), in Broadway, Deptford, and Church-street; the Metropolitan Electric Supply Co., in Warwick-avenue, Howley-place, Park Place-villas and St. Mary's-terrace; South Metropolitan Electric Light & Power Co., in Rushey-green and Brownhill-road; and St. Pancras Metropolitan Borough, in Augustus-street.

LYME REGIS.—Subject to the existing contract being extended for three years, the local Electric Lighting Co. have promised the Town Council to place the present overhead wires along the Parade underground.

MOHILL (Ireland).—A system of street lighting by electricity has been adopted. Mr. Robert Stewart, of Boyle, is the contractor.

NORWICH.—It has been decided to apply to the Local Government Board for powers to borrow £17,783 for extension of the electric mains, services, exhaust steam turbine with condenser, steam exhaust, water pipes, etc., centrifugal pump, coal elevator, feed water filter, and other plant. The electricity undertaking is a remunerative concern. Norwich has close upon £12,000 sunk in the wiring of working class dwellings, and it is claimed that the town has the highest percentage of working men's dwellings lit by electricity of any town in the United Kingdom.

SCARBOROUGH.—A project is on foot to erect a radio-telegraphic station on the Castle Hill, in connection with the Admiralty and the Board of Trade. This will make another link in the coast protection chain and will be of considerable use in connection with the fitting out of the North Sea fishing fleets with wireless apparatus.

SMETHWICK.—The Town Council have resolved to oppose the provisional order promoted by the Birmingham and Midland Tramways (Ltd.) transferring the Smethwick Electric-lighting Order to the Shropshire, Worcestershire and Staffordshire Electric Power Co.

SOUTHAMPTON.—It has been decided to change over 596 street gas lamps to electricity in the course of the year. Last year 433 street lamps were changed over from gas to electricity, to the great benefit of the municipal electricity department and the improvement of the street lighting.

SOUTHEND-ON-SEA.—Application is to be made to the Local Government Board for powers to borrow £1,000 for the purchase of a new form of bracket to be used in place of dwarf standards for street lighting by Osram lamps.

TAUNTON.—Osram lamps have been substituted on circuit No. 3 for old arc lamps, with satisfactory results. In connection with the lighting of two new houses the borough electrical engineer is utilising a kiosk on the side of the road instead of a pit (which would be liable to be flooded) for sheltering a transformer with high and low tension gear, at a cost of £34 5s.

TAVISTOCK.—The movement, originated by Mr. E. C. Spooner, for the adoption of electric lighting by the Urban District has fallen through. At a ratepayers' meeting it was resolved that the electric lighting of the town should be left to private enterprise. Mr. Spooner had obtained estimates from Messrs. Drake & Gorham.

TONBRIDGE.—On the advice of the Local Government Board the Urban Council have instructed Mr. Collins, of Norwich, to report on the proposal to instal electric pumping in connection with the sewage disposal scheme.

YARMOUTH.—The Borough Council have decided to convert all the street lamps from gas to electricity. There are 673 gas lamps still in use, 80 c.p. lamps are to be adopted, the change over will be completed in two years, and it is estimated that the saving will amount to £211 0s. 8d. The charge by the electricity department will be £3 per lamp, and when the complete change over is made the present price of three guineas for the existing 282 electric lamps will be reduced to the general level. Electric fans are to be installed in the News Room of the Central Library at a cost of £10.

WORCESTER.—It has been decided that the electricity department shall take over 44 street gas lamps and convert them to electricity. This work will be gradually extended to all the lamps on the tramway route.

LIGHTING AND GENERAL—Overseas.

AGRAM (Austria).—The municipal authorities have decided to enlarge the city electrical works by the addition of a 1,200 kw. steam turbine, new boilers with all accessories, electric conductors, etc., at a cost of 420,000 kronen (£17,500).

HAVANA.—The Cuban Legislature have authorised Señor Antonio Larrez to proceed with the installation of an electrical plant for lighting and power purposes at Bolondrón, Province of Matanzas, as soon as he shall have obtained the requisite powers from the municipal authorities of Bolondrón.

LUCKNOW.—As regards the concession for the supply of electrical energy or gas within the town of Lucknow for house and street lighting and other purposes, the Commercial Intelligence Branch of the Board of Trade are now informed that it has been decided that electricity shall be used. Detailed plans in this connection are in course of preparation.

PATZAU (Bohemia).—The municipal authorities have resolved to erect electrical works.

PETERBORO', QUEBEC.—The City Council propose spending $70,000 in developing the electric power at the waterworks dam.

TRACTION—Home.

DUBLIN.—Under the Tramways (Ireland) Acts the Dublin and Lucan Electric Railway Co. have given notice of application for an Order confirming and giving effect to a resolution of the company, duly and unanimously passed at an extraordinary general meeting of the company, duly summoned by notice and advertisement, and duly held on October 21, 1909; and authorising the Dublin and Lucan Electric Railway Co. (1) to take from the Dublin and Leixlip Electric Railway Co. (when duly incorporated under Order in Council) a lease or leases of the railways mentioned in said Order, for the purposes of working the same, as in the said Memorial mentioned; (2) in addition to the objects of the company already heretofore authorised, to carry on the business of an electric light and power company in all its branches, upon such terms and conditions, and particularly as in the said Memorial mentioned; (3) to apply to the Board of Trade for, and to obtain and execute all necessary Licenses, Provisional Orders and Statutory Powers under the Electric Lighting Acts, 1882 to 1909, subject as in the said memorial provided; (4) for the purposes of such additional objects, to issue, raise and use share capital and debenture stock of the company already authorised, but not yet issued or raised, or to create, issue and raise additional capital and debenture stock of the company; and (5) if required for the purposes of such order or orders, that the name of the Company shall be changed to the Dublin and Lucan Electric Railway and Lighting Co.

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EDINBURGH.—The Edinburgh South Side Merchants' Association have prepared a memorial for presentation to the Town Council with regard to electric tramway extensions to the suburbs, with special reference to East Preston-street, Dalkeith-road, Duddingston, and Portobello. The memorialists urge the Town Council to arrange for immediate consideration of the whole question. They state that electric tramways are essential to the development of the city; that it is imperative no time be lost in deciding upon these electric tramways for the suburbs, in order that there be no further necessity to extend cable lines, and that the latter, as it may seem desirable from time to time, can be linked to a suburban electric system, leaving for future consideration the gradual electrification of the whole city tramways; and that tramway extension is a commendable form of public expenditure, as it is calculated to prove a profit-earning investment when worked by the city.

SOUTHEND-ON-SEA.—The Council have under consideration an elaborate scheme for widening and improving the esplanade west of the pier. The scheme includes the laying of a tramway track between an avenue of trees. The estimated cost is £51,000.

YORK.—After inspection by Major Druit, of the Broad of Trade, the tramway extensions from Nessgate to Dringhouse and from Holgate-road to the railway bridge, have been thrown open to traffic.

TRACTION—Overseas.

ARGENTINE.—Work on the electric railway between Buenos Aires and La Plata (Otto Franke concession) will be commenced on April 15.

CONSTANTINOPLE.—An application has been lodged with the Turkish Minister of Public Works for a concession for the construction of an electric tramway in Beirut.

VALLADOLID. (Spain)—Permission has been granted to the "Sociedad Anónima Tranvías de Valladolid" to electrify its lines, and also to extend its service so as to include the carriage of merchandise.

COMPANIES' MEETINGS AND REPORTS.

GATESHEAD AND DISTRICT TRAMS.

In their report for the year to December 31 the directors of the Gateshead and District Tramways Co. recommend a dividend of 6 % and the transfer of £3,453 to depreciation and reserve account (making it £17,000), carrying forward £840.

CITY OF LONDON ELECTRIC LIGHTING.

Mr. J. B. Braithwaite, presiding, said that there had been no issue of capital since 1901, although since then they had laid out £231,000 on capital account, provided entirely out of revenue. During the year under review the expenditure on this account had been £58,940. They had paid for a large new unit of generating plant and the first portion of a large economiser, and were putting up new offices on the Bankside frontage. During the current year capital expenditure would also be considerable. They proposed to complete the new offices, to erect the second portion of the economiser and commence replacing old alternating current plant with Parson's turbines.

DIRECT SPANISH TELEGRAPH.

Presiding at the meeting of the company, the Marquess of Tweeddale said there had been £1,087 increase in traffic receipts during the year under review, due to general improvement in commercial traffic. Working expenses showed an increase of £402 as compared with 1908, principally due to higher salaries, while office expenses were £51 more owing to necessary alterations to the company's offices at Marseilles. Repairs and maintenance showed a decrease. The Bilbao cable had been twice interrupted during the year. On both occasions repairs had been promptly carried out, and the cost had been £3,215, which had been paid out of revenue. The value of the company's securities showed an increase. After carrying £50,000 to reserve, and the necessary amount to provide for redemption of first mortgage debentures, they were able to pay dividends of 4% on the ordinary and 10% on the preference stock.

SCARBOROUGH ELECTRIC SUPPLY.

At the annual meeting, Mr. Alderson Smith presided; those present including Mr. John Hall, J.P. (secretary), Mr. A. A. Campbell Swinton, Mr. F. G. Holden (resident engineer).

The Chairman, in moving the adoption of the report, which has already appeared, said that it was fairly satisfactory, as it recommended the payment of a dividend of 3%, though it was not what they would have liked. They had, however, to put up with what they could get. They had sold 1,787 more units during the past year, but had taken £352 less money. If that could not be explained it would be a serious matter, but it was because of the greatly increased use of the new metallic filament, and because of the transformers which people put in their houses. For instance, he had between 70 or 80 lights in his house, and whilst his electricity bill in 1907 was £28, last year it was only £14.

Mr. Swinton, in seconding, said that the outstanding feature of the report was that they had been able to pay the same dividend as last year, to carry the same sum forward, and to put double the amount to depreciation (£1,500 against £750). Proceeding, Mr. Swinton said that there were various methods of charging for electricity, and the directors proposed experimentally to put forward a new method which intending customers could use at their option. Instead of paying 6d. per unit (plus discount according to quantity used by adopting the Norwich system, proposed to be introduced, customers could be supplied with electricity on the same basis as water, at a fixed charge according to rateable value. The charge would be 15% of the rateable value, and, in addition, only 1½d. per unit for the electricity used, which could thus be used for all purposes at a much cheaper rate than gas. Anyone who wished to adopt that system could start with the next quarter.

The report was adopted, and Mr. Harold Ellis, son of the Right Hon. J. E. Ellis, M.P., was re-elected director, the Chairman remarking that Mr. Ellis was a very valuable member of the Board, being an expert in electricity.

LIVERPOOL DISTRICT LIGHTING.

The report for the year ending December 31 states that the supply of electricity continues to show satisfactory progress, an additional 2,197 lamps having been connected during the year. The total number of lamps connected to the supply at December 31 was 27,995. The electricity sold aggregates 368,825 units, as compared with 357,507 for 1908. When the reduced consumption of the new metallic filament lamps is taken into consideration this must be considered very satisfactory. The demand for electricity and the sales for the first two months of 1910 compare favourably with the sales for the corresponding period of 1909. The new boilers installed at the end of 1908 are proving very satisfactory in work, a saving of over £700 having been effected in the coal consumption for the year. While this exceptionally high standard may not be maintained as the boilers become older, there is no doubt that a very great economy has been secured through replacing the old Lancashire boilers by high-pressure water-tube boilers. The directors regret to say that the working expenses for the year have been increased by the interest paid to the bank on an overdraft, owing to the last issue of shares not having been fully applied for. The directors have decided to take up the balance of this issue. In order to meet this overdraft and to provide additional working capital debentures have been issued to the bank for £6,000 in six debentures of £1,000 each. An option has been arranged whereby any shareholder can have one or more of these debentures, which carry interest at the rate of 4½%, and are redeemable in 1913. To meet the convenience of the consumers, the premises in Brighton-road, Waterloo, are being altered, and very shortly an inquiry office and show-room will be opened, which it is hoped will meet the requirements of the district, and promote the well-being of the company. The profit for the year, together with the balance brought forward from 1908, after payment of the balance dividend for that year, leave an amount available of £3,448. Out of this an interim dividend has been paid at 4% per annum, £20 written off the cost of fitting up the offices in Tithebarn-street, a further £100 transferred to reserve fund, and £975 set aside for depreciation, leaving £1,238, out of which it is recommended that a dividend be declared for the half-year ending December 31 at 4% per annum, less tax.

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M. T. HENLEY'S TELEGRAPH WORKS.

Mr. Sydney Gedge, M.A. (chairman of the company), presided at the ordinary general meeting of W. T. Henley's Telegraph Works Co., Ltd. He said that the report and accounts for the year were so satisfactory that, though he had presided at 25 annual meetings of the company he had never felt greater certainty that they would be heartily welcomed. The directors recommend a dividend at the rate of 15% per annum, free of income-tax. The company had pursued the even tenour of its way, uninterrupted by disputes with the workmen or by accidents of any serious consequence. The result was that, although the managing director had often told the board of contracts on which there would be very little profit, they had, in a year which was not very good for the trade, managed to make more profit than in the year before, to declare the same dividend, to carry forward a larger balance, and to be as liberal as usual in the appropriations made for dilapidations, reserves, and so forth. After paying the dividend they would have a balance of some £200,000 over and above all liabilities; in other words, the whole of the ordinary share capital might be returned to the shareholders, were it not that it could be employed in the business much more to their advantage. The reserve under the cable-repairing contract, with regard to the Bahamas cable, now exceeded £8,000, and they had very good hope that at the end of the two years there would be a large balance to be divided equally between the company and the Government of Bahamas.

Mr. George Sutton, M.I.E.E. (managing director), said that perhaps the best feature of the year was the development and extension of the company's foreign and colonial trade. China, Japan, South America, India, and the British colonies had all contributed to this excellent balance-sheet. In Africa they had had the best year since, and perhaps before, the war, and in Australia they had had a record year. The one fly in the ointment was Canada, where they found it impossible to accept the conditions which were creeping into municipal contracts. A particular objection they had was to the condition which placed the company's reputation as contractors, and the contract money, entirely at the disposal of the engineer supervising the work, no arbitration being provided for. The increased profit shown in the accounts was due in great measure to their large stocks, which were made when a very low price ruled for india-rubber. They had been selling their old stock at increased prices, and had now to replace that rubber at higher prices. The whole of the profit made was not shown in the accounts, the board having made certain provisions in view of eventualities in the rubber market. The company, therefore, would not be hit very hard whatever happened in regard to the price of rubber. He was often asked how it was that, if there were such keen competition in the electrical industry, the company was able to pay 15% dividends on its capital. As a matter of fact they did not do so. Upon £350,000 they paid 4½%, upon the £200,000 in reserve they paid nothing, and upon £200,000 of ordinary shares they paid 15%, making just over 6% over all, which was not a very large return for an industrial company.

The resolution was then put to the meeting and unanimously adopted, and a dividend was declared as recommended by the board.

The Chairman said it would be remembered that a year ago a large shareholder suggested that a substantial recognition should be made by the company of the very valuable services which had been rendered by the managing director, Mr. Sutton, and the suggestion was taken up with enthusiasm. A committee was appointed to carry out the instructions of the company, and to lay out in the best manner the £1,000 voted for the purpose. Part of this was to be expended in obtaining a portrait of Mr. Sutton by an eminent artist, and a portion was directed to be spent upon a silver service of plate. With regard to the service of plate, they decided to leave that to be chosen by Mr. and Mrs. Sutton, and he thought when the shareholders saw the collection that had been chosen they would agree that the greatest taste had been displayed in its selection. The portrait had been painted by Sir Luke Fildes, and was a great success, and altogether there was every reason to be satisfied with the way in which the intentions of the company had been carried out. Mr. Sutton was now entering on his 30th year in the service of the company. He had not only deserved success, but had obtained it, and had devoted his life and energies to the interests of the company. He was glad to say they were not dropping their pilot, but that they had him still with them, and he hoped Mr. Sutton would long remain with them to take charge of their business.

The portrait was then unveiled and the service of plate uncovered, and the Chairman, in a few well-chosen words, made the formal presentation to Mr. Sutton.

Mr. Sutton, in a brief speech, thanked the meeting for the honour which had been conferred on him, and referred to the great help he had always received from the efficient and loyal staff which he had had under him. He specially mentioned Mr. Hatton, the works manager at North Woolwich. In conclusion, he expressed the desire that the portrait might be allowed to hang at the company's offices, where his work had been carried on.

The Chairman said the directors would gladly fall in with this view, and the proceedings then terminated, with a vote of thanks to the chairman for presiding.

COMPANIES REGISTERED.

Dawlish Electric Light & Power Co., Ltd.—£10,000, in £1 shares. Warren-cottage, The Warren, Starcross, Devon.

PUBLICATIONS.

"The Electrical Trades' Directory and Handbook, 1910" (28th year). London: "The Electrician" Printing & Publishing Co., Ltd. Price 15s. net.

This portly and well arranged book gains in importance every year, for it is not only kept up-to-date, but new features are introduced as demand arises. It is hardly necessary to give a lengthy notice of so well-known a book, but we may enumerate the various sections for the enlightenment of those who are not already acquainted with it. The "Handbook" portion comprises a collection of short articles and tables relating to electrical topics of special interest; a digest of law and cases relating to all aspects of the electrical industry; notes on the past year's events; data as to international telegraphs and telephones; information relating to electrical companies; alphabetically arranged telegraphic addresses of British electrical firms. The "Directory" is divided into alphabetical sections, classified trades, and special sections for the Colonies, Continents of Europe, Asia and Africa, Central and South America and the United States. There is also a section of biographies and another of obituaries. A fold-up inset gives "Tables of the Electric Lighting, Power and Traction Undertakings of the United Kingdom," with some particulars of the chief colonial and foreign undertakings.

"The British and Foreign Guide to the Engineering, Steel and Hardware Trades." London: Adolphe Francis, Ltd.

This is a comprehensive directory, the names of firms being arranged alphabetically under classified headings of trades. It is divided into two parts. Part I. relates to machinery, metals, minerals, general hardware and railway plant and materials. Part II. is concerned with electricity, telegraphy and galvanism. It is well printed and handy for reference.

Journal of the Institution of Electrical Engineers, February, 1910.

This part contains the inaugural address of Dr. Gisbert Kapp and addresses of the chairmen of the different local sections, and the following papers: "Present Aspect of Electric Lighting," by Handcock and Dykes; "Low Tension Fuses," by Maccall; "Flicker Photometer for Coloured Lights," by Morris-Airey; "Metallic Filament Lamps," by Lavender; "Stator and Rotor Circuits of the Single-Phase Induction Motor," by Smith; "Variable Wave Forms," by Wild; "Experimental Determination of the Moment of Inertia of a Continuous-current Armature," by Dr. Kapp.

"The Aeroplane Portfolio." London: Percival Marshall & Co. Price 1s. net.

This attractively got-up portfolio contains nine sheets giving scale drawings of aeroplanes by Farman, Voisin, Santos Dumont, Wright, Curtiss, Cody, Bleriot, Antoinette,

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and Rep. The portfolio also contains a small pamphlet giving a description of the machines. It is a publication that seems to fill a need just now, when most people are either dreaming, thinking or talking in terms of aeronautics.

REVIEWS.

"The Conflict in Wales": Being No. 1 of Coal Trade Pamphlets. (London: *The Colliery Guardian*. Price 1d.)

Our contemporary, recognising the far-reaching effects of the present unrest in the colliery world, has been publishing a series of authoritative articles on the coal position, and these articles are being issued in handy little pamphlets for wide distribution. The present one deals with the Welsh trouble, and treats the whole question with fair impartiality. Pamphlet No. 2 is concerned with the "Multiple Shift-system of Working in Northumberland and Durham," and is from the pen of Mr. H. F. Bulman. Other pamphlets to follow shortly will deal with "The Small Coal Question," "The Treatment of Pit Ponies," and other subjects.

FINANCIAL NOTES.

The Metropolitan Electric Tramways, Ltd., have issued £250,000 worth of 5% stock at 91%. The proceeds of the issue will be applied to the discharge of temporary loans, the provision of additional rolling stock, the equipment of the remainder of the authorised light railways and the general purposes of the company.

An exhaustive interim report has been issued by the Rio de Janeiro Tramway, Light & Power Co., dealing at length with the position and prospects of the undertaking. It is stated that the new concession to the Rio Gas Co. has been finally approved, and the work of reconstruction and erecting new plant is being pushed forward vigorously. The completion of the new works will result in more economical working and augment the receipts. The work of reconstructing and electrifying the company's tramways is now approaching completion and the company has strengthened its position by acquiring a dominant interest in the share capital of the Jardin Botanico Tramway Co. To provide funds for these works and for other extensions and developments of the company's property the board have made a further issue of 62,500 shares.

The issue of the prospectus of the Lobito, Benguella and Catumbella Electric Light & Power Co., Ltd., (whose capital was, we understand, over-subscribed), possesses considerable interests. This company, with a capital of £200,000, was formed to acquire concessions granted by the municipalities of Benguella and Catumbella for the supply of electricity for illumination and power to these towns, including the port of Lobito, Portuguese South-West Africa. The concessions amount to a monopoly for ninety-nine years. The company also secures the right to use the waterfall on Catumbella River in perpetuity at a nominal rental. The towns mentioned are 300 years old and are the chief towns in the Province of Benguella, Angola Colony, Portuguese South-West Africa, which has a population of 4,000,000. The estimated net profit of the company on present supplies alone is £19,965 a year, which would pay the debenture stock interest four times over or be adequate to provide a dividend of 15% on the shares now offered.

Another promising issue was that of the £250,000 five per cent first mortgage debentures at 9½%, of the Vera Cruz Electric Light, Power & Traction, Ltd. This one of Sir Weetman Pearson's company. It has a capital of £350,000 in £1 shares, and authorised debenture issue of £300,000. It was formed in 1906 to acquire the business of the Lighting Co. of Vera Cruz (a Mexican company), in the Republic of Mexico. In 1907 the company also purchased the city tramway system, which was then carried on with mule traction. Since then the company has laid underground cables in the principal streets of the city, has rebuilt and extended the transmission lines, and has constructed a new electric tramway system 10½ kilometres long, with new cars and full equipment. A power-house has been erected and equipped, it is stated, with six Diesel oil engines (aggregating 2,850 h.p.) and the most modern electrical plant.

DEVELOPMENT OF TEMPERATURE.*

By S. FIELD, A.R.C.Sc.

This paper gave a brief review of the various methods of producing high temperatures and incidentally referred to a number of important applications, especially those of engineering interest. The conversion of the latent energy of coal to the kinetic energy of the prime mover, was a process in which high temperature was necessary, and all the methods in common use for coal saving and smoke prevention were in essence, methods for ensuring more complete combustion and developing higher temperatures. The chief constituents of coal, viz., carbon and hydrogen, were compared as regards their capacity for generating heat and developing temperature. Hydrogen with its calorific power of 34,200 (calories per gram) is under ideal conditions incapable of developing as high a temperature as carbon with its calorific power of only 8,080 (cals. per gram). This is due to the large amount of product formed by hydrogen (one gram of hydrogen producing 9 grams of water), and the high specific heat of that product (Sp. Ht. steam = ·48), whereas the smaller amount of product from carbon (one gram carbon produces 3·66 grams carbonic acid gas), has also a much lower specific heat (·22). The maximum temperature of a coal or coke fire was limited to 1,700° C. or thereabouts.

Passing to the oxyhydrogen flame it was pointed out that the high temperature here produced was in part due to the ease of mixing in correct proportion for complete combustion, the combustible and supporter of combustion. But the temperature of this flame was far below that which might be anticipated, and the important limiting factor was that of dissociation. Steam begins to dissociate at about 2,500° C. or even less, and thus the rate of combustion is limited at the high temperature, and the flame contains appreciable amounts of the uncombined gases. Applications of the oxyhydrogen flame, such as lime-light, platinum melting and welding, the production of quartz fibres and silica ware, and more recently prepared artificial rubies, were referred to. The oxy-coal gas flame with its temperature of over 3,000° C. is now considerably used for metal cutting, special burners having been designed for this purpose, and has become of great value in engineering problems.

The high temperature of the oxy-acetylene flame was in part due to the eudo thermic character of acetylene.

Passing to still higher temperatures, the "thermit" reaction was next discussed. Highly positive metals like aluminium and magnesium evolve a considerable amount of heat on burning to oxides. In order to develop high temperatures the oxygen can be supplied in the form of an oxide of a less positive metal, such as iron. No volatile products are formed and heat to the extent of about 3,500 calories per gram of aluminium used is evolved. Iron and alumina are thus obtained at a very high temperature approximating 3,000° C. Considerable use has been made of this reaction for welding purposes, and, in similar reactions, metals ordinarily obtained with great difficulty, are readily produced free from carbon. The electric furnace was next briefly described with its wide range of temperature up to 3,500° C.—this limit being the volatilisation point of carbon under ordinary pressures. A number of interesting applications were referred to, and brief mention was made of the success achieved by Moissan in many high temperature reactions, notably that of the crystallisation of carbon.

It was further stated that temperatures even exceeding that of the carbon arc, may be attained by an arc in air such as is now commonly used in the production of nitric acid from the atmosphere, and finally, mention was made of the high temperature—probably about 5,000° C., which was obtained in Sir Andrew Noble's experiments on the explosion of cordite in closed vessels.

OBITUARY.

We regret to record the death of Mr. John Lancaster, borough tramway manager, of Blackpool.

*Abstract of paper to be read before the Northampton Institute Engineering Society, Friday, March 18.

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PATENTS.

Contact Breaker for Magneto Electric Sparking Apparatus for Internal Combustion Engines.

4030.—1909. Unterberg & Helmle, Durlach, nr. Karlsruhe. This improvement is in interrupters for electrical ignition apparatus in which a lever moving at right angles to the plane of rotation carries one contact and is pressed by a bent leaf spring towards the fixed contact. Fig. 1 is a section on the line A—A of Fig. 2; Figs. 2 and 3 show sections on the lines B—B and C—C of Fig. 1. The contact breaker spring *a* which itself gives in the direction of the axis is bent over at a^{11} and the part a^1 which is parallel to *a* is secured upon the central boss of the device. The part *a* is formed as an annulus so as to increase the leverage of its action on the contact support. This contact-support *c* carrying the movable interrupter contact *b*, is secured to a pin *e* loosely mounted on the rigid plate *d* on the opposite side to the fixed

Fig. 1.

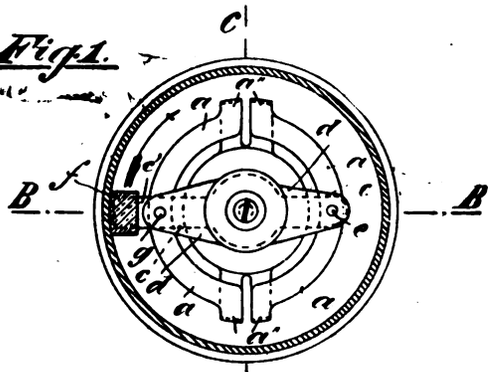


Fig. 2.

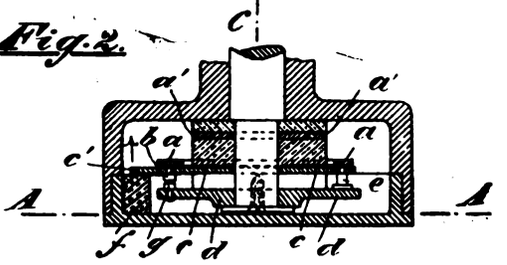
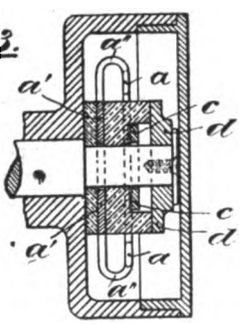


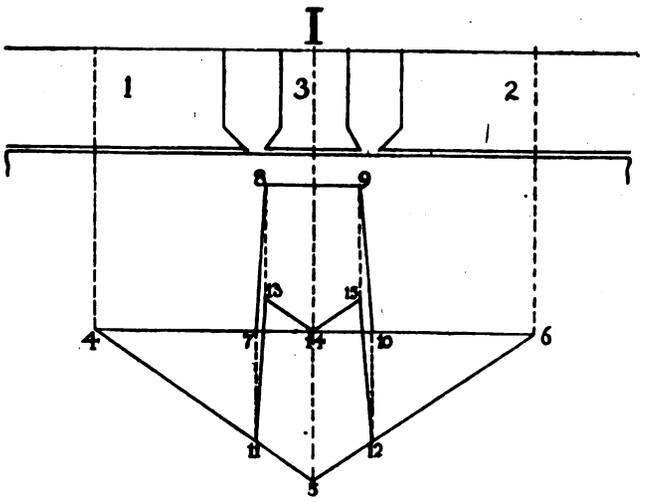
Fig. 3.

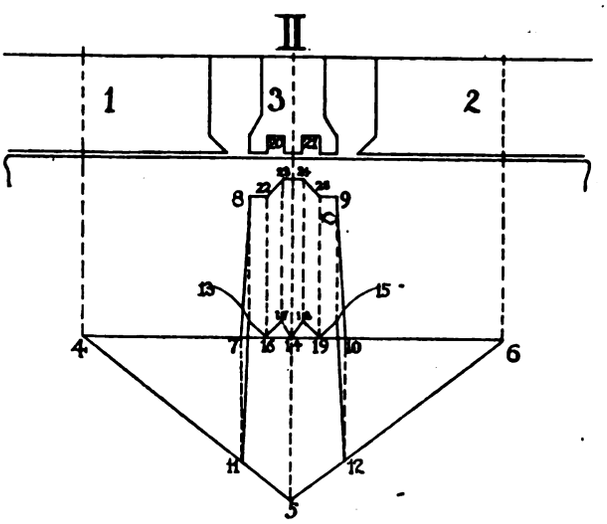


contact *g*, so that the whole lever with the pin can oscillate slightly in the mounting of the latter. The lever *c* has an extension c^1 suitably curved to engage with the fixed projection *f*. The shaft carrying the central boss, with the spring *a* and lever *c*, rotates in the direction of the arrow shown in Fig. 1. The lever extension c^1 strikes against the projection *f* (see Fig. 2) the stress in the plane of rotation being taken up by bending chiefly at a^{11}, while the motion which separates the contacts is obtained by the bending of *a*. When the extension c^1 is released, the spring returns the lever to its original position It will be clear that in order to obtain the required resilience the direction of the bend in the leaf spring must be parallel, and not as in earlier constructions at right angles to the direction of movement of the contact lever at the time of breaking contact.

Continuous Current Dynamo Electric Machines.

4374.—1909. W. Buchanan, Wolverhampton. This is an improvement in current dynamo electric machines of the type in which commutating poles are placed between the two main poles and consists more particularly in the shaping and winding of commutating poles, the effect being that a practically uniform commutating field is obtained. Fig. I. is a diagram showing the magnetic flux density under the commutating pole face in the case of a commutating pole as usually constructed, and Fig. II. is a similar diagram in the case of a commutating pole constructed in accordance with this invention. In Fig. I., 1 and 2 represent main poles and 3 a commutating pole between them. The curve 4, 5, 6 represents the armature magneto-motive force and the curve 7, 8, 9, 10 the magneto-motive force due to the commutating pole winding, the leakage being deducted. The magneto-motive force which results is therefore given by the curve 4, 11, 13, 14, 15, 12, 6 and this cruve may also represent the magnetic flux density under the commutating pole face. The effect of the flux from the main poles on the commutating pole is slight. For example, in the case of a generator rotating counter-clockwise the point 13 would be slightly higher and the point 15 slightly lower. In Fig II. the magneto-motive forces of the armature and commutating pole are shown as before. In this case, however, the





ordinates 8, 9 are reduced so as nearly to neutralise the corresponding ordinates of the curve 4, 5, 6 and the winding in the slots 20, 21 adds the magneto-motive force represented by the curve 22, 23, 24, 25 where the ordinates at 23 and 24 are approximately equal to the ordinate 14, 5 of the curve 4, 5, 6. The resultant curve 4, 11, 13, 16, 17, 14, 18, 19, 15, 12, 6 shows that the magnetic field under the commutating pole face is much more uniform than in the case of the corresponding curve 4, 11, 13, 14, 15, 12, 6 of Fig. I. Some modifications are described in the patent.

Slow Motion Device for Operating Switches.

7053.—1909. F. J. Moffett, Birmingham. This is an improvement in operating motor starters, controllers, and other electric switches having two or more positions, of the type by which a slow step by step motion is imparted to the contact arm with a definite pause at each position of the arm between the "off" and "full on" positions, thus preventing the resistances being cut out too quickly. The principal object is to provide an improved operating device, simple in construction but reliable in operation, allowing the contact arm to be moved quickly from one position to the next. Fig. 1 represents a sectional elevation of a slow motion device for a motor starter constructed in accordance with this invention, showing, by dotted lines, the raised position of the rocking member and also the various positions occupied by the operating arm; Fig. 2 is a vertical section through the apparatus. The device is enclosed in a metal case A attached to the case of the motor starter by means of the four lugs B. The spindle C is an extension of the worm shaft of the starter through the medium of which the contact arm is moved through the necessary angle. D is a crank rigidly secured to the spindle C and having at the end a roller E working on a pin F. On the front end of spindle C, and keyed to it outside the case A, is a cranked handle G. H is a pin fixed in the back of the case A; on it is pivoted the cam I provided with an inwardly projecting part. The cam has a continual upward pressure exerted upon it by the spring J, the back end of which bears against the case A.

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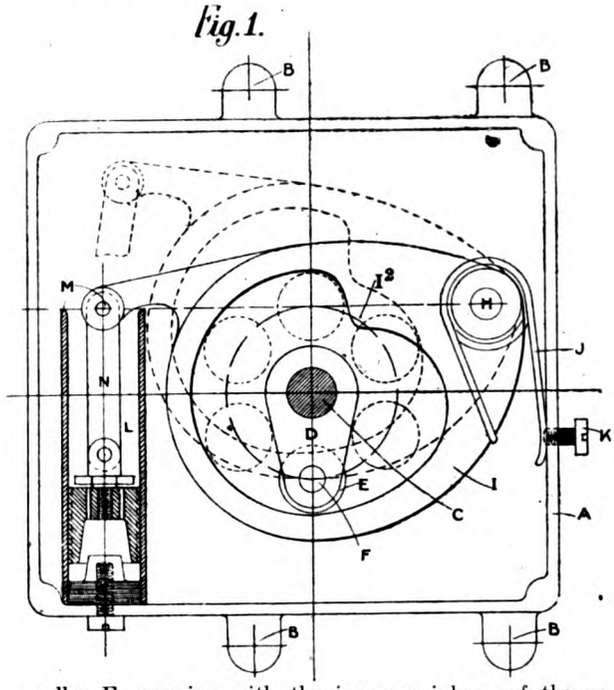
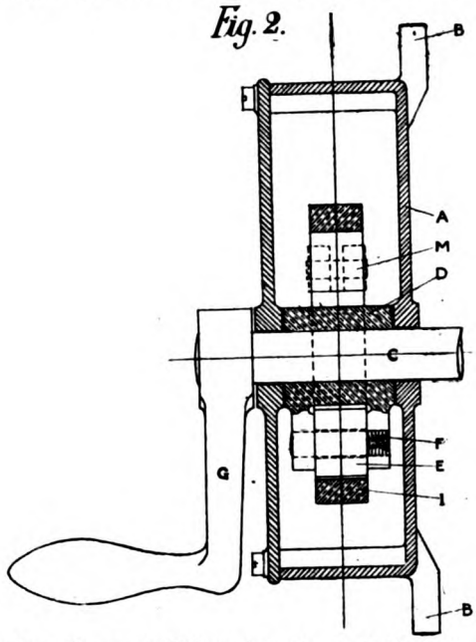
An extension of the cam is connected to a dashpot plunger L by a pin M and the connecting rod N. When applied to a worm motion starter as above referred to the pitch of the worm is so made that one complete revolution of the handle will cause the starter arm to move from one contact to the next. The handle G is rotated in a clockwise direction the

Fig. 1.



roller E engaging with the inner periphery of the cam member I, depressing this and also the dashpot plunger L. The crank D and outside handle continue to revolve until they can go no further owing to the roller E coming in contact with the projecting portion of the cam. The handle can be turned no further until the dashpot allows the cam to rise. When the dashpot has allowed the cam to assume its highest position, as shown by the dotted lines in the

Fig. 2.



drawing, the crank D keyed to the shaft C can be rotated, but as it approaches its lowest position it again depresses the cam and the piston of the dashpot. The cycle of operations is thus repeated until the starter arm has reached the full running position. The period of time during which the handle is detained can be altered at will either by adjusting a small valve in the piston of the dashpot or by altering the tension of the spring J by means of the set screw K.

Combination Coupling for Electric Conductors.

24771.—1909. L. M. Waterhouse, Hampton Wick. This is an improved adapter to be used to couple a two pin plug to a wall plug or to a lampholder. The contacts and the corresponding tubular sockets are made in the form of cylindrical plugs and fit in through a hole in the adapter. One end of the plug has an eccentric cylindrical recess to take the pin, and the other end of the plug forms the contact for the plunger of the lamp-holder.

Regenerators for Electro Zincing.

11842.—1909. S. O. Cowper Coles, Westminster. This regenerator comprises two upright casings connected at the lower end by a curved section. One of the upright passages is lower than the other, and serves as an inlet for the electrolyte. The other passage serves as a discharge for the regenerated electrolyte, the precipitate in which is deposited in the curved bottom section.

Conduit Fittings for Electrical Purposes.

24892.—1909. A. Brampton, Birmingham. In conduit fittings made from sheet metal the lugs are pressed up to form a neck to receive the securing screw.

Electric Switches.

12335.—1909. W. D. R. MacDiarmid, Ottawa. This switch comprises in combination, a base, a central post thereon, a depressible member slidably mounted on the post, means for preventing rotation of the depressible member, a tubular connecting member rotatably mounted on the post, connecting means extending between the depressible member and the connecting member, whereby the depression and raising of the depressing member oscillates the connecting member, mounted on the post, and means for communicating the movement of the connecting member in one direction only to the rotary contact member.

Distributing Box for Underground Cables.

13129.—1909. R. Monnier, Paris. The connecting rods and clamps are fixed in one plane and electrically connected together by the bridge pieces. All the various parts are interchangeable for the purposes of easy manipulation, inspection or repairs.

Brush Holders for Dynamo Electric Machines.

12774.—1909. M. A. McLean, Stretford. This improved brush holder consists of few parts, and is so arranged that it occupies very little space in a circumferential direction around the commutator. This is particularly desirable in machines having a large number of poles and comparatively little commutator space.

Electric Arc Lamps.

14165.—1909. O. Millauro, London, W. The object is to enable the arc, on being struck by closing an electric circuit, to attain in a minimum period and with a minimum degree of fluctuation, a stable condition, and maintain a condition of uniformity whilst the electric current undergoes considerable fluctuations. For this purpose the position of the movable carbons are automatically adjusted by a lever mounted on the core of a solenoid and pivoted to the movable element of a dashpot pair operating as a crosshead to adjust the position of the dashpot element to the normal strength of the current. The axes of the carbons are arranged to intersect each other.

Electrical Heating Apparatus.

17353.—1909. A. F. Berry, Ealing. The apparatus is for use with alternating electric current. A magnetic core with primary and secondary winding is supported within a casing and the secondary wind has its ends connected to extensions that are connected to air heating elements arranged to be heated by the passage of secondary current and are also connected to other air heating elements arranged to transmit heat by conduction from the extensions to the surrounding air and prevent the transmission of heat to the ends of the secondary winding. The arrangement is such that when the apparatus is in action air will flow through the casing and come into effective contact with the heating elements so as to be quickly heated.

Positive Electrodes.

8195.—1909. Nya Ackumulator Aktiebolaget, Fliseryd. The positive electrode for alkaline accumulators consists of a mixture of nickel hydrate, with finely granulated natural graphite and cadmium oxide as a conducting substance.

Fixing Electric Conductor Wires to Insulators.

13786.—1909. C. Linke, Strassburg. The fixing is effected by means of a bending device arranged upon the wire and embracing it in such manner that by rotating the spanner the bent ends of the wire bow piece disposed upon the insulator head are bent around the stretched conductor wire.

Electric Switches.

22896.—1909. A. P. Lundley, Islington. This combined switch and wall connection has a spring so arranged that it holds the movable switch member in the off position, and is also so disposed that it can be influenced by the plug part of the wall connection, and when so influenced permits of the ordinary working of the movable switch member.

Electric Signalling for Fire Alarms.

24185.—1909. Siemens & Halske, A.G., Berlin. When the call receiver is set in action it starts the generator of the alternating current for the alarm receiver. This alternating current is then, like the continuous current for the call-receiver, periodically interrupted by the interrupter of the transmitter.

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TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns per week.			Increase or decrease.		Miles of track open.		Accounts for past year.						Cost per car mile.
	Ending	1909-10.	1908-9.	Week.	Current year.	1909.	1908.	Ending	Total receipts.	Passengers carried.	Car miles run.	Receipts per Passenger.	Receipts per Car mile.	Receipts per Mile of track.	
		£	£	£	£				£						
Aberdeen Corporation	Mar. 16	1,199	1,132	+ 67	— 636	27½	27½	May 31	71,930	17,517,304	1,566,119	·98	11·02	4,940	5·93
Ayr Corporation	Sept. 18	671	562	+ 108	—	8	8	—	—	—	—	—	—	—	—
Baker Street and Waterloo Ry.	Nov.	8,141	6,070	+2,071	—	4·25	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	Mar. 13	995	939	+ 56	+ 286	24·003	13·52	—	—	—	—	—	—	—	—
Birmingham Corporation	Mar. 12	6,796	6,315	+ 481	—	56·792	58·52	—	—	—	—	—	—	—	—
Blackburn Corporation	Oct. 6	1,100	1,293	— 173	—1,036	24·53	28·3	—	—	—	—	—	—	—	—
Blackpool Corporation	Aug. 26	2,152	2,050	+ 102	+ 732	—	—	—	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams	„ 8	2,304	2,309	— 24	—	—	—	—	—	—	—	—	—	—	—
Bolton Corporation	Oct. 10	2,416	2,337	+ 79	— 259	42	42	Mar. 31	117,799	25,492,902	2,492,147	1·1	11·34	2,804	6·50
Bournemouth Corporation	July 21	1,681	1,723	— 42	— 23	29½	29½	„ 31	86,225	13,991,328	1,766,068	1·47	11·71	2,912	7·22
Bradford Corporation	Mar. 12	4,630	3,958	+ 672	+ 11,185	98	54·81	„ 31	235,258	47,839,569	5,331,007	1·17	10·59	2,378	—
Brighton Corporation	Mar. 13	787	632	+ 155	+ 2,644	9·5	—	—	—	—	—	—	—	—	—
Bristol Tramway Company	Mar. 18	5,090	4,529	+ 561	—	57	51½	Dec. 31	265,362	46,652,389	5,756,842	—	—	—	—
Burnley Corporation	Mar. 12	1,179	1,069	+ 110	—	19½	19½	Mar. 31	64,261	12,355,958	1,202,330	1·23	12·83	5,971	7·92
Burton Corporation	Mar. 13	246	230	+ 16	— 22	6½	6½	„ 31	14,918	3,221,595	430,913	1·04	8·30	1,460	6·65
Cardiff Corporation	April 3	2,000	1,957	+ 43	—	—	—	„ 31	109,979	25,058,146	2,497,169	—	10·57	—	—
Carlisle Tramways Company	June 19	170	175	— 5	— 89	—	—	—	—	—	—	—	—	—	—
Central London Railway	Mar. 12	5,693	5,541	+ 152	— 407	6·32	6·32	Dec. 31	350,150	41,898,373	1,456,781	2·01	5·769	55,404	30·27a
Charing X, Euston, & Hamp. Ry.	Nov.	6,822	6,092	+ 730	—	7·75	—	—	—	—	—	—	—	—	—
City and South London Railway	Mar. 13	3,307	3,373	— 66	— 701	7·26	7·26	—	—	—	—	—	—	—	—
Colchester Corporation	July 14	200	219	— 39	—	8	—	Mar. 31	10,983	2,308,721	349,539	1·09	7·74	1,477	6·44
Cork E. T. and L. Company	Mar. 17	479	416	+ 63	+ 239	9·89	9·89	Dec. 31	24,044	5,737,478	896,945	—	6·48	—	6·43
Croydon Corporation	Mar. 4	1,607	1,551	+ 56	+ 9,090	11½	—	Mar. 31	74,132	16,277,418	1,884,187	1·06	9·56	3,703	7·169
Darwen Corporation	Oct. 1	239	256	— 17	— 201	7·23	7·23	„ 31	13,899	2,557,654	245,584	1·30	13·68	1,922	9·40
Dover Corporation	Sept. 18	230	252	— 22	— 395	7	—	„ 31	11,593	2,697,672	316,754	·98	8·78	—	—
Dublin and Lucan Electric Ry.	Mar. 18	131	111	+ 20	— 26	7	7	—	—	—	—	—	—	—	—
Dublin U.T.	Mar. 11	4,983	4,450	+ 532	+ 1,976	54½	54½	—	—	—	—	—	—	—	—
Dundee City Tramways	Oct. 6	1,332	1,305	— 27	— 569	—	26½	May 15	60,573	16,367,911	1,281,552	·875	1·9	2,371	7·46
East Ham Corporation	Mar. 12	974	866	+ 108	+ 5,763	15	15	Mar. 31	47,430	15,355,703	1,091,586	·73	10·26	—	6·99
Glasgow Corporation	Mar. 12	17,633	15,730	+1,903	— 1,966	189	185	May 31	907,494	226,948,290	20,766,722	·96	10·49	5,060	5·69
Gloucester Corporation	Oct. 6	395	425	— 30	+ 535	15	—	—	—	—	—	—	—	—	—
G.N., Piccadilly and Brompton	Nov.	13,429	9,354	+4,075	—	9·25	—	—	—	—	—	—	—	—	—
Halifax Corporation	—	—	—	—	—	52·574	37	Mar. 31	81,872	20,378,672	1,786,390	11·40	11·13	1,528	8·10
Huddersfield Corporation	Dec. 4	1,613	1,357	+ 256	+ 2,663	28	28½	„ 31	84,704	16,200,020	1,960,329	1·29	10·37	2,421	5·19
Hull Corporation	Mar. 12	2,743	2,403	+ 339	+ 7,354	29	26	„ 31	128,722	30,964,254	3,022,844	1·	10·22	—	6·94
Ilford Corporation	Feb. 12	451	391	+ 60	+ 1,969	10	10½	„ 31	25,328	6,385,466	634,446	·87	9·58	2,066	6·42
Ilkeston Corporation	Mar. 16	114	119	— 5	— 287	4	4	„ 31	7,214	1,968,850	198,415	9·1	7·9	1,803	7·04
Kirkcaldy Corporation	Sept. 8	259	266	— 7	—	7½	7½	May 15	14,993	4,874,199	459,066	·711	7·838	1,856	5·29
Lancashire United Tramways	Mar. 16	1,204	1,140	+ 64	+ 295	39	39	Dec. 31	68,904	12,554,593	2,244,344	—	—	—	—
Leeds Corporation	Sept. 18	6,896	6,624	+ 272	+ 3,662	108	96½	Mar. 31	340,368	75,734,083	7,694,989	1·06	10·62	3,527	6·61
Leicester Corporation	Sept. 11	2,162	2,130	+ 32	—	—	—	—	—	—	—	—	—	—	—
Liverpool Corporation	Nov. 6	10,803	10,687	+ 116	— 1,977	109	104	Dec. 31	572,822	124,043,239	12,231,799	1·108	11·24	5,508	7·94
Liverpool Overhead Railway	Mar 13	1,304	1,230	+ 74	— 115	6·65	2·40	June 30	79,004	11,171,515	1,106,386	—	—	—	—
London County Council	Mar. 5	39,961	28,125	+11,836	+138446	131½	122½	Mar. 31	1,274,660	279 166,461	25,591,028	1·08	11·74	—	6·79
Lowestoft Corporation	Dec. 11	155	150	+ 5	+ 30	3½	—	Sept. 30	11,399	2,645,206	370,320	1·03	7·36	2,279	6·12
Maidstone Corporation	Mar. 6	157	100	+ 57	—	7·4	—	—	—	—	—	—	—	—	—
Manchester Corporation	Sept. 11	15,631	15,297	+ 334	— 2,871	183	181	—	—	—	—	—	—	—	—
Metropolitan District Railway	Mar. 12	11,003	9,512	+ 1,491	+10,564	24	24	—	—	—	—	—	—	—	—
Metropolitan Railway	Mar. 13	16,213	15,395	+ 818	+ 5,874	24½	24½	June 30	680,357	99,846,735	—	1·46	—	—	—
Nelson Corporation	Oct. 16	151	131	+ 20	+ 7	2½	2½	Mar. 31	7,362	2,060,712	204,740	·85	8·63	1,907	9·31
Newcastle-on-Tyne Corporation	Mar. 12	3,758	3,667	+ 91	— 1,215	60½	59½	„ 31	211,085	46,203,164	4,411,745	1·10	11·48	3,504	6·38
Newport (Mon.) Corporation	Oct. 9	663	638	+ 25	— 311	14½	14½	„ 31	35,531	8,174,003	798,029	1·04	9·89	2,450	7·21
Oldham Corporation	Jan. 24	1,778	1,516	+ 262	— 386	—	—	—	—	—	—	—	—	—	—
Portsmouth Corporation	Oct. 10	2,046	1,809	+ 237	—	28½	28½	Mar. 31	97,741	21,247,048	2,309,439	1·10	10·15	—	6·46
Reading Corporation	Mar. 17	528	490	+ 38	+ 214	13½	13½	„ 31	32,769	7,933,572	915,481	—	8·93	—	—
Rochdale Corporation	Dec. 26	1,240	1,126	+ 114	+ 746	20·9	20·93	„ 31	56,558	10,196,148	1,252,925	1·32	10·83	2,693	6·47
Rotherham Corporation	Feb. 4	555	587	— 32	—	—	—	—	—	—	—	—	—	—	—
Salford Corporation	Sept. 27	4,096	4,662	— 66	— 3,326	78	74½	Mar. 31	244,065	45,771,611	5,486,150	1·25	10·67	3,135	—
Scarborough Tramways Co.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Sheffield Corporation	Mar. 13	5,786	4,992	+ 794	+ 8,837	39½	37	Mar. 25	289,745	17,568,686	7,065,380	·896	9·842	4,225	5·04
Southampton Corporation	Mar. 9	967	865	+ 101	+ 622	18	18	„ 25	52,647	10,121,887	1,157,451	1·25	11·33	—	7·92
Southend-on-Sea Corporation	Aug 21	995	557	+ 438	+ 1,483	—	—	—	—	—	—	—	—	—	—
Stockport Corporation	—	—	—	—	—	25	25	Mar. 31	52,004	9,155,172	1,335,911	1·34	9·342	1,830	4·75
Sunderland Corporation	Jan. 27	1,310	1,336	— 26	— 7,984	—	—	—	—	—	—	—	—	—	—
Swindon Corporation	Dec. 11	126	114	+ 12	—	—	—	—	—	—	—	—	—	—	—
Torquay Tramways	Aug. 26	630	647	— 30	—	8·41	—	Dec. 31	15,065	2,880,420	353,297	1·40	1·023	—	—
Wallasey U.D.C.	Mar. 12	804	762	+ 42	+ 951	12·68	12·45	Mar. 31	43,823	8,331,038	891,540	1·2	11·79	3,453	7·72
Warrington Corporation	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
West Ham Corporation	Mar. 10	2,378	1,858	+ 519	+ 8,553	27	14·7	Mar. 31	122,881	35,502,836	2,556,854	·789	10·95	4,417	6·79
Wolverhampton Corporation	Nov. 3	841	823	+ 18	— 206	21½	—	„ 31	44,432	9,440,369	975,714	—	10·929	2,190	6·508

a Train Miles. *h* Half-year's figures.

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NOTES.

SWITCH AND TRANSFORMER OILS.

Considering the important part oils play both in the economy and safety of electrical engineering, it is a little astonishing that not more attention has been devoted to their scientific investigation. Certainly the paper on the "Physical Properties of Switch and Transformer Oils," read by Mr. W. P. Digby and Mr. D. B. Mellis before the Manchester Local Section of the Institution of Electrical Engineers, was a valuable and welcome contribution to the subject. The authors laid down the properties requisite in a mineral oil for transformers as follows: (1) Absence of moisture; (2) good dielectric strength; (3) a low viscosity to facilitate the heat transfer from the core and windings to the case; (4) a flash-point expressed by a figure which is two to three times the designed temperature limit of the transformers in °C; (5) an absolutely neutral reaction; (6) complete absence of vegetable oils or resinoid material; (7) freedom from metallic salts. For switchgear they emphasised the need of points 1, 2, 5, 6, and 7. The flash-point might be put at least six times the expected engine-room temperature. While the guaranteed flash-point, specific gravity and viscosity of commercial oils were generally found excellent, there was a grave variation of chemical purity and dielectric strength, not only between oil and oil, but between two different samples of the same oil. The authors pointed out that the chemical purity is of the utmost importance, because the presence of any soluble impurity in oil must tend to decrease its value as a medium for offering resistance to the flow of electric current.

TEMPERATURE *V.* INSULATION.

A most valuable set of tests was made to show the influence of high temperature on oils. Baking was resorted to for 24 hours at a temperature of 240° Fahr., with the following results:—(1) An increase in the disruptive voltage where this was less than 10,000 volts over the test distance; (2) no increase in specific resistance for oils of high specific resistance, but an increase of specific resistance in those cases where decreases in specific gravity indicate the expulsion of moisture; (3) a general increase in specific gravity and viscosity, and a raising of the flash-point, due to the evaporation of the more volatile constituents; (4) marked changes in the colour of the oil, in each case of a darkening nature. This is probably due to the evaporation mentioned above, coupled with molecular regroupings of the constituents; (5) a tendency to emphasise the indications of any traces of alkali, the change being from neutral to very faintly, or from faintly to distinctly alkaline; (6) irregular behaviour in regard to the indications of the presence or resinoid matter. This varies with the nature of the oil, and is probably worth further investigation. Further tests were made, and the authors came to the conclusion that for all oils the dielectric strength increases with increasing temperature, but that consistent readings on the ascending and descending temperature curves are only obtained by oils of high specific resistance, *i.e.*, pure oils. This fact of increase of dielectric strength with temperature throws a grave doubt on the soundness of the general practice of nearly all makers of oil-cooled transformers, who apply lower test pressures to the transformer when heated at the end of a test run, than when it has been allowed to cool down.

VISCOSITY.

For transformer use it is considered that a viscosity higher than 70 or 75 is undesirable. It should be sufficient to ensure free convection with a moderate rise of temperature above 60° Fahr. Where atmospheric temperature, load and loss of running are not such as to induce high temperature, a viscosity of between 45 and 50 is preferred, and, generally, given equality in other respects, oils having the lowest viscosity should be selected for transformers. As regards switchgear, the investigators speak far more guardedly. A viscosity impeding subsidence of suspended matter is, of course, to be avoided. But of the respective merits of thick or thin oils the authors prefer to remain silent pending further investigations. The functions of a switchgear oil are to prevent an arc or to quench it promptly when struck. In effecting the latter function the decomposition of the oil should be as low as possible. Theoretically, a heavy oil should hinder the formation of an arc owing to its molecular tenacity, while a thin oil with a more rapid flow should be quicker in extinguishing the arc. These are the points in dispute. One thing is clear, prolonged sparking causes darkening of colour, due to formation of amorphous carbon particles in the oil. The paper, which was accompanied by numerous tables, curves and micrographs, touches upon many other points, but the above are those of most instant interest.

ELECTRIC ALARM FOR GASSY MINES.

Graham's law on the diffusion of gases through porous obstructions has been put to practical and much wanted service by an Italian professor of physics, Dr. A. Di Legge, of Ancona. His apparatus consists of a box divided into two chambers by a partition of porous porcelain. If the two chambers are filled with gases of different densities, the diffusion from one compartment to the other will be irregular. This irregularity of diffusion is made use of by Dr. Di Legge to operate a small mercury index, which in turn is utilised to close an electric contact and so ring a bell. The apparatus is contrived in such a way that a different toned bell is set going if the index is set in motion by a diffusion from the right than if the exciting cause operates from the left. The apparatus is, of course, applicable to signal the presence of any gas, and can be manufactured so as to announce any volumetric compound desired. While specially useful for mining purposes, it will be equally applicable in chemical works, and should prove a veritable godsend on board submarines and other modern warships.

AN ALPINE RAILWAY.

News comes from Switzerland which concerns all electrical engineers as well as lovers of the Bernese Oberland. It is to the effect that the Bernese Alpine Railway Company have decided to adopt electrical traction for the line they are about to construct between Spiez and Brigue, and which crosses the Loetshberg range. So far, however, the directors have not definitely decided to adopt a system for the whole line, and electrification will proceed by stages for experimental purposes. The first stage will be between Spiez and Frütigen. Power will be supplied by the Société des Centrales Bernoises, from its station at Kander. Two turbo-alternators of 32,000 h.p. each will generate currents of 15,000 v., with a periodicity of 15. The double overhead conductors will be of copper, 100 mm. in section, and suspended on the "multiple suspension" system, about

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39 ft. above the ground. One of the cables will be connected to the rails by means of special coupling joints at the stations, and the other will be connected with the rails at Spiez. The cables will be kept taut by automatic apparatus. Current will be picked up by means of bows. The rolling stock will consist of three double bogies, four springed auto-cars, driven by four single-phase alternating current motors of 225 h.p. each. These are intended for local service. Two locomotives, destined for international communication, as soon as the line is completed, will be fitted with two single-phase 400 v. motors of 1,000 h.p. each. It is claimed that these are the largest single-phase motors so far built. Both types of trailers will be fitted with transformers to step-down the high tension current. M. L. Thormann, of Berne, is the engineer, while the locomotives have been supplied by Oerlikon and the Siemens-Schuckert companies.

ELECTRICITY IN NEW SOUTH WALES.

According to returns recently issued by the State Bureau of Statistics, electricity is making very satisfactory progress in New South Wales. While in 1899 there were only 33 electricity works, employing 147 persons and having machinery valued at £129,027, in 1908 there were 97 works employing 748 persons and having machinery valued at £1,012,231. In the latter year the works consumed 172,968 tons of coal and produced 14,793,000 kw.h. for electric lighting, valued at £160,676, and 67,600,000 kw.h. for power purposes, valued at £453,882.

"BENEVOLENT SATISFACTION."

The increasingly philosophic attitude of provincial electric light undertakings towards the metal filament lamp may be regarded as a healthy reaction from the pessimistic forecasts of a year ago. At the meeting the other day of the Bournemouth and Poole Supply Co., the chairman, Mr. Aymor Sanderson, counselled the shareholders to try to cultivate a benevolent satisfaction that their loss in this matter had been their consumers' gain, and urged upon them the exercise of that patience which all great economic changes called for, feeling confident that they would eventually be compensated by the large expansion of business which would arise out of the increasing popularity of electric lighting by reason of its comparative cheapness. This is excellent advice, and conceived in quite the right spirit, but it becomes especially noteworthy when the circumstances of consumption are considered. Bournemouth is essentially a pleasure resort and offers few opportunities to a supply company of compensating for a loss on lighting by an increase in the sale of electricity for power purposes. The reduced consumption of current under the new conditions was bound in such circumstances to have a very marked effect upon revenue, and as a matter of fact the Company found itself compelled to raise its rates by a half-penny per unit. We still think that the increase is a mistake in tactics, but it is fairly evident in the case of Bournemouth that augmented custom will soon make it possible to bring the rate down to the old level.

A SOUND POLICY.

In this connection we may commend to the notice of the Bournemouth and other companies which have put up their rates the very statesmanlike exposition of this phase of the question which was put forward by Mr. Beeton at the meeting last week of the Brompton and Kensington Co., as was explained in our last issue.

BLENDED DIFFUSED LIGHT.

Some useful experiments have been carried out by Mr H. E. Ives, of the Washington Bureau of Standards, with a view to obtain "daylight" effects with artificial illuminants. After trying a blend of mercury vapour lamps, with (a) incandescent gas lamps, (b) carbon filament electric lamps, he obtained the best results with (c) mercury vapour and metallic filament lamps. He arranges the lamps in clusters, the metallic filament lamps slightly predominating, so placed that the light is diffused. While this system, of course, is not the most economical if tested by the ordinary photometric methods, it gives great satisfaction, producing a soft, steady light, without glare or deep shadows.

LARGE UNITS AT HIGH SPEEDS.

MANCHESTER DISCUSSION ON MILES WALKER'S PAPER.

M. B. Field raised the question of where the energy came from which did the twisting of the end connections on short circuit, and thought this energy might not necessarily come direct from the turbo. The energy of the field stored up in the direct current field was equivalent to many foot tons. This energy might be expended in heat or in bending the end connections. The load conditions at the time of short circuiting he thought would affect the result of the short circuit itself, and he asked was the load on the tested turbine more or less than normal immediately before short circuit? By measuring up the oscillograph record giving armature current on short circuit, he found the generator appeared to accelerate for a time, afterwards slowing down again. Why was this? He was interested in the account of sparking from the bolt heads on an armature. A friend of his had trouble with circuits on motor generators. On starting up on the direct current side, they got a great kick and sometimes a flash. The flash was a puzzle, but in the light of the experience quoted in the paper, he could now understand why it was. In the diagrams showing oscillograph records of the different behaviour of the short circuit current depending on the particular instant at which the switch was closed, he noticed the tops of the waves were slightly rippled. Some time ago, in some experiments, he had a good regular shaped wave form, but on putting in a transformer to act as an inductance he got the wave rather flattened and rippled on top. This effect proved to be due to the capacity of the transformer he was using as an inductance.

Wm. Cramp thought there was little difference between a short circuit and a sudden application of an e.m.f. to an inductive circuit. The maximum possible current at 90° with constant permeability worked out to be equal to about twice the full load, using a formula similar to that given by Mr. Miles Walker. If the result was larger actually, it showed that the permeability was not constant, but changing. From a general look at the paper, he thought a consideration of the two terms which Mr. Miles Walker had analysed, showed that to get rid of the forces, the low induction should not be increased, though from another point of view this seemed to be the way. Was the initial rush of current less on a higher frequency?

Dr. Marchant: Regarding the armature conductors, the only effect on them when shorted is due to lost leakage. Speaking of the time taken by the armature reactance to penetrate into the rotor core, he recalled some of John Hopkinson's experiments made many years ago. In some of these experiments on cores 11 in. diameter, with ballistic coils fitted, it was found that about 25 sec. elapsed before the core at the centre was magnetised. With an 18 in. core it actually took 4 min. for the field to penetrate from the outside to the centre.

Mr. G. W. Worrall said the apparent speed variations mentioned by another speaker might be due to the working of the oscillograph. Also the slight ripples on the tops of some of the waves might be due to the damping of the oscillograph. He had had considerable experience with oscillograph measurements, and had found that great care was required to obtain correct results. In all the experiments, the conditions seemed to be that the machine was on open circuit before short circuiting. Now if the machine was running at full load when short circuited the results would probably be very different. Mr. Miles Walker had dealt with the effect of switching on at various points of a full voltage wave. The effect of switching on at various points on the current wave would also be different, for as the rate of change of current changed at various points, so would the rush of current vary. Again, if a machine having a ripple wave form instead of a smooth wave were used, very different results would be obtained. In the tests, the switch was probably right up against the machine, if it had been a little way from it, the resonance and the results would have been different.

Mr. Seaton: As a turbine man he had found three very bad points in the practical running of large turbo-alternators. First, the sets went periodically out of balance. This was due to bad aligning and setting out. In one set they had had to take down a discrepancy of 2½ m/m was found in the centre of the turbine and the alternator. This was the cause

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of the trouble, and it ceased after proper alignment. Secondly, the alternators had a tendency to run sideways, and thirdly, a tendency to burn out.

Dr. Rosenberg: The effect of shorting high speed turbo-generators was well known, but on 6,000 kw. slow speed generators short circuiting was also very bad. The potential energy of the magnetic field was suddenly discharged, and this caused the damage.

Mr. A. R. Everest: The magnitude of the current in the stator was generally assumed to be measured by the reactance of the winding. He had found that putting in external reactance actually did reduce the short circuit current, as Mr. Miles Walker states.

Mr. Miles Walker (in reply): He would reserve his reply for the journal, but pointed out that the forces on short circuit were not altogether due to the storing up in the field of magnetic energy. It did not appear as mechanical energy in the rotor field. The magnetic energy was dissipated in overcoming resistance. At the instant of short circuit the whole stator tended to shake off the bed plate and the rotor slowed down appreciably at that instant. The forces would be greater with lower frequencies.

THE ELECTRIC MOTOR FOR MARINE PROPULSION.*

By WILLIAM P. DURTNALL.

(*Continued from page 368*).

When at full vessel speed the main turbines are used direct, running at, say, 300 r.p.m. They can also be assisted by the extra turbo-generator T_3, by sending current into the electric motors, etc. It will, however, be noticed in this instance, that the main turbines run at a speed set by the propellers; there cannot, therefore, be any fuel economy as compared with the existing methods of turbine ship propulsion, except when the vessel is steaming at a slow speed, when the turbine T_3 may run at, say, 1,000 r.p.m., and therefore take advantage of the lower steam consumption her horse-power developed, when the turbine is run at such high speed compared with the lower speed turbine. The motors may be run in either direction, so that the reversing can be obtained, with efficiency, on all shafts, and it will be evident that great saving of fuel is possible by the adoption of such a system at cruising or other slow speeds, making also possible a very efficient manœuvring power, from the bridge, etc. This system, which was brought out in 1905, is a further indication of what the writer means by his statement that many minds have been at work to secure a means of running the turbine and the propellers at their most efficient speeds. It is, however, in the author's opinion, doubtful if the above system is really a great advantage over the ordinary method of putting reversing and cruising turbines in for purposes mentioned, as the period during which reversing

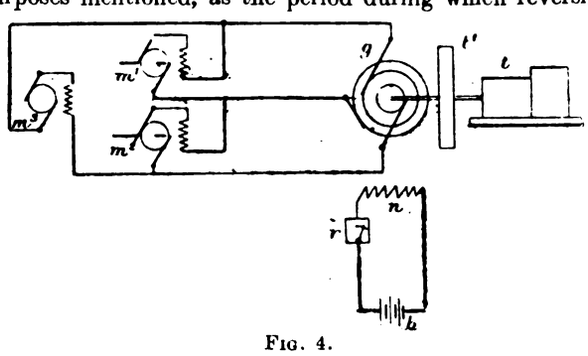

FIG. 4.

A GERMAN SYSTEM OF ELECTRICAL MARINE PROPULSION WITH SINGLE PHASE COMMUTATOR MOTORS.

and low speeds are required (except in the case of warships, etc.) is so small that it would be much better to have the all-electric drive, in which the great economies of the high speed turbine and superheat can be taken advantage of during the greatest portion of the vessel's life, *i.e.*, when the vessel is travelling at top speeds, making economies when they are most needed, when the power is highest.

Fig. 4 illustrates a German system of electrical marine propulsion with single-phase commutator motors, M_1, M_2 and M_3; these are connected to the propeller shafts shown. A three-phase alternating current generator G is shown, coupled to the steam turbine T, and T_1 is the flywheel suggested for use to possibly assist the turbine when reversing, etc. The field of the alternator is shown at N, the regulating resistance is shown at R, and the source of supply for the exciting current is shown at the battery B; no doubt, in an installation of large power, a small continuous current dynamo would be substituted.

The motors are in mesh connection; that is, that they are balanced across the three-phase leads, from the generator. They are single-phase commutator motors, and such motors have the possibility of speed variation by varying the voltage supplied to them from the generator; by means of regulating the resistance the excitation can be varied for the generator, and therefore, as the turbine runs at constant speed, the voltage of the alternating current can be variable. Consequently the speed of the motors, the reversing of the direction of the motors, and therefore the propellers, can be brought about by the change in the connections at the motors through suitable controlling gear, etc. It is, however, doubtful, in the author's opinion, if such a scheme is practical at sea, owing to the fact that the single-phase motor will have a series characteristic, and will be racing up to synchronism should the propellers be either unequally immersed or come out of water in boisterous weather, etc.; at the same time, such machines have commutators and brush gear, upon which further comment is needless. Also, the weight per horse-power developed by the motors will be increased with this type of motor, which is not desirable. Although this type of motor is certainly receiving much attention for railway work at the present time, it is questionable if it is the ideal method for marine propulsion, owing to the diametrically opposite running torque characteristics involved.

Fig. 5 shows Mr. Parsons' system of reciprocating engine exhausting into the low-pressure turbine which drives the electric generator, supplying current to the motor on engine propeller shaft.

The author thinks that the lay-out shown will be applied with some success in the early future, especially in vessels that may be converted, utilising the existing engines, and with high-speed exhaust turbines getting greater power for the same fuel and steam consumption; and with slightly altered propellers, higher vessel, speeds may be obtained on existing ships. The engine valves, to get the best efficiency, will require slight alteration, but very little.

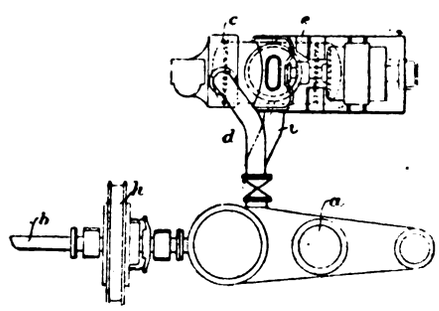

FIG. 5.

SYSTEM OF MR. PARSONS' RECIPROCATING ENGINE EXHAUSTING INTO LOW PRESSURE TURBINE WHICH DRIVES ELECTRIC GENERATOR. SUPPLYING CURRENT TO MOTOR ON ENGINE PROPELLER SHAFT.

The lay-out shows continuous current machinery, but the system can also be arranged for use with the Paragon system, in which, by means of variable frequency, alternating current generation, the motor speed may be made to suit the propeller, although the turbine may then run at its top speed, getting the maximum power for a given amount of exhaust steam from the reciprocating type of engine.

The lay-out that the author would propose for twin or triple-screw ships is such that the centre shaft shall run from the reciprocating engine, and the wing shafts shall be driven by motors supplied with current from the exhaust or mixed pressure type of turbines. In this way of utilising steam power a better means of ship propulsion is well within the range of practice to-day.

Fig. 6.—An American electrical marine propulsion system, using single-phase alternating current machines. It is here proposed to utilise single-phase alternating current machinery for propeller driving, and at the same

* Read at the Spring Meeting of the Institute of Naval Architects.

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time to reduce the weight of same for a given shaft horse-power by taking advantage of the torque between the turbo-generator members 3 and 4. It will be seen that 4 is mounted on the propeller shaft and revoles with it; and that the turbine can by this method be run at, say, double the speed of the propeller shaft at top speed. The current generated in the armature of the generator by the difference in speed between the two members 3 and 4 is taken to a small transformer and therefrom taken to a commutator type of single-phase current motor, also mounted on the propeller shaft, so that the energy is not lost, but in this way taken advantage of. As compared with the all electric drive, this system has no chance, as it involves heavy revolving masses, and also owing to the

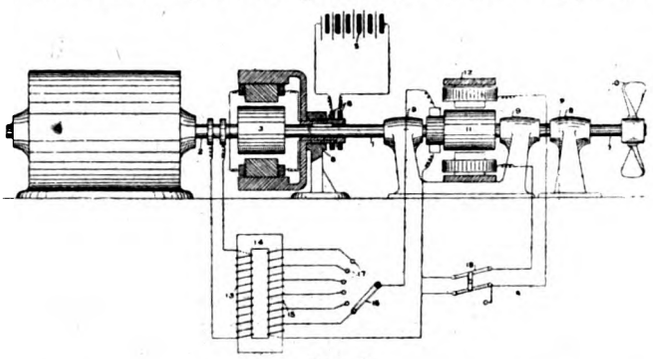

FIG. 6.

AN AMERICAN ELECTRICAL MARINE PROPULSION SYSTEM, USING SINGLE PHASE ALTERNATING CURRENT MACHINES.

fact that the whole of the machinery has to be in line with the propeller shaft, etc., which in big powers is not always practicable, owing to the over-all length, etc. The system was, however, brought out by a well-known American electrical engineer, but the author has heard from him to the effect that the single-phase alternating current machinery has too much weight to be put to practice in large work. At the same time, in the author's opinion, by having only a two to one reduction in speed from the turbine, the saving in steam effected by such a small reduction at full load and vessel speed would not warrant the expenditure in first cost, etc.

Fig. 7.—An American system in which a synchronous generator is proposed. The system shown is another attempt to utilise electrical machinery for the driving of ships' propellers in conjunction with steam turbines. It is very similar to that of the previous type of single-phase method, and has all the disadvantages of the latter, with the exception that in this method it is proposed to use the robust type of polyphase alternating current machinery for the purpose. At the same time, it involves the use of two turbines to drive one propeller, and it is certainly ingenious, but the turbine is limited in speed and therefore the fuel saving is not what it would be with the turbine running at a much higher speed, say, 4 to 1 reduction to the propeller at top speed and power, as can be got with an all electric drive.

The lay-out as proposed for each screw is as follows: A is a steam turbine which only drives the squirrel-cage rotor; B is the primary member of a non-synchronous type of polyphase alternator, which is also mounted on the propeller shaft shown at C. It is wound for two different polarities for two propeller shaft speeds; D is the primary or stator of a squirrel-cage motor, with its secondary, or rotor, mounted on the propeller shaft C. E is a small turbine that supplies mechanical power for driving the small synchronous type alternator, which sets the speed of the revolving magnetic flux in the member B. The armature of this machine is shown at F, and the exciter is shown at G, the steam supply is shown at H, and the main steam valves are shown at I; the switch gear for sending the exciting three-phase current into the different polarity windings in the member B is shown at J, and the switch gear that either puts the motor on the propeller shaft "ahead" or "astern" is shown at K. A control valve that sends high-pressure steam into the back end of the small turbine when reversing for short periods is shown at L. It is very interesting to note the working of this proposed system, which has been brought out by one of the most noteworthy turbine engineering firms in America, if only to show the action of polyphase alternating current apparatus, the type of generator proposed, and the method of taking advantage of the torque in the main generator to assist the turning moment of the propeller shaft.

Working: We will suppose that the turbine A is running governed at, say, 700 r.p.m.; the operation will be better understood by assuming certain conditions, and considering the operation of the several parts of the system under these conditions, we will leave the small amount of slip that will, of course, take place between the revolving and fixed parts of the main generator B and the motor D. We can take it that it is desired to get a propeller speed at top vessel speed of 350 r.p.m., and that the member B is wound for 16 poles, and the induction motor also for 16 poles, the synchronous generator F wound for 4 poles. With this combination the generator and the motor have the same number of poles, the relative speed of the primary and secondary members must be approximately the same. The speed of the induction motor D has been assumed to be 350 r.p.m. and that of the turbine A to be 700 r.p.m., so that if the turbine is to still run at that speed (which is desirable from a steam consumption point of view), then, assuming that the same is running in a clockwise direction, the current that excites the member B must be sent into the winding of 16 poles in the direction that will allow the revolving magnetic flux in the iron of the member B to travel also in the clockwise direction, which means that the member B, and therefore the propeller shaft C, is started and accelerated to a speed of 350 r.p.m. In practice the turbine A would run at about 2 to 3% 700 r.p.m., so that, as the propeller shaft is running at 350 r.p.m., and the revolving flux is also revolving in the iron of member B at 350 r.p.m., if the turbine is increased in speed by a small amount, the squirrel-cage rotor, which is driven

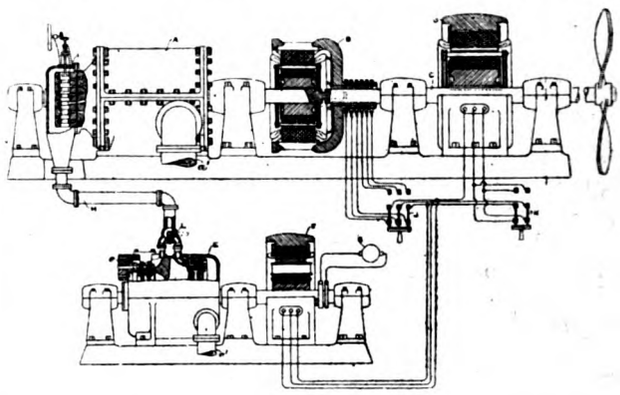

FIG. 7.

AN AMERICAN SYSTEM IN WHICH A SYNCHRONOUS GENERATOR IS PROPOSED.

by the turbine, will be run above the synchronous speed of the magnetic flux, and the consequence is that a powerful torque is set up in the air gap of the main generator B. This being mounted on the propeller shaft assists the turning of same, so that some of the mechanical power of the turbine goes direct to the propeller shaft, and also the main generator sends back some current for use in the induction motor, which then also assists to drive the propeller shaft. The exciting current is three-phase, so that as the frequency is equal to 16 poles at 350 r.p.m., and the generator F has 4 poles, it has to be driven at 1,400 r.p.m. by the turbine E.

It has been calculated that if the shaft horse-power is 6,000 b.h.p. the energy is transmitted from the two turbines, as follows:—The turbine A does 4,000 b.h.p., one half of which goes direct to the propeller shaft by reason of the torque set up between the air gap on the main generator, the other half goes as current from the main generator to the induction motor, and the synchronous generator is sending 2,000 h.p. to the motor. The total power thus delivered to the propeller shaft is therefore 6,000.

Now, let it be assumed that the speed of the propeller shaft has to be reduced in speed to 250 r.p.m., the switch J is then thrown over to the other contacts shown, and the exciting current is then sent into the other winding on member B, which is revolving at, say, 250 r.p.m. on the propeller shaft. In order that the main turbine shall

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not be reduced in speed, the magnetic flux or polarity of the member B must travel just under the revolution speed of the turbine A, so being connected with an 8-pole winding, and that running at 250 r.p.m. mechanically on the propeller shaft, the difference in speed of the poles on the member B must be made up by running the turbine E and the generator F at a revolution speed of 1,000 r.p.m. The generator F being of 4 poles, the frequency of the current will be 4,000 per min., the winding being 8 poles, so that the difference in pole speed is thus made up, if the turbine A is running at 570 r.p.m. in this way, 4,600 alternations from the exciting generator, and 250 times 8 equals 2,000, making a total of 6,000 alternations per min. for 750 r.p.m. and 8 poles on the member B.

Assuming that the power required for the propeller shaft is at this speed of 250 r.p.m., 2,149 b.h.p., it is proposed that the power be made up as follows. The generator F will deliver 537 h.p. to the motor D, the turbine A will deliver 1,612 h.p., of which one-third, 537 h.p., will be delivered direct by means of the torque set up in the air gap between the squirrel-cage rotor driven by the turbine A and the number B on the propeller shaft, and the other two-thirds will be transformed into electrical energy by the generator B, and delivered to the motor D, the induction motor on the propeller shaft. The induction motor will, when working in this condition, deliver 1,612 h.p. to the propeller shaft at 250 r.p.m., receiving two-thirds of this power from the generator B, the other third from the synchronous generator F. The total power delivered to the propeller shaft is thus 2,149: from the motor B 1,612, and from the turbine A direct 537 b.h.p.

For reversing, steam is cut off from the turbine A, and by means of the valve L steam is turned on to the back part of turbine E. Switch J is put in the off position, thus opening the circuit of the main generator. The switch K is then thrown over to the other contacts, so that the magnetic flux in the stator of motor D revolves in the reverse direction, at slow speed, the turbine E and the generator F being then driven at, say, 1,000 r.p.m., with 4 poles, means that the frequency is equal to 4,000 alternations per min., so that, the induction motor having 16 poles, a powerful torque is set up in the reverse direction, and the motor will run in that direction at a synchronous speed of 250 r.p.m. Slower speeds in either the "ahead" or the "astern" direction may be obtained from this generating set by slowing the small turbine in revolutions.

The author is, however, of opinion that although economy in steam may be possible by the application of such a system at slow vessel speeds, as compared with the direct turbine drive, yet the system will not meet with general approval, owing, amongst other things, to the fact that the turbine A must be in line with the propeller shaft, with the result that the over-all length of the total equipment would bring the turbine and the boilers too far forward, and also owing to the fact that only a two to one reduction is possible in this lay-out.

Fig. 8.—The "Paragon" system as arranged for use with internal combustion engines and with direct drive at top speed. A is the armature of direct current exciter, B is a control switch cutting out the windings C of exciter field for regulation purposes. D is the revolving field of the alternator; the armature winding is shown at G, the winding of a magnetic clutch is shown at E, and short-circuiting contact is shown at F. The motor is arranged with two separate windings in the stator, arranged for two different speeds, or wouud for different sets of poles, as will be after described. These windings are shown at I and J. The shaft K is coupled to the propeller shaft, and is also in direct line with the engine shaft. The rotor of the motor is shown at N, the winding of which is of the simple squirrel-cage type, and this arrangement is suitable for small boats up to, say, 500 b.h.p. Assume that the members A and D are mounted on the engine shaft forming its flywheel, and that they are therefore running at constant speed, say, 200 r.p.m.; that D is wound for 8 poles, for the first speed of the propeller the operation is as follows: By means of controller H, operated from lever L, the contacts are so made that the armature of the generator is connected with the I winding, which is a 24-pole one, therefore the speed of the propeller will be approximately one-third of the engine, and will also start up with considerable torque, running at, say, 66 r.p.m.

Second speed: Pull trigger I., which is coupled to contact M. This is so coupled with the exciter field that it short-circuits it; therefore, the whole system falls to a no-voltage condition. Then the controller H is moved so that the other winding J of the motor stator is coupled to the generator. This is only a 12-pole winding, so that the motor is immediately accelerated in speed to about 132 r.p.m. *Top speed:* This is got by pulling the handle B over so that the field of the alternator D is short-circuited, but the winding of the magnetic clutch E is made live,

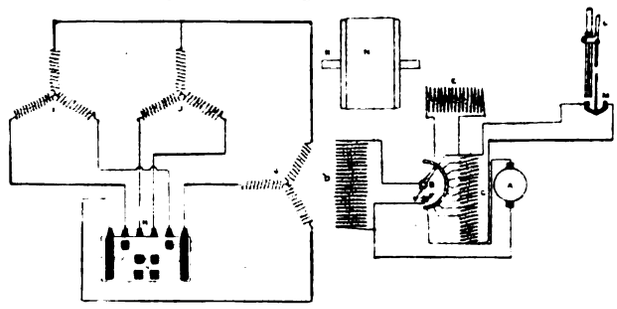

FIG. 8.

so that the armature haft of the clutch engages with the live side, and as the generator and the motor are coupled in line with the propeller shaft adn the engine crank-shaft, the engine then drives direct to the propeller, which is then accelerated to the same speed, namely, say, 200 r.p.m.

The reverse can be made on either the bottom or the middle speeds, with the engine always running in the same direction, but, of course, the magnetic clutch becomes disengaged so that the propeller shaft is free from the engine. The above method has worked very well in motor vehicles that the author has constructed with some success, especially in climbing severe grades, also braking and reversing on same.

Fig. 9 shows the lay-out of the "Paragon" system of electrical driving for propulsion by means of the variable periodicity alternators, squirrel-cage induction motors, and propellers running at slow speed, with the engines and generators running at high speed. This arrangement is especially suitable for slow-speed cargo vessels, in which the direct-coupled internal-combustion engine is not suitable owing to its high speed in revolutions. At low speed speeds one engine can be closed down and the other run at top speed doing all the work necessary for propulsion. Assume that A and I are two internal-combustion engines

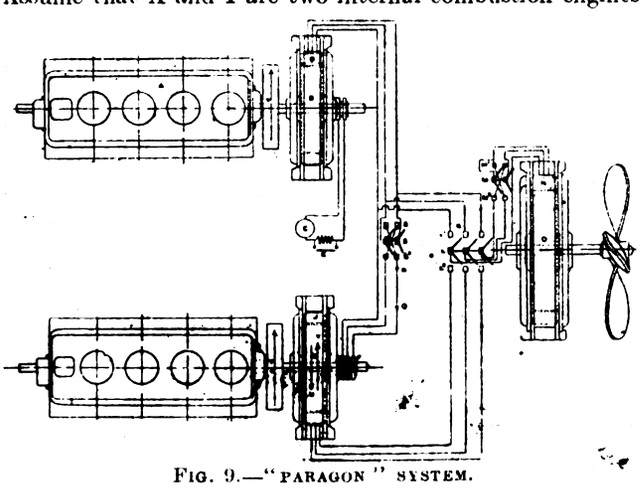

FIG. 9.—"PARAGON" SYSTEM.

that are each running in the direction marked T at 350 r.p.m. The one marked A is coupled to an 8-pole generator, while the engine marked I is coupled to a 4-pole transformer-generator. The motor shownis of the short-circuited squirrel-cage type, and is wound for 34 poles. The exciter C is arranged to be either direct-coupled or separately driven by the engine. A, by placing the switch marked S on contacts shown at S_2, and the switch marked L on I_2, and placing the reversing switch, shown at M, on either side, whether it is desired to run ahead or astern. Then, by the raising of the contact marked E the exciter builds up on the generator field, and a three-phase current

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flows from the armature of the generator marked D to the primary member of the transformer-generator marked H, through the slip-rings marked F. The member marked H being only wound for 4 poles means that for every one turn that the engine makes in the direction marked T, the magnetic flux in the iron of the member marked H revolves electro-mechanically in the direction marked U, or counter to that of the engine speed, with a result that a current can be sent to the motor stator marked N from the stationary secondary marked J, with a frequency of 1,400 alternations per min. The motor being wound for 34 poles has a synchronous speed of 41 r.p.m., but the actual speed would be about 40·25 r.p.m. which constitutes the, say, first speed.

Second speed: Short-circuit the exciter field, by means of contact E the whole system then falls into a no-voltage condition, and whilst in such open the switch S and place the switch L on to L_1 contacts. By opening the contact E the exciter builds up, and the current from the generator A goes direct to the motor, which then runs at a synchronous speed of 82, or actual speed of 80 r.p.m. This speed will only require the work of the full output of the engine and generator A and D, although the engine is running at full speed the motor and propeller is only running at ·66 speed.

Third speed: Short-circuit as before, and while in the no-voltage condition change the connections in so much that the current from D will provide that the magnetic flux will again flow into the primary member of the transformer-generator, but in the direction marked V, the same way as it is being driven by the engine I, with a result that the frequency of the current that may be taken to the motor from the secondary member of the transformer J, by placing the switch marked at L again on L_2, this current will have a frequency of 2,800 + 1,400 = 4,200 alternations per minute, with a consequence that the motor will run at a synchronous speed of 123 r.p.m., or actual speed of the propeller of 120 r.p.m., and this is the top speed and power.

Assume that the engines A and I are each of 500 b.h.p., the power transmission efficiency being 85% means that 850 shaft h.p. may be drawn from the motor N, and the work of both prime movers taken up and concentrated in same. The extra propulsive efficiency got in slow boats with the slow revolution propeller per shaft horse power developed, and the increased thermal and mechanical efficiency that may be got from the comparatively high-speed prime movers, together with their reduced weight per brake horse power developed, at least compensates for extra weight of the electrical machinery, and at the same time gets over the difficulty of using this type of prime mover, insomuch that same need not be reversing, and can also run at constant speed, and governed. It is possible thus to use, say, four 500 b.h.p. engines on to a 1,750 shaft h.p. motor, with single propeller, or two propellers may be used each of 850 brake or shaft h.p., with separate port and starboard control from the bridge.

In Fig. No. 10 (Plate II.), which illustrates the "Paragon" system of transmission, the coupling from the steam turbine or prime mover is A, the driven shaft is shown at B, which extends through the generator revolving magnet C, and also drives the primary member of the transformer-generator D. On the shaft are also mounted slip-rings K and G. The armature winding and stator iron of same are shown at E and F, the winding of the primary member of the transformer-generator is shown at H; the stator secondary member of the transformer-generator is shown at I, and the winding of same at J, and the bedplate of the whole plant at L.

Working.—Assume a steam turbine is running at 1,000 r.p.m. and is capable of giving off 7,000 b.h.p., working with a steam pressure of 180 lbs. per square inch, superheated by 150° Fahr., exhausting into a vacuum of 28·5 in. with barometer at 30 in. The generator C E would be a synchronous polyphase alternator (three-phase) and the transformer-generator D I would be wound for two poles on both primary and secondary members.

The exciting current can be drawn from the existing electric light circuit, or may be supplied from a little continuous current dynamo either direct driven from the turbine shaft over-hung from the end of the transformer-generator or separately driven by a small steam engine.

First Speed Ahead.—By means of the controller (not shown here), its handle is put into the notch shown, marked "Ahead 1st." This so couples the alternator that when the current comes from the armature winding E it goes into the winding marked H, forming the primary member of the transformer-generator, in such a way that on putting the exciting current on the slip-rings K (which are connected with the revolving magnet windings marked M) the current flows in the primary member windings H. The resultant magnetic flux revolves in the iron of same in the opposite direction to which it is being driven mechanically by the turbine, being a 4-pole generator, and the winding H, being arranged for only 2 poles, it means that for every turn "mechanically" in, say, the clockwise direction, the magnetic poles in the member D revolve in counter-clockwise *twice*. The effect is that the winding in the stator I receives a transformed current equal to *two* poles at 1,000 r.p.m., or the current that can be taken from the secondary winding J has a frequency of 2,000 alternations per minute. This current being at the time (by means of the controller) coupled to the lines leading to the squirrel cage induction motor, which is wound for 42 poles, will then start with a powerful torque, and run in the ahead direction, at a speed (allowing 1½% for magnetic slip) of 46·8 r.p.m. (The motor secondary member or rotor is direct coupled to a propeller shaft).

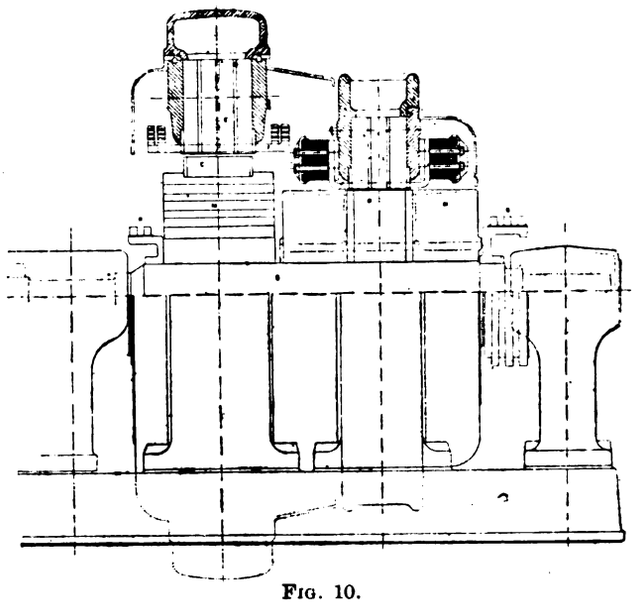

FIG. 10.

DETAIL OF "PARAGON" SYSTEM OF POWER TRANSMISSION.

Second Speed Ahead.—By taking the exciting current off the slip-rings K the whole system falls to zero voltage, and while in that condition the controller is placed in the notch marked "Second Speed Ahead." This means that the armature member of the alternator, or its windings F, are coupled direct to the motor stator windings, and by letting on the exciting current the frequency of the current going to the motor is then equal to 4,000 alternations per minute, or the motor accelerates in speed, from, say, 46·5 r.p.m. to 92·8 r.p.m. (allowing 2½% magnetic slip, as more work will then be on).

Third Speed Ahead.—By taking the exciting current off (which is arranged for automatically in the control gear) the system falls to zero voltage as before, and then, by placing the controller in the notch marked "Third Speed Ahead," the connections are so arranged by the controller that the current from the alternator windings E are again connected to the slip-rings G, but in this case *two* out of the *three* phases are reversed, so that on letting the exciting current on the magnet windings C, through slip-rings K, the current in the windings of the primary member H cause the resultant magnetic flux to revolve in the iron of same in the same way that it is being driven "mechanically." Thus for every revolution in a clockwise direction that the turbine takes, the windings in the stator secondary member J are excited *twice* electro-magnetically, and *once* by means of the mechanical turn, being wound for two poles. The current that can be drawn from the windings J

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has a frequency of 6,000 alternations per minute. The motor stator windings, being also coupled to same, then accelerate in speed from 92·8 r.p.m. to 138 r.p.m., which is the top speed (allowing 3½% for magnetic slip).

Reverse.—If it is desired to immediately reverse the speed direction of the propeller, this may be attained by bringing the controller to the neutral point or notch marked "Stop," then by placing the controller lever in the notch marked "First Speed Astern," this means that *two* out of the *three* phases leading to the motor are reversed, and that the 2,000 frequency current is then turned on the motor stator, so that, being of such low frequency, and the motor of such a large number of poles, a powerful torque is set up in the reverse direction. At the same time a very powerful braking action is set up, because if the rotor or propeller has not already come to a standstill, the magnetic flux in the iron of the stator is travelling in the reverse direction at a speed of 47·6 r.p.m., so that the rotor bar winding is then cutting lines of magnetic force in the leading direction, and the motor momentarily becomes a non-synchronous generator, the windings being short-circuited on themselves, producing a very powerful couple to the poles in the stator, thus tending to stop, and then reverse the propeller, then accelerating same in the reverse direction (a matter of seconds). The same process is gone through as regards the middle and top speed reverse, as in the ahead direction, until the vessel is travelling at full speed reverse.

It is interesting to note that all through the above operations the turbine is being run governed in the ahead direction, and at constant speed, utilising steam with the maximum efficiency, at all propeller speeds, whether in the ahead or the astern direction. The controller can be just as easily placed, if desired, on the bridge, or in the engine-room, or it may be arranged for at either important positions.

Steam used at Full Power and Speed.—It may be taken that such a turbine will use under the above conditions at sea 10 lbs. of steam per turbine shaft horse power hour. The over-all mechanical efficiency of the combined generator and motor can be guaranteed to be not less than 88%, so that at top speed the steam used per shaft horse power will be 11·66 lbs. per hour (without auxiliaries), the total steam flow being then for propulsion 71,825·6 lbs. per hour, and shaft horse power delivered 6,160.

Middle Speed.—If the shaft horse power is 6,160 at 138 r.p.m. for the propeller, it may be taken that at 92·8 r.p.m. the shaft horse power will be in the neighbourhood of 1,500, so the steam flow at this speed will be approximately as follows :—

Although the turbine is still running at the same revolution speed it will not have so much work on, so that the steam consumption per turbine shaft horse power hour will increase, as compared with that at full load, and the turbine will use approximately 11·5 lbs. of steam per brake horse power hour, the current being taken from the alternator direct to the motor. The power transmission efficiency at this speed can be guaranteed to be not less than 83%, so that the steam consumption per shaft horse power hour at this low power and revolution speed will be 13·85 lbs. The total steam flow at this vessel speed will then be 20,775 lbs. per hour.

Bottom Speed.—Assuming that at 46·8 r.p.m. the shaft horse power is, say, 600, the over-all transmission efficiency will be approximately 77%, and the steam consumption per turbine shaft horse power will be about 14 lbs., so with a transmission efficiency of 77%, the steam per shaft horse power at this revolution speed for the propeller will be 18·4 lbs. per hour, or the total steam flow will be, say, 11,040 lbs. per hour.

Fig. 11 (Plate II.).—This is a lay-out of the "Paragon" system that is proposed in the case of small cargo boats (as in example No. 1), which require a slow-speed propeller, and upwards of 500 shaft h.p.; it is in this instance shown for 830 shaft h.p. It will be observed that it consists of a combination of reciprocating steam engine and mixed pressure (one that takes both exhaust and live steam) turbine, which drive the electrical generators and the transformer-generator. A is the live-steam delivery pipe, which is branched to feed both the live-steam end of the turbine B and the stop-valve end C of the triple-expansion engine T, this same exhausting at, say, one pound above atmosphere through the exhaust pipe D, to the low-pressure end of the turbine E. The exhaust steam is again utilised for the production of mechanical power, delivered by the turbine, which exhausts into vacuum by means of exhaust end F. The engine runs at, say, 500 r.p.m., and drives the 4-pole generator G and the 2-pole transformer-generator H, also the small exciter I, the whole revolving in the direction marked J. On the engine shaft is also mounted the three slip-rings M, which are connected to the two pole windings of the primary member of the transformer-generator H, the turbine drives the 2-pole non-synchronous polyphase alternating current generator rotor N at, say, 1,550 r.p.m. The conductors O run from the generating plant shown to the squirrel-cage induction motor shown; Q is the rotor coupled to the propeller shaft, and P is the stator, or primary member of same, wound for 36 poles, with single winding; R is the propeller shaft, which will have speeds of 81, 54, and 27 r.p.m., both ahead or astern.

Working: Assume that the live steam is turned on the reciprocating engine, which is set running governed at 500 r.p.m., in the direction marked J, the engine is then arranged to exhaust direct to the condenser, and will thus remain for the first two propeller speeds.

First Speed Ahead: The exciter I is turned on the slip-rings S, which are coupled to the winding of the generator revolving magnet, which is four pole, a three-phase alternating current is then produced in the generator armature stationary windings, with a frequency of 2,000 alternations per minute. This current is coupled to the slip-rings M, which are coupled to the 2-pole winding on the mechanically-driven primary member of the transformer-generator H, with a result that the revolutions being 500 r.p.m., and the generator being 4 poles, and the transformer-generator being only 2 poles, the three-phase current in the primary windings of the transformer produces a revolving magnetic flux that revolves in the opposite direction in the iron of

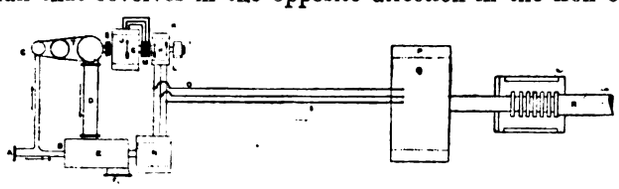

FIG. 11.

PROPOSED ARRANGEMENT FOR AN INSTALLATION OF 830 S.H.P. WORKING A SINGLE SCREW.

the primary member to that in which it is being driven mechanically twice for every mechanical turn, so that the two pole windings on the stator secondary member of the transformer are excited once for every mechanical turn of the engine. The frequency of the current that may now be coupled to the motor is then 1,000 alternations per minute, the motor being wound for 36 poles. It runs at a speed of (allowing 2% for slip between the revolving magnetic poles in the stator iron and the rotor of the motor) 27·5 r.p.m.

Second Speed Ahead: The engine is still running at 500 r.p.m., but the connections are made in such way by means of the controller (under no-voltage conditions) that the three-phase current is taken direct from the generator G to the motor, the frequency of the current being 2,000 alternations per minute. The motor runs at a speed of (allowing 2½% for slip) 54 r.p.m.

Full Speed Ahead: The engine is still run at 500 r.p.m., but the exhaust is then changed so that the engine exhausts into the turbine as explained. Some live steam is sent also to the turbine, also shown; so that the turbine runs at approximately 1,550 r.p.m. Fig. 11 shows the steam and electrical connections for this speed, the extra power for propulsion at full speed is provided for by the turbine, utilising the exhaust steam from the high-speed engine for the purpose, as well as a certain amount of live steam to make up the difference, in order that the turbine shall have as high a speed as possible, and also to provide the necessary frequency in order that the motor shall run at (allowing 3½% slip) 80·5 r.p.m. The electrical working is as follows :—

The current is taken from the generator at 2,000 alternations per minute and sent into the primary member of the transformer-generator, in the opposite direction to that

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which it was sent when the first speed ahead was on, so that the 2-pole windings of the stator secondary member of same are excited twice by electro-magnetic rotation and once by mechanical rotation, with a result that the frequency of the current in the stator member of the transformer is at 6,000 alternations per minute.

As the shaft horse power required at this vessel speed is 830 b.h.p., and as the reciprocating engine is only about 250 b.h.p., the electrical power is raised by the following means. As the electrical connections go to illustrate, the 6,000 alternation current is sent into the 2-pole stator winding of the non-synchronous generator that is driven by the turbine, in such a direction that the magnetic poles revolve in the iron of the stationary portion of the generator at a speed of 1,500 r.p.m., in the same direction of rotation that the squirrel cage, which is driven by the turbine, is running at 1,550 r.p.m., with a result that further power is delivered to the conductors running to the motor, which then runs at the speed named and delivers 830 b.h.p. to the propeller shaft R. The turbine will give off 730 b.h.p., the engine 250 b.h.p., the power transmission efficiency is 85%.

type of cargo boats, and he thought that the electrical driven boat in this sphere of action would have more chance. He did not think that more than 85% over-all power transmission efficiency could be claimed. (Here Mr. Durtnall interposed with the remark that as much as 92% can be guaranteed in large powers.) Mr. Parsons admitted that what Mr. Durtnall had just said might be the case in the matter of the "Paragon" system. He also recognised that this system with the floating field, so as to provide variable frequency for the motor supply, did present a method that, as electrical systems go, was very efficient, although he maintained that it was not so efficient as his own mechanical power transmission gear. For cruising speed or slow vessel speed the electrically driven boat had certain advantages over all other proposals, insomuch as in the case of running at slow speed, some of the turbine generators could be closed down. Economy could be secured by still running the turbines at a high blade speed, although by changing the frequency the motors and, therefore, the propellers, could be run at a slow speed, but the steam was under that condition being used with the maximum of economy. He did not consider that to be a sufficiently strong case, as the time

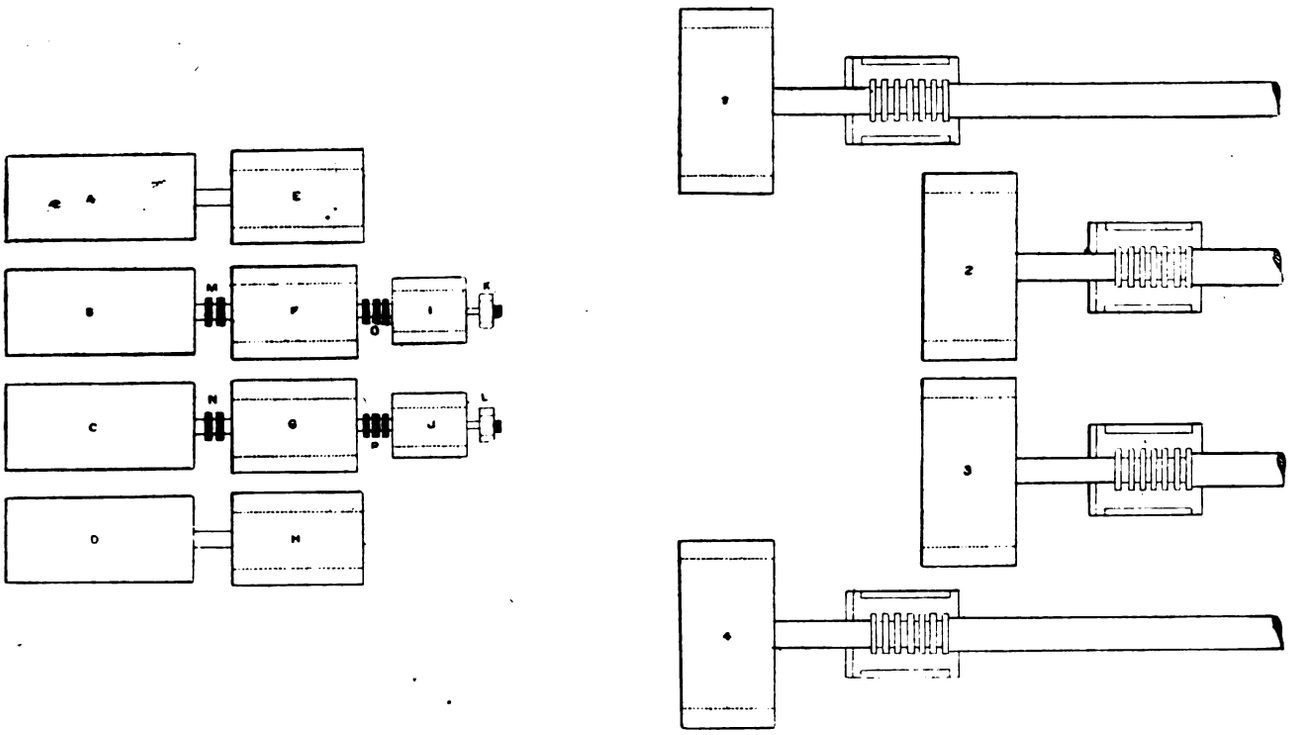

FIG. 12.—PROPOSED ARRANGEMENT FOR 46,800 SHAFT HORSE POWER. PROPELLER SPEEDS, 224, 150, 75, AHEAD OR ASTERN. CONSTANT TURBINE SPEED.

It will be seen that when the vessel is travelling at the first two speeds the *turbine is not running*, the whole of the necessary work being done by the engine, which runs at its top speed, and is then condensing; thus for slow vessel speeds, or reversing, the minimum of steam is thus used. There is no necessity for the engineer to touch the engine, but all the electrical connections are changed by means of the controller, which may be either on the bridge or in the engine-room, as may be desired. At top speed it is, however, necessary to either by hand or automatically turn the exhaust from the engine to the turbine, and the turbine to the condenser. For reversing only two out of the three-phase on the conductors O need be reversed, the rotation of the engine and the turbine speeds are always in the same direction.

DISCUSSION.

Sir William White, K.C.B. (in the chair): It was a very interesting paper, and he would call on the Hon. C. A. Parsons to open the discussion.

Mr. Parsons thought that for large vessels the methods proposed were not suitable, as the efficiency between the direct-coupled turbine and the electrical scheme was only about 5%, and the extra cost and trouble involved by indirect methods did not warrant the extra complication, etc. There was, however, a very large field to be attacked by this and other methods for driving the slow speed propellers of slow running boats, such as "tramps" or other

in his opinion that such conditions existed at sea was not long enough to warrant the extra machinery, etc. He further considered that the electrical equipment of large boats would entail very great risks of danger, as in the event of a short-circuit on the main generators, everyone in the engine-room would be killed by copper poisoning.

Mr. Herbert H. B. Deane (Engineer, The General Electric Co., Witton), did not agree with many of Mr. Parsons' statements, especially as regards the danger of a short circuit. He also took up the matter of the efficiency of the direct-coupled marine turbine and that of the high speed turbine, proposed in Mr. Durtnall's paper. He did not agree with Mr. Parsons on this point, as it was every day practice in all parts of the country, that steam consumptions per b.h.p. on the high speed turbines, such as were used with electrical generators, were much more economical than with the comparatively slow running marine turbine. A much higher propulsive efficiency could also be obtained by slow running electrically driven propellers. This was especially so, as with such high speed turbines the use of superheat was possible, and the great economies that were to be got by such means could be taken advantage of. He did not agree with Mr. Parsons that the cost and the weight of the electrical plant, was excessive. On the contrary, as in a good many cases which he had had recently to go into with Mr. Durtnall, it was proved without doubt that the cost was no more, and also that after allowing for the decreased weight of the smaller amount of boiler, condenser,

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and steam pipe capacity required in the large schemes that Mr. Durtnall had brought forward, it was found that, on the whole, the electrically driven vessel was the best from both practical and commercial aspects. He doubted if it was really a fact that as much as 98·5% power transmission efficiency was possible in so small a mechanical gear as Mr. Parsons had adopted in his vessel, and which he was comparing with the "Paragon" boat.

Dr. Ing. Hermann Fottinger (Professor of Marine Engineering, Danzig Uinversity), stated that some years ago he went into the matter of the economy of utilising the high speed, and, therefore, efficient turbine to generate the prime-power for marine propulsion, and the possible adoption of the electric motor for propeller driving. He found that the schemes that were gone into with the electrical machinery of those days were not so effective as a method that he had brought out and tried at Stettin, in which hydraulic power was adopted, and this system had made a sound success of the problem. He, however, appreciated the advantages that Mr. Durtnall's system possessed over the methods that he had gone into with constant frequency and voltage for the same purpose, and freely admitted that this system was meriting of the closest attention by scientific engineers. He stated that his hydraulic system would shortly be fitted in this country on a vessel that was to utilise the efficient internal combustion (suction gas) engine, running at high speed while the propeller would be driven by his hydraulic method at a slow speed, thus getting economy in the weight of the generating plant, and also securing great efficiency on the propeller per shaft horse-power.

Mr. A. C. Holzapfel mentioned that he was equipping the vessel referred to by the last speaker with the hydraulic power transmission. This would be working in October next, and should be of great interest to the engineering profession. He was not an engineer, but realised that great possibilities were ahead for the application of the internal combustion engine at sea. He thought that of many electrical schemes both in this country and abroad he had gone into during the past three years, the "Paragon" system which Mr. Durtnall had invented was the best. He had, however, seen the hydraulic system at work, and had consequently placed his order for the hydraulic gear for this particular ship. He would be pleased to see Mr. Durtnall get a ship at work on the system that he had for so long advocated, as it would be interesting to know the actual results. The system that had recently been put before the Institution of Marine Engineers for driving auxiliary machinery on ships was ideal for the purpose, and he strongly recommended Mr. Durtnall to press its use for such purposes.

Mr. Martin (of the Parsons' Marine Turbine Co.): He would like to know what Mr. Durtnall considered the weight per shaft horse-power delivered by his system in the case of a large vessel. In the electrical schemes that he had gone into the weight was much more than that for the direct-coupled steam turbine, and consequently put the electrical scheme out of the field.

Mr. Frank Broadbent: The hour was so late that justice could not be done to the subject in the time.

Mr. Thomas Browett, M.I.E.E., M.I.M.E., agreed with the remark of Mr. Broadbent.

Mr. Durtnall (who curtailed his reply owing to the lateness of the hour): The question of utilising mechanical gears had been gone into by him some six years ago for the matter of propeller driving for steamships by means of high speed turbines as prime-movers, but after searching Great Britain and Europe for suitable gears that could be guaranteed as regards power transmission, efficiency, silence, and reliability, he gave up the idea as impractical, and turned his attention to other methods of achieving the same or similar results. As the paper stated, the methods that he had gone into involved the use of continuous current apparatus, but these failed on practical design for large powers. Other means had been investigated by him during the last ten years, and he had carried out a vast number of practical experiments in order to ascertain the best method of getting at the most suitable results. He came to the conclusion that if the matter was to be successful the squirrel-cage motor was the one to use for the purpose. It then involved the designing of a scheme in which the motor should have large starting torque and at the same time be able to run at variable speed. This lead to the invention of the "Paragon" system, which gave all the advantages that had been claimed, and he was pleased to say that British manufacturers had at last gone into the system, with a result that to-day he was in a position to be able to lay the matter of electrically propelled vessels before the shipping industry in real concrete form and under guarantees that firms, with the necessary capital, could stand by for the performance of the machinery specified, and that not only for small cargo boats, but the equipment of very large boats was consequently a matter of ordinary business. He was really surprised to hear Mr. Parsons make a claim for the mechanical gear of 98 5%, as this was in his opinion impossible for so small a gear, but he thought it quite within the range of practice in much larger gears. He was in a position to guarantee a power transmission efficiency in very large boat of 92%, and with that and the other many advantages that the electrical drive offered, he would stand by for the development of the "Paragon" system for ship d iving. He, however, would not entertain any proposition that failed to embody the use of superheated steam, by which vast economies could be effected. Fuel consumption was the greatest burden in cost, and the sooner ship-owners realised that better means were at hand for ship propulsion than the well-tried but very inefficient methods that had so far been used, the better they would be able to compete with profit with much advanced and foreign competition. As regards Mr. Parsons statement that in the event of a short circuit the men in the engine-room would be killed by copper poisoning, this was really surprising. Concerning Mr. Deane's remarks, he had nothing to add. It was true that Mr. Deane had gone very closely into the whole matter, in fact, further than most engineers, and his remarks could be taken as being correct. Mr. Durtnall stated that he had had a long conversation with Dr. Fottinger on the whole subject the evening before. While appreciating the interesting hydraulic system that Dr. Fottinger had produced, he believed Dr. Fottinger would admit that the "Paragon" system was altogether different and more efficient than the method that he had gone into in Germany. Mr. Durtnall hoped that Dr. Fottinger would have a great demand for his interesting system, as he really looked on this system of hydraulic transmission as the most serious competitor for ship driving with high speed turbines. The results of the vessel in hand would prove its efficiency. Mr. Durtnall mentioned that a vessel was now in hand in which the propeller would be driven by means of the squirrel-cage induction motor of 600 h.p. The results would be published for the guidance of ship-owners and the engineering science and industry generally. As regards Mr. Martin's question concerning the total weight of the boilers and machinery for propulsion purposes, Mr. Durtnall referred him to a drawing of a vessel with four propellers dealing with 46,800 shaft horse-power. Firms of the highest repute had gone into the matter, and were in a position to quote for the "Paragon" equipment, with water tube boilers, giving the total shaft horse-power with a propeller speed of 224 r.p.m. at top vessel speed. This was 17 8 shaft horse-power per ton of total weight, which compared, in his opinion, very favourably with the results which Admiral Oram announced recently, that with the ordinary direct-coupled steam turbine drive on a cruiser, only 13·8 shaft horse-power was possible per total ton weight of boilers, and propelling machinery (and that was with a propeller speed of 300 r.p.m., which could not provide the same thrust per horse-power developed at the propeller as with the 224 r.p.m. of the electrically driven boat. He was sorry that time was so pressing that neither Mr. Broadbent nor Mr. Browett could express their views, as they were especially able to deal with the matter. No doubt they would have favoured the electrical scheme.

A vote of thanks to the author was then passed with acclamation for his most interesting paper, which closed the proceedings.

TELEGRAPHS AND TELEPHONES.—According to official returns just issued during the year ending March last, the loss on the Post Office telegraphs amounted to £573,802, the surplus on telephones to £268,694, including a surplus on trunk calls of £56,510. These amounts do not take into consideration capital account charges.

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THE PHYSICAL PROPERTIES OF SWITCH AND TRANSFORMER OILS.

By W. POLLARD DIGBY and D. B. MELLIS.

MANCHESTER DISCUSSION.

Mr. C. J. Beaver: His experience was that the substances dealt with in the paper were not the most injurious impurities, and they did not account for the wide differences in dielectric strength met with. Water had not been treated by the authors with sufficient importance. In his opinion, it was impossible to get a dry oil, or to dry it thoroughly by any apparatus. He did not understand the peculiar change in the author's test samples, from slightly alkaline to strongly alkaline, etc., after having undergone a series of disruptive tests. Water was the most important impurity, but he thought electrical engineers were asking oil makers to do a lot for them in the matter of getting rid of it. The elimination of the moisture should not be left to the maker; it was much better to filter the oil through calcium chloride on the spot. This process would make far more difference than anything described in the paper. The general shape of the curves given for variation of breakdown voltage with temperature rise for oils was quite dissimilar to that of curves for solids. While increased temperature raised the value of the breakdown voltage for oils, it lowered it for solids. Under these circumstances, the practice of transformer makers to lower the testing voltage as the transformer heated up was correct, as they are testing solids and not oils.

Mr. J. E. Southcombe: The results of his tests on transformer oils were not quite in agreement with the authors'. He had very rarely come across alkaline action. His experiments had been made at 20,000 to 75,000 volts, and at these voltages the authors' tests would not give reliable results. He had found it necessary to keep the voltage on two or three days. The carbon particles line up in the electrostatic field, and they had also to get rid of air bubbles in the oil. He thought the question of who should dry the oil was a commercial one of who could do it cheapest: the transformer maker or the oilman. The method given of detecting resin was not a very satisfactory one. It was of great importance to have chemically pure oil to keep the windings sound. Windings were more damaged by alkalines than by any mineral acids. Organic acids were also bad, and should be kept out.

Mr. J. S. Peck: In actual practice he had found that the two great requisites of a good transformer oil were: (1) High dielectric strength; (2) freedom from deposit. The second requirement was the more important, and while it was comparatively easy to get oils of high dielectric strength, it was difficult to meet that condition. Although oil makers claimed to have full knowledge of the requirements, they had a good deal to learn yet. It was no use buying a high grade oil if it was shipped in a careless way. Wooden barrels were very bad for the purpose, and were not much used now on that account. It was quite customary to dry out the oil. Very high voltage transformers were vacuum dried, as was the oil, which was afterwards sucked in without coming in contact with the air. The specific resistance of the oil was not a matter of great importance to the user, and there was no definite relation between specific resistance and high dielectric strength; they did not necessarily go together. The practice of the transformer makers in using a lower voltage at the end of the test was quite justified, as the breakdown, if it occurred, would be through solid insulation. The oil simply reduced the surface discharge. He referred to the inefficiency of oil immersion for direct current arcs. The oil used with some direct current oil-immersed controllers was found to carbonise very rapidly.

Mr. J. Lustgarten, M.Sc.: Asked if the wooden barrels in which oil was sent from America were made of oak. If so, resinoid matter could get in by contact. He had carried out a considerable number of experiments on oils, and found that the mode of testing any dielectric depended entirely on the glass vessel; its width; the position of the spark gap in the oil; whether the electrodes were earthed or insulated; the rate of growth, or the amplitude factor of the voltage. It was necessary, therefore, to know whether the voltages given in the paper were r.m.s. or maximum values, and the shape of the electrodes. With a flat-topped wave, the results would be lower then for a peaky wave. The earthing of the electrode altered the potential gradient at the needle point. Referring to the authors' curves for sparking voltage between various differently shaped electrodes, he thought there must be some inaccuracy in the method of obtaining them, since their curve for two $\frac{3}{4}$ in. diameter spheres lay below that for two needle points. In air, of course, it came above, and he had tried with various spheres in oil, and had always found it above. The potential gradient of the spheres was much less than for needle points. A possible disturbing factor in the authors' tests might be the position of the spark gap and the glass vessel. Contrary to the experience of the authors, he had not found the results with the spheres to be erratic, but had got better results the larger the spheres. The curve for sparking between two $\frac{3}{4}$ in. spheres was actually not at all straight, but followed the shape of the others, bending down. The best oils had a breakdown voltage of 160–180 kilovolts per centimetre, and some recent samples he had tested varied between 160 and 149 kilovolts per centimetre. From the authors' curve, however, their value was only 80 kilovolts per centimetre. This was too low for switch or transformer work. He had proved for himself that flashing improved the oil. The oil must stand before being tested to give correct results. He had found the results sometimes doubled after standing 24 hours. The improvement was entirely due to the spark drying out the oil and driving off the impurities.

Mr. Mellis (in reply)*:* They quite realised the importance of moisture, and for that reason thought it was so obvious as to need no special emphasising. It was most important. He thought the exact method of drying oil would depend on the engineer concerned. The suggestion of drying by means of sodium was not very feasible, as the sodium would form caustic soda and the result would be worse. Heating oil to a medium heat was probably the best way. The heat must not be too great or the oil would change. All their results were for r.m.s. voltage values, and the alternator used gave a wave just slightly flatter than a true size. They did not earth one electrode, and as they had used a needle point and a disc, this would not introduce an error. They had taken 25,000 volts as their maximum, as this was the limit for work in this country so far. The samples they were dealing with were commercial ones, and regarding the poor value of 80 kilovolts per centimetre, according to Mr. Lustgarten, they found this was quite as good as the majority of oils in use. The curve they had considered straight—dealing with voltages below 25,000 volts—would, of course, bend over higher up. Regarding the needle points curve coming above the same for spheres, those were the results they got, and they agreed with the theoretical curve they had previously worked out. In air, of course, there was ionisation influencing the breakdown, but in oil he did not know yet what the exact phenomenon was which took place. It was, however, hardly the same as for air.

WINNIPEG'S ELECTRICAL DEPARTMENT.—The tenth annual report of Mr. F. A. Cambridge, the city electrician of Winnipeg, Manitoba, just issued, shows interesting developments of municipal ownership, as figures are given for the first year, as well as for that just passed. In the former there were 55 fire-alarm boxes, operated under a contract at a cost of nearly £11 each; last year 211 boxes were operated at less than half this cost (£5 each). In 1898–9 there were 123 arc lamps, which cost, under contract, £29 each by moon schedule; last year there were 866 arc lamps, operated by the city at £8 10s. per lamp by moon schedule, and 116 incandescent lamps at a little under £10 for an all-night schedule. Tungsten lamps have been used in the place of carbon incandescent ones, "thereby effecting a great reduction in current used and affording a much better light." In view of the damage being done to underground water and other pipes through the electrolytic action from the wires of the Winnipeg Electric Railway Co., Mr. Cambridge was sent to some of the principal cities in the United States to investigate systems of bonding the rails, and as a result of his consequent report, confirmed by Prof. Herdt, of McGill University, the company has had to undertake the re-bonding of all its system on the plan recommended by Mr. Cambridge.

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ALUMINIUM AND ITS USES.

II. ARMATURE WINDING.

Questions of economy rather than any idea of saving in weight first induced Continental electrical engineers to experiment with aluminium wire for armature winding. But, as a matter of fact, the gain has been both in cost and weight, for in spite of many difficulties the experiments succeeded so well that aluminium wound motors are now generally used on the tramway systems of Berlin and Hamburg, as well as several other administrations. The first stumbling block to be overcome was that of space, for here, of course, as with transmission wires, the inferior conductivity of aluminium requires a greater section than is the case with copper. This was partly overcome by discarding lapping with cotton or silk, the natural tendency of aluminium to protect its surface with a thin patina of oxydised metal being taken advantage of to insulate wire from wire in one layer, for it will resist a tension of rather over 0·5 volt. It is necessary, however, to place paper between the layers, partly because the difference of tension between layer and layer is greater than between wire and wire of the same spiral, and partly because the coating of oxide is rather susceptible to compression. This latter defect is largely due to the extreme tenuity of the patina, about one-thousandth milimetre, and to the fact that a gaseous layer is found between the oxide and the pure metal. This inconvenience can be overcome in two ways: either by heating the wire to 120° C., and subsequently protecting the whole winding by a coating of good insulating varnish to prevent dampness penetrating when attracted by the cooling down of the wires, or by polarising the wire by means of electrolysis. This latter method is adopted for transformer and high tension practice. It is found that this oxide, extremely thin though it be, is quite sufficient for purposes of insulation. Another step to secure economy of space is to use square wires, which pack better, and which allow of more even distribution of pressure. In this way

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armatures are prepared with aluminium wires which are no larger than copper wound armatures, and only have a very small reduction of windings. While the guiding idea of engineers had been the reduction in price, it has been found that the actual saving in weight is a very decided gain. The reduction in weight of the armature is about 50% when aluminium is used, and of the motor between 40 and 50%. This is an enormous advantage for traffic purposes, both directly and indirectly; indirectly because the apparatus suffers less from vibration and so gives less trouble. Indeed, the burning out of fields seems to be almost unknown on the Berlin and Hamburg tramways, now that the square section of the wires, the paper between layers and the fixation of the oxide have been adopted. Although Continental traffic engineers are somewhat cautious in expressing an opinion upon the relative duration of copper and aluminium wound armatures, experience with the latter not having been sufficient to permit of positive statements being made, nevertheless, it is held that even if the life of the aluminium was shorter than copper, its use would be fully justified. Indeed, Herr Rucker, of Berlin, who, however, may be considered prejudiced owing to his connection with the Specialfabrik für aluminium Spulen, roundly declares that aluminium has proved itself less influenced by heat, humidity, etc., than copper. He is able to assert that the amount of aluminium wire used has been about 10% short of what it should be according to its lower conductivity as compared with copper; yet, in Berlin at least, no fault has been found with the new armatures, even after two years' wear. There can be no doubt that Continental engineers are satisfied with matters as they are, for the use of these armatures is extending, but hopes are entertained that great improvements may eventually be produced. The subject is being very closely studied, and elaborate experiments carried on.

THE NEW ACT.

The new Electric Lighting Act comes into force to-day. Though not altogether what we could desire, and much criticised as some of its clauses are, on the whole it marks a distinct progress on the previous Acts. The chief points to be noted are: The provision for compulsory purchase of land for generating stations; provisions as regards supply in bulk; supply of current by central stations to railways, tramways, and canals partly outside areas; general supply outside areas; joint lighting powers (which should give a very real impetus to electrical engineering); revision of maximum prices; revision of clauses relating to the supply of premises having a separate supply; and the granting of privileges which amount to monopolies. This last feature is one, however, that bristles with difficulties, because the Act is very indefinite, and apparently "undertakers" who deemed themselves injured by illicit competition could only proceed by applying for an injunction.

TIMBER MILL ELECTRIFICATION.

An installation on a large scale and possessing many peculiar features is that of the Franklin County Lumber Co., Greenfield, on the Green River, near the outlet of this stream into the Connecticut River, Massachusetts.

The mill has been running with its electrical equipment for about a year, although many of the wood-working machines were formerly used in the old steam-driven mill, now used for storage purposes. The existing mill is served by the same yards and the same dry kilns, but is in a separate two-storey brick building with basement, and has a detached concrete building for shavings and sawdust, removed from the mill proper by, perhaps, twenty feet.

The machines are equipped with individual sixty-cycle, three-phase, 220-volt Westinghouse motors, mainly of the squirrel-cage type. Power is supplied from the circuits of the local light and power company at 2,300 volts, but is stepped down by three 50 kw. transformers and distributed through the mill at 220 volts. Grounded gas-pipe conduit is used throughout the mill for the wires, and all fuses and starting switches are enclosed in tin boxes. The wires enter the building in the basement through a three-phase cable in an iron pipe, running down the pole and into the ground, and lead through a high-tension circuit breaker and panel to the primaries of the three delta-connected transformers, and from the secondaries, also connected in delta, the cables run to a distributing panel with meter, switches and fuses. These are all located in a fireproof room of brick and concrete, without wood, except a small rack in front of the board to stand on. This room, called "the tomb," is regularly kept locked, so that no idle curiosity can lead anyone into danger.

The secondaries of the transformers are fused inside the delta connections, and the seven separate branch circuits are also fused inside the tomb. These branch circuits run outside to distributing boxes from which the circuits run to the individual motors. The motor circuits are all fused at this point, and again at the starting switch.

A commendable feature is that close to the switchboard is to be found a list of the circuits and the proper fuses to be used in each and a list of the motors from each circuit. It is to be noted that each motor starting box has its own number, which applies to the motor as well. Thus it is possible for even a new man to trace the circuits with perfect ease. Too often a wireman leaves a maze of wires without any trail whatever, so that the difficulties of tracing out the circuits when a fuse blows are greatly multiplied.

In addition to these conveniences a 220-volt lamp with special handles for hooking on to a circuit is also provided to permit ready determination of the location of a blown fuse.

The work done in the mill is of a general jobbing nature for inside and outside house furnishings as well as some cabinet work, so that pine (hard and soft) hemlock and cypress constitute the greater part of the material worked though some brown ash, oak and birch are run through in small lots.

The motors are, in the main, located elsewhere than on the floor, as on the side wall or a post or the ceiling, or on the ceiling below and belted up through the floor. Where motors are on the floor, together with belts, they have been boxed in, with allowance for ventilation, by a screen; thus they are protected both from dirt and off-fall and, guarded against accident. The motors mounted on the wall where the belts protrude into the passage-way, are also equipped with boxes for the belts.

There are employed, in addition to a foreman, and a steam engineer to run the dry kilns, shaving baler and kindling saw, three or four benchmen and seven to ten machinemen, according to the amount of work going through.

The machines are piped with individual sawdust collectors, and the entire exhaust system supplied from a double 30 in. blower with fans direct connected to the extended motor shaft. The housing is mounted on a platform suspended by iron bars from the ceiling of the first floor, which makes the piping as short as possible, as there is but one outlet in the basement. The shavings are carried by collector across a roadway to the cyclone on the top of the shavings building in which are separate rooms for sawdust

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and shavings, with chutes on the ground floor for delivery into wagons or for delivering the shavings to the baling press located on the ground floor. This baling press, made by Dederick & Sons of Albany, makes two bales at a time, 30 by 16 by 16 in., a convenient size for handling. It is driven through a counter-shaft, necessary for reversing, by a 7·5 h.p. squirrel-cage motor with a two-point auto-starter. The motor has no moving contacts, and the starting contacts are all under oil. There are no lights in the building and the main construction is of concrete, so that the possibility of fire is thereby reduced to the minimum.

Shavings and refuse are used under the low-pressure boilers for the dry kilns and for heating when required, but considerable revenue is obtained from the sale of loose and baled shavings, in fact almost enough to pay for the full power bill of the entire factory.

All motors over 5 h.p. are started by a standard two-point auto-starter, of Westinghouse make, with the exception of the two-wound secondary motors which are equipped with regular external resistance type of starter. All motors of 5 h.p. and below are started from a 3-pole double-throw switch, wired without fuses for starting but with fuses on the running side.

The mill equipment is shown in a table (to be given in a later issue) where the machines and drives are all specified. Two vertical motors are included; one on the column sander, thus eliminating a quarter-turn belt, and the second on the single-spindle shaper. This motor was originally intended to be belted directly to the shaper spindle, but it was found that there was insufficient room below the table to bring the motor and spindle pulleys in line, so the motor was mounted below the table and belted to a vertical countershaft, and from it to the spindle. The other motors are all standard floor-type motors mounted on floor, wall or ceiling as desired.

The total installed motor horse-power aggregates 231, and the working time, nine hours a day with Saturday half-holiday, in summer, amounts to about 225 hours per month.

The load factor of the plant is but 13%, so that the kw.-hours consumed are far from equalling the produce of the total installed motor capacity and the number of hours worked. The energy consumed has averaged approximately 6,600 kw.-hours per month, a large share of this being due to the blower. The latter runs continuously nearly loaded although gates are installed at each machine, and a notice printed at each which acts as a constant reminder, "Close Gate." And again, on each motor switch-box are lettered the words "Stop Motor," so that each operator has a constant suggestion that the realisation of the advantage of intermittent operation are up to him.

WESTINGHOUSE DINNER.

The fourth annual dinner of the British Westinghouse Engineers' Club was held at the Grand Hotel, Manchester, Friday, March 18, 1910, and was attended by about two hundred members of the staff, mostly members of the Club.

Mr. J. S. Peck, chairman of the Club, presided.

About nine o'clock Mr. Newcomb Carlton, Managing Director of the Company, arrived from London and received a great ovation.

Mr. D. N. Dunlop, Sales Manager of the Supply Department, proposed the toast of the Company, coupled with the name of Mr. Carlton. Mr. Dunlop, in the course of his remarks, referred to the excellent spirit of co-operation which now permeated the whole organisation. He voiced the sentiment of all present in expressing the hope that Mr. Carlton would long continue to direct the affairs of the Company in the able manner which had characterised his work and which had produced such a marked improvement in its position during the years of his administration.

Mr. Carlton responded to the toast in a masterly speech which has become one of the features of these annual dinners. He referred at some length to growing competition between the great manufacturing nations of the world and spoke of the necessity of Great Britain bringing up its efficiency in technical matters to the same high pitch as it has attained in commercial ability. He also referred to the limitations placed by trade unions on productive output, and while recognising the benefits that British working men derive from trade unions, hoped that they would soon realise the necessity of removing such restrictions from production and enable Great Britain to maintain her position in the markets of the world. It was in the interests of employers and employees alike that both should work together to this end.

In concluding his speech, Mr. Carlton referred to the great progress made during the past few years in the Company's business, and referred to its future prospects in a way that inspired everyone with confidence in even greater success being attained.

Mr. Blunt, General Sales' Manager, proposed the toast of the Works Organisation, coupled with the name of Mr. Lange, Managing Director of Works. Mr. Blunt stated that during a year of considerable trade depression, the Company had maintained and improved its position and that the business done during the two months of the current year showed considerable improvement over the same period of the previous year. He said that this spoke well for the Company's Sales Organisation, and congratulated the various Sales Engineers and District Office Managers on the excellent results obtained by their efforts. He also expressed his appreciation of the excellent way in which the Selling and Manufacturing Departments were working together.

Mr. Lange, Managing Director of Works, responded to the toast. Mr. Lange began his speech by expressing his thanks to Mr. Carlton for the allusion he had made to the labour conditions, which made it unnecessary for him to deal with that subject as he had done on previous occasions. He could, therefore, he said, restrict his speech more particularly to the actual conditions affecting the Works Organisation and the relations of the Works Organisation to the Sales Organisation. While expressing in general his agreement with what Mr. Blunt had said with regard to the benefits of co-operation between the various sections of the organisations, he stated that in his opinion, improvements in many directions were still necessary, and gave various illustrations in his usual forceful manner showing the necessity for greater co-operation between the various departments of the works, so that each Works Department would utilise to the utmost the experience of all other departments. He mentioned the difficulties in a large organisation in accomplishing the best results without such co-operation, because the customers of the Company looked upon it as a unit and did not take into consideration the departmental system in their dealings with the Company.

Mr. Lange, in concluding, thanked the various superintendents and foremen for the way in which they have responded to his suggestions in the past, and he had no doubt but that he could look forward with equanimity to the continuance of their support in the direction indicated in the early part of his speech.

Mr. Tearle, Deputy General Accountant, in a suitable manner proposed the toast of the Engineers' Club and the Foremen's Association. The toast was responded to by Mr. Peck on behalf of the Engineers' Club, and by Mr. Currie on behalf of the Foremen's Association. Mr. Peck hoped that the Company's apprentices would take more advantage of the opportunities afforded by the Club for their benefit in an educational as well as a social direction. Mr. Currie expressed the hope that the engineers would be able more frequently to attend the meetings of the Foremen's Association and so give them the benefit of their advice and experience in discussing the problems which come before them.

During the evening several members of the staff contributed to the musical programme. Mr. T. M. Kirkby sang a topical song in which allusions to the weaknesses of various members of the staff were received with much appreciation.

Mr. C. E. Crowther, who has assisted us frequently in the past, was received with much enthusiasm.

Mr. Geddie made his debut at this dinner and sang. He promises to be of great assistance in future social events as his song was charmingly rendered.

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PUBLICITY.

In this Section of "The Electrical Engineer" we give Publicity to New Inventions and Specialities.

"DISC AND DRUM" TURBINES.

In view of the great attention being devoted at this moment to the question of the efficiency of turbines, it is opportune to give the claims put forward by Messrs. Willans & Robinson, Ltd., for their Willans-Impulse "Disc and Drum" type of steam turbine. They say that (1) a weak point in a turbine of the Parsons type lies in the high pressure blading. In the interests of economy the clearances over this blading must be small, and in proportion to the extent to which leakage is kept in check by these fine clearances, risk is run of fouling and stripping of the blading with its concurrent danger of injury and distortion of the shaft and other parts of the turbine. Over the low pressure Parsons blading the clearance spaces form but a small fraction of the blade area, and therefore the clearances at this portion of the turbine can be kept ample without appreciable losses from leakage.

2. In the impulse type of turbine the weak point lies in the small clearances necessary between the revolving shaft and the bushes in the diaphragms separating the successive pressure stages. The drop in pressure between successive stages is large compared to the drop in pressure between the numerous stages in a Parsons type of turbine, and therefore, to prevent serious leakage losses, the clearances in the impulse type of turbine are not only kept small in amount but the shaft itself is kept down to the smallest practical diameter in order to reduce the area of the clearance spaces.

3. In order to place on the market a turbine which shall be free from the above disadvantages, Messrs. Willans & Robinson, Ltd., have developed and are now offering a type of turbine from which the weak points above described have been eliminated. The single impulse wheel (without the accompanying shaft glands) is used for the high pressure portion of the turbine, and this is directly bolted to the low pressure drum of the Parsons type of turbine which forms the low pressure portion of this new turbine. In this way the Willans-Impulse "Disc and Drum" type turbine has large clearances at all points and has small clearances nowhere, and it is claimed that this is the only type of turbine which has large clearances everywhere.

4. The "Disc and Drum" type turbine has the great advantage that in most cases steam is not admitted to it at a higher temperature than 212° F. In other words, excessive temperature and consequent distortion is confined solely to the nozzle box or nozzle passages, the casing of the turbine, and the rotor not being exposed to steam of a higher temperature than 212° F., excepting in special cases. The isolation of high temperatures and pressures from the turbine body proper eliminates one of the principal causes of steam turbine troubles. This will be understood from the fact that the steam is expanded in the nozzles of the turbine from boiler pressure (whether superheated or not) down to atmospheric pressure, after which the velocity generated in the steam is extracted in a compound velocity disc—namely, in a disc fitted with two rows of revolving impulse blading (and one row of fixed impulse blading). This disc is steam balanced, *i.e.*, the same pressure exists on both sides of the disc. The steam, after leaving the disc at atmospheric pressure and temperature (but with the velocity extracted from it) then passes to the low pressure rows of Willans-Parsons blading mounted on the drum. The distance between the bearings in a turbine of the Willians-Impulse "Disc and Drum" type, is short. This, combined with the fact that the shaft is of the "drum" type (and not of the slender dimensions always found in turbines of the pure impulse type) implies that the greatest possible rigidity is obtained with a turbine of this type. In those exceptional cases where steam at a higher temperature than 212° F. is admitted to the turbine, the temperature is still much below that at which steam is admitted to other turbines.

6. This design of turbine ensures maximum economy over a wide and varying range of load, due to the fact that the high pressure steam to the impulse disc is controlled by nozzles which can be opened or closed automatically or by hand.

7. The design and construction of Willans & Robinson's turbine rotors are generally accepted as being the most mechanical of any design. In the Willans-Impulse "Disc & Drum" type turbine the same method of connecting the two end-shafts to the "drum" has been adopted. The single impulse disc is fitted between the drum and the end-shaft at the high-pressure end, and in no way interferes with the rigid attachment of the end-shaft to the drum.

8. The Fullagar system of steam balancing (whereby the low pressure drum is balanced by means of a piston at the low pressure end of the turbine instead of at the high pressure end), which was introduced and developed by Messrs. Willans & Robinson, Ltd., adapts itself with great advantage to the "Disc & Drum" type turbine. This means that the low pressure drum is balanced by steam being admitted to the exhaust end of the drum. (The impulse disc is of course already in steam balance without artificial means of balancing being adopted). The above method of balancing means that the low pressure gland (viz., the gland at the exhaust end of the turbine) has atmospheric pressure on both sides of it, thus avoiding the tendency of steam to leak outwards, or of air to leak inwards.

9. From the above description it will be gathered that the Willans-Impulse "Disc and Drum" type turbine differs from the present Willans-Parsons turbine in that a single impulse disc is substituted for the high pressure part of the drum, thus reducing the length between the bearings by about two-thirds. The external portions of the turbine proper, such as bearings, governor gear, thrust, oiling arrangements, etc., etc., remain in accordance with the designs which Messrs. Willans & Robinson, Ltd., have standardised in connection with their Willans-Parsons turbine.

10. It will also be gathered that the "Disc and Drum" type turbine is particularly suitable for use with high and low pressure steam—in other words, for mixed pressure working. When supplied with exhaust steam, the only part of the turbine which will revolve "idly" is the impulse disc, and the frictional loss will therefore be small.

It appears that already 112 of these turbines have been built, aggregating 190,200 kw., and the type of turbine which they are now offering is the outcome of their experience in the construction and subsequent working of these turbines

---

FIRES: SAFETY OF ELECTRICITY.—In Glasgow, during the four weeks ending Ma ch 15, there were 60 fires. Of these, five were due to gas, one to "defective electric light installation," and one to "electricity," secondary cause not stated. Two to five speaks eloquently in favour of electricity.

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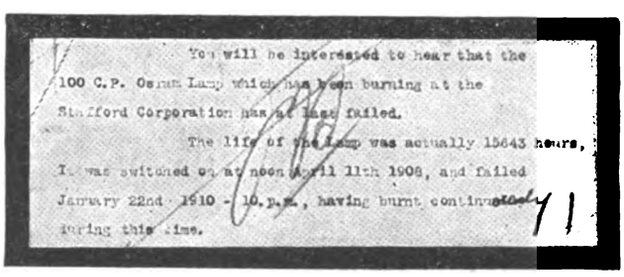
"TANTALUM" FOCUSSING LAMP.

It has been often remarked that the end-on candle power of the new metallic filament lamp is decidedly weak, whilst a good *horizontal* candle power is always maintained. Messrs. Siemens Bros., Tyssen-street, Dalston, London, N.E., who are the makers of the "Tantalum" Metal Filament Lamps, are now placing upon the market a new type of lamp which will be known as the "Tantalum" Focussing Lamp, which has an entirely new arrangement of filament by which a maximum end-on candle power is obtained. The spider on which the filament is wound is

constructed in a conical shape, the cone pointing downwards. The special feature of this lamp is that it distributes the light very evenly except towards the cap of the lamp where the light is not required. These lamps are now being supplied for 100–130 volt circuits in 25 c.p. sizes in spherical bulbs measuring approximately 75 m/m. diameter. They are especially suited for places where it is desired to obtain a strong and even light without the aid of special reflectors, and should prove useful for stage lighting, ceiling lighting and decorative purposes. They are listed at the price of 3s. each, and are of the same efficiency and durability as the ordinary standard type of "Tantalum" lamps. In every particular the new lamps are precisely similar to the present "Tantalum" lamps, which possess such an excellent reputation, the only difference being in the arrangement of the filament.

WELL-EARNED REST.

A lamp having a record of 15,643 hours useful life has certainly earned rest and a little to fame. The honour of having achieved such an arduous career has fallen to the lot of an Osram lamp. When it had been burning for 10,000 hours a kind of jubilee card was sent out by the owners, who were as proud of the event as the manu-


You will be interested to hear that the
100 C.P. Osram Lamp which has been burning at the
Stafford Corporation has at last failed.
The life of the lamp was actually 15643 hours,
It was switched on at noon April 11th 1908, and failed
January 22nd 1910 - 10. p.m., having burnt continuously
during this time.
71

facturers. Now that another 5,643 hours have been added and the lamp gone out of commission an In Memoriam card has reached the General Electric Co., and we give a facsimile of it. It is only just to add that the lamp was burning at its proper voltage and gave a good light right to the end.

SHIP EQUIPMENT.—The *Onitsha* twin screw passenger steamer, built by Messrs. Irvine's Shipbuilding & Dry Docks Co., Ltd., at Hartlepool, for the Elder Dempster line, is fitted throughout with the electric light. This equipment also includes signal lamps, binacle lamps and cargo clusters at each hatch.

ELECTRICAL PUMPS—WHISKEY.

At Messrs. James Buchanan & Co.'s premises in Holborn an electrically driven pump has just been installed, and is put to a novel use. It is arranged to pump various whiskeys from barrels in the basement of the building to large vats on the top floor, so as to obtain certain blends of the spirit. A special suction is provided for adding the required quantity of water to give the liquor the proper density, and the pump is also arranged to discharge air into the vats in order to effect the blending. In view of the nature of the liquor the inside of the pump is tinned, so is also the inside of the copper pipe which has been fitted for conveying the whiskey from the basement to the top floor. The pump, which is capable of dealing with no less than 130 gallons of whiskey per minute, is of Merryweather's "Hatfield" pattern, and is driven from an electric motor by means of silent chain, the whole being mounted on bed plate and forming a very compact installation. The "Hatfield" is the type of pump which has met with conspicuous success on the motor fire engine supplied to the London and other fire brigades.

ELECTRICALLY DRIVEN CHAIN WORKS.

Messrs. Hans Renold, Ltd., manufacturers of chains for textile machinery and cycle driving, have opened a new factory, the Progress Works, in Brook-street, Manchester. These works are equipped throughout with electricity, including lifting cranes. Particulars of the excellent arrangement of the line shafting and the electric installation are given by our contemporary, *The Iron and Coal Trades Review*. Every line shaft throughout the shop is of an uniform length, and runs in bea.ings at 10 ft. centres. These bearings are suspended from double joists, which are built into the longitudinal joists at 10 ft. centres, an arrangement which permits the line shafts to be slid from side to side of the respective bay by merely easing the hanger bolts, while the complete removal of a given shaft from any one bay, and its erection in either of the other bays, is a work of minutes only. The countershafts are of standard lengths, and of two sizes only—1½ in. and 2¼ in. in diameter. The countershaft hangers are fixed to the joists which run lengthways of the shop, and these, as also the whole of the striking gear, are interchangeable. The motors for operating the line shafting are of a standard size of 12 h.p., mounted upon concrete pillars. They run at 750 r.p.m., and driving through silent chains give a shaft speed varying from 150 to 300 r.p.m. The works are lighted by 50 flame arc lamps, which run in series groups across the lighting mains.

Current is taken from the Corporation mains and delivered to the works sub-station at 6,500 volts. Here are installed two sets of transformers together with the necessary switchgear, supplied by the British Electric Transformer Co., the current being reduced to 400 volts for distribution in the shops. For the main feed from the sub-station to the central distribution board, bare copper conductors are used. These are carried on an overhead gallery which extends round the main aisle of the shop. Lighting circuits are obtained at 250 volts by connecting the neutral point of the system with any one of the outer wires.

Space does not permit of our dealing at length with the special manufactures of Messrs. Hans Renold. Briefly, it may be said that three principal types of chains are produced, viz., the block chain, which in the smaller sizes is suitable for machine-tool driving, etc., and in the larger sizes is specially adapted for conveyor and elevating plants, etc., as the block readily lends itself for the necessary attachments; the roller chain, which in the main is used for bicycle and general motor work, but is also used for machine drives; and the now well-known silent chain, which has been specially designed for high-speed transmission. This last certainly justifies its name; it runs with the smoothness of a belt, and at the Burnage Works, where a very large number of such chains are in operation, the shop is as quiet as though belt drives were in service. The various modifications of the block chain, designed to meet special requirements, are too numerous to classify. Messrs. Renold, however, have prepared an interesting little booklet on this subject, as also some tabulated tests they have made for comparative purposes between the belt and chain drive.

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Electrical Contractors' Section.

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Town Clerk.

Town Hall, Blackpool,
March 29, 1910.

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BRAY (IRELAND).—Annual supplies for electricity department. Particulars from Town Clerk. April 5.

COLWYN BAY.—Urban District Council.—Cables, stores and metres for electricity department. Particulars from Clerk. April 9.

EGREMONT.—Wallasey Urban District Council.—Annual supplies for electricity supply works at Liscard. Particulars from Engineer, Seaview-road, Liscard, Cheshire. April 18.

HACKNEY.—Borough Council.—80,000 pairs yellow flame arc lamp carbons. Specifications, £1, Town Clerk, Mare-street. April 7.

SOUTHAMPTON.—Corporation Tramways.—Construction of tramways in New and Northam-roads. Specifications, £3 3s., to Borough Treasurer, Tramway Manager. April 4.

MANCHESTER.—Corporation Tramways.—One four-cylinder engine and chassis for use as motor tower wagon. Particulars from General Manager, 55, Piccadilly. April 5.

OVERSEAS.

ANTWERP.—Lower Scheldt Works.—Electric lift for vehicles on floating pier. Dep., £320. Specification No. 19, 2d., plans 1s. 5d., Direction du Service Spécial de l'Escaut Maritime. June 16.

BREMEN.—Two electric capstans (April 6). Electric cranes (April 12). Particulars from Bauinspection für Zollan Schlussgebeit, Bremen.

BUDAPEST.—H.M. Consul-General at Budapest (Mr. Esme Howard, C.V.O., C.M.G.) reports that tenders are invited by the Municipality of Pécs for the building and working of an electric railway in that town. Tenders will be received up to noon on June 6, by the "Pécs varos gazdasagi tanacsnokanak, Varosi Székhaz," Pécs, Hungary, from whom also detailed conditions and forms of tender may be obtained at a cost of 2 kronen (1s. 8d.). The plans and other documents can be examined on personal application at the Engineering Office of the town of Pécs.

HERTOGENBOSCH, HOLLAND.—Tenders are invited for the installation of an electric lighting and power plant, including the laying of underground cables, etc. Tenders should be sent to "Heer Administrateur der Godshuizen, Gasthuisstraat, 9," Hertogenbosch, at which address they will be opened at 11 a.m. on April 19. Plans and specifications may be purchased from the same official on payment of 12 gulden (20s.).

MADRID.—Electric tramways in the Calle Nelasqiez and Alcalla towards Diego de Lew. Particulars from Direccion General de Obras Publicas. May 9.

TENDERS ACCEPTED.

BELFAST.—Electricity Department, insulated cables, Callender's Cable & Construction Co., Ltd.

LONDON.—County Council.—Supply of 2,000 steel fishplates for the Council's tramways. Walter Scott, Ltd., Leeds (accepted), £10 10s. a ton; P. & W. Maclellan, Ltd., Glasgow, £13 13s. 9d. a ton. Insulating Varnish: Pinchin, Johnson & Co., Ltd., Bevis Marks, E.C.

SYDNEY.—Contracts have been let by the Postmaster-General's department for the supply of about 1,200 wall and table telephone sets; the British Insulated & Helsby Cables Co. will supply 1,000 common battery wall sets, the price being £1,975, and Messrs. Lawrence & Hanson, as agents for the General Electric Co., of London and Birmingham, will supply 200 common battery table sets for £307 10s.

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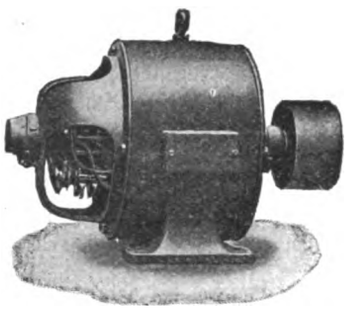

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DUBLIN ELECTRICAL ENGINEERS' SOCIAL.

The annual conversazione of the Institution of Electrical Engineers, Dublin Local Section, last week, in the Lecture Theatre, Leinster House, Kildare-street, which was filled with members and guests. An organ recital was given by Mr. Charles G. Marchant, Mus.B. Dr. Pollock contributed an interesting lecture, entitled "Constantinople and the Bosphorus," and afterwards an entertaining programme of music was gone through. During the evening Mr. H. H. Poule, B.A., gave a demonstration, of the working of the X-ray apparatus in a room adjoining the theatre, and demonstrations of electrical cookery were given by Mrs. M'Carthy Judd. All the arrangements were carried out in satisfactory style, and the conversazione proved extremely successful from every point of view.

CONTRACTORS' NOTES.

There is still much which electrical undertakers, acting in conjunction with the contractors in their districts, can learn in the way of publicity from the gas companies, who, in their policy of rentals, have not only increased the sale of domestic gas heating cooking apparatus, but have also largely increased the total consumption of gas. More effective co-operation between electric supply authorities and contractors would be no less productive of general good to the whole of the electrical industry. One line which might be developed in this way is that of small motors. The central station companies in the United States have found that one of the quickest ways of building up a motor load in a town where there has been little electric power service has been to put motors out on trial. If good judgment is used in the installation of these motors by the central station companies, they will nearly always remain in service, and the consumer will accept and pay for them. This is a plan which has been tried in the United States with satisfactory results. But a scheme which seems more suited to this country is that of renting small motors to consumers for a short time, or, in fact, for any length of time that the consumer is willing to use and to pay for them. The rate of rental should be high enough so that there would be considerable inducement for the consumer to purchase his motor. Along with this plan of motor-rental, it might be worth while considering a plan of installing motors to be paid for by instalment. This spreads the first cost of the motor over a long enough period so that the consumer would frequently put in a motor where he otherwise would not.

A FEARLESS WINCH.

The change which has overcome the trimming of arc lamps from hand to mechanical methods is a noticeable feature in the streets of those towns which are illuminated by arc lamps. Thanks to the ingenuity of the designs of arc lamp raising and lowering gear introduced by the London Electric Firm of George-street, Croydon, and to their enterprise in "pushing" these devices, the slow hand method of trimming is being gradually superceded. The London Electric Firm are now manufacturing a self-sustaining winch, which was primarily designed for raising and lowering arc lamps, but the principle involved has already been adapted to a number of other uses, including winches with two and three-space reels for raising theatre curtains, and winches with comparatively long barrels for hoisting purposes, while the most recent development comprises a special combination with a pulley for reducing the speeds of electric motors. The wall plate of this winch has in its simplest form two channels or grooves cut in it; in these grooves work three pins cast on the second fitting, which is an annular ring. On the opposite side of this are three other pins. On the centre of the crank spindle is cast a cam of the same diameter as the hole in the ring; over this comes the barrel proper, with three recesses in it which engage the pins on the face of the ring. There is in the construction of this winch neither ratchet, forms

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SITUATION WANTED.—Knowledge of Wiring, Arc Lamp Work, X-Ray Apparatus, etc.—Box A. D., c/o THE ELECTRICAL ENGINEER, 149, Fleet-street, E.C.

FOREMAN WANTS SITUATION with Arc Lamp firm; well up in Theory and Practice of Mechanics and Electricity; 32 years of age, and 17 years' practical experience.—Box W. E., c/o THE ELECTRICAL ENGINEER, 149, Fleet-street, E.C.

WIREMAN, Experienced in all branches, requires situation —Box A., c/o THE ELECTRICAL ENGINEER, 149, Fleet-street, London, E.C.

ELECTRICAL ENGINEER desires berth in Central Station, or charge of private installation.—Box C., c/o THE ELECTRICAL ENGINEER, 149, Fleet-street, London, E.C.

ELECTRICIAN, young, requires situation; could take charge of small plant.—Box H., c/o THE ELECTRICAL ENGINEER, 149, Fleet-street, London, E.C.

MEN OUT OF EMPLOYMENT in all branches of the Electrical Trade should write to Box No. 20, c/o THE ELECTRICAL ENGINEER, 149, Fleet-street, London, E.C.

worms nor gear wheels. The movement depends upon the travel of the pinned ring round the grooves, and this is effected by means of the crank acting through the cam. Given the leverage operating from the centre, the movement is smooth and easy; but, no matter at what point the power is released, the load is at once held without any accessory parts. The ratio is in the proportion of 3 to 1, but by varying the shape of the grooves and increasing the number of highest and lowest points in the full travel, the proportion may be altered, while by charging the shape it is possible to produce a movement of the winch opposite to that taken by the handle. The construction of these winches is such that, apart from safety and efficiency, the article is smaller and cheaper than winches for similar loads made on smaller lines.

COUNTRY HOUSE ELECTRIC LIGHTING.

It is almost a shock to realise that electric lighting is now so old-established an affair that replacement of installations is becoming necessary. At Blagden Hall, the country seat of Lord Ridley, however, the re-wiring of the electric light installation is being undertaken to the specificatoins of Mr. E. Wingfield Bowles, of Victoria Mansions, Victoria-street, S.W. The new installation is a very complete one, including a suction gas plant and batteries, a switchboard of adequate capacity and underground cables. The wiring is being carried out in screwed tubes, a maximum of two wires per conduit being allowed, and every provision for an up-to-date and efficient equipment is being made. In addition to the electric lighting equipment, a complete system of bells and telephones is to be installed, the latter being the Sterling secret service system, the calls being given by the illumination of lamps.

OSRAM LAMP PRICE REDUCTIONS, BUT NOT PRICE CUTTINGS.

As will be seen from our advertisement pages of this week, The General Electric Co., Ltd., announce certain reductions in the price of Osram lamps. It is pleasant to notice these reductions are not of the nature of undercutting previous price reductions by other makers, but appear to be the outcome of a purely premeditated policy. When the previous reductions in the price of Osram lamps were announced, it was explained that the 17-watt lamp at 2s. 9d. was taken as a standard. So as to assist station engineers and to encourage the public in the use of higher candle-power lamps, the price of the 25, 32 and 55-watt lamps were only 3d. dearer than the 17-watt lamp. This policy has been carried a step further, and now the price of the 100–135-volt lamps are the same for all candle-powers from 16 to 50. As regards the high voltage lamps, these are only reduced by 3d., which no doubt is the outcome of a cheapening in the manufacture, while the 55-watt lamp is reduced to 3s. 9d. Upon our enquiry as to this apparent incongruity in price, we are informed that this type of lamp is principally used for public lighting in

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PLANT FOR SALE.

Advertisements under this heading: Twenty-four words, 1s. per insertion; three insertions for 2s. 6d.; or each additional line of eight words, 4d.

HORIZONTAL HIGH PRESS CONDENSING ENGINE for sale by Woodhouse & Mitchell, capable of developing 20 to 30 h.p., first rate order. Selling as more power is wanted. —For particulars apply Box O, c/o THE ELECTRICAL ENGINEER, 149, Fleet Street, E.C.

FOR SALE, 25 b.h.p. MOTOR, built by the Electric Construction Co., Ltd., Wolverhampton, with spare armature, extended shaft, and extra wide pulley, pedestal and plate, coupling, starting switch, and resistance, 200 volts, 102 amps., at 830 revs.—Box S.H.P., THE ELECTRICAL ENGINEER, 149, Fleet-street, London, E.C.

FOR SALE, 20 h.p. Suction Gas Plant and 14 b.h.p. Engine; also 10 h.p. Vertical Boiler and 6 h.p. Vertical Steam Engine.—Box C.E., c/o THE ELECTRICAL ENGINEER, 149, Fleet-street, London, E.C.

LANGDON DAVIES ELECTRIC MOTOR; alternating current, 16 h.p.; 100 volts.—Box G.S., c/o THE ELECTRICAL ENGINEER, 149, Fleet-street, London, E.C.

ELECTRIC MOTORS.—Two 15 h.p., 500 volts; one 20 h.p., 100 volts; one 10 h.p., 460 volts; tramway controllers.—Box W.G., c/o THE ELECTRICAL ENGINEER, 149, Fleet-street, London, E.C.

competition with gas, and the makers are wishing to encourage the electrical industry in their fight with the gas industry by means of this type of lamp. In any case, the new move is an interesting one, and should prove of considerable use to contractors by encouraging a brisker sale.

CONTRACTS WORTH WATCHING:—

Below we present a list of building contracts which have recently been placed or for which tenders are invited. We have no means of ascertaining whether electricity will be used at all; but it is evident that in the majority of cases electricity will be used either for lighting or for power, or for both. Where names of firms are mentioned, and unless otherwise stated, they are those of the builders or contractors who have the work in hand, and it will repay electricians to keep in touch with these jobs.

Barnsley.—Crawshaw & Wilkinson, Architects, 13, Regent-street, Barnsley. Additions and alterations to works at Summer-lane.

Barnstaple.—Cooke & Son, Barnstaple. Wesleyan Church.

Bradford.—S. Spencer, Architect, Old Bank Chambers, Gt. Horton, Bradford. Alterations to Fuddock Dye Works.

Brighton.—W. J. McMillan, Western-street, Brighton. Houses.

Bristol.—A. Dowling, 125, North-road, Bishopston, Bristol. Bungalow.

Coventry.—W. Chattaway, Architect, Trinity Churchyard, Coventry. New Building for the Triumph Cycle Co., Ltd.

Darlington.—Blackett & Sons, Darlington, High School for Girls.

Derby.—E. J. Johnson, Hon. Secretary, Royal Nursing Institute, London-road, Derby. Additional Wards to Nursing Home.

Downham Market (*Norfolk*).—L. F. Eagleton, Architect, King's Lynn. Billiard Room at Conservative Club.

Dover.—Hayward & Paramour, Dover. Wesleyan School House.

Durham.—F. E. Coates, Shire Hall, Durham. School Alterations.

Forest Hall (*Northumberland*).—Hope & Tasker, Architects, Trinity-buildings, New Bridge-street, Newcastle-on-Tyne. New School.

Frizinghall (*Bradford*).—The City Architect, Town Hall, Bradford. New Chemical Works.

Hamilton (*Scotland*).—H.M. Office of Works, 3, Parliament-square, Edinburgh. Post Office Alterations.

VULCANITE
SPECIALISTS
IN
TURNED & MOULDED GOODS.
F. CARSON & EVANS.
34 Fenchurch Buildings
LONDON, E.C.
EBONITE

Leytonstone.—W. Jacques, Architect, 2, Fen Court, Fenchurch-street, London, E.C. School.

Longton (*Staffs*), *Burslem* and *Tunstall.*—Bertie Crewe, 75, Shaftesbury-avenue, London, W.C. Electric Theatres.

Middlesbrough.—W. S. Holt, Architect and Surveyor, 61, Albert-road, Middlesbrough. Extension to Workman's Institute.

Shotley Bridge (*Gateshead*).—Newcombe & Newcombe, Architects, 89, Pilgrim-street, Newcastle-on-Tyne. Erection of Hospital for Consumptives.

Shrewsbury.—A. E. Williams, Architect, County-chambers, Shrewsbury. Corporation Stables.

Southend.—B. H. Davey, Southend-on-Sea. Tramcar Shed Extensions.

Stockport.—J. W. Bain, Clerk to Education Committee, Romiley, near Stockport. Elementary School for 800 children, with housewifery, laundry and cookery centres, at Hazel-grove.

Warrington.—J. Moore Murray, Secretary and Director, Education Office, Warrington. Extension of School of Art.

REVIEWS.

"Electricity," by H. M. Hobart, B.Sc., M.Inst.C.E. (London: Constable & Co. 6s. nett.)

Mr. Hobart is one of our best writers on the design of dynamo-electric machinery, but judging from this book he is not so good when explaining the *theory* of electrical phenomena. In trying to be original and to get right away from the accepted methods of existing text-books, he succeeds only in fogging the readers' mind. He has what might be called the "curve habit" strongly developed, and the book has many curves, which, although interesting for those who have already studied the subject pretty thoroughly, are not helpful to learners. At the same time there is a good deal of common-sense reasoning in the book, and it should be helpful to teachers, giving them hints on how to present fundamental facts in a new light. As with all Mr. Hobart's books, the bread and butter side is kept in view; the author says in the preface, problems involving cost have been deliberately introduced, since the cost factor is of paramount importance and can no more be neglected than can other important attributes of various materials and processes. He manages to get all the figures for "Lines, Corners and Tangents of Angles," in a page and a half and introduces the tables in this way. The comprehensive tables usually employed giving an exactness by many significant figures are of value to astronomers, but they are about as much of a nuisance to an electrical engineer as would be a slide rule made one metre long with a view to increased accuracy. The two last chapters in the book are the best; they deal with "The Magnetic Circuit" and with "Insulating Materials." Mr. Hobart is approaching actual experimental data when he deals with these two subjects, and so he is more at home. Even here, however, some of his sentences sound very quaint. For example: "The hysteresis loss on representative good material may be taken as some ten kelvins per ton per million cycles. When the density is 10,000 lines per square centimetre. Here is a case when the kelvin is an inconveniently large unit and it is much more useful to make our calculations in joules. A joule is a watt second, consequently one kelvin = 3,600,000 joules."

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COMMUTATING-POLE DIRECT-CURRENT MOTORS.*

By E. H. ANDERSON.

The armature in its simplest conception is a drum divided into four sections for four poles; under a north pole is a broad distributed sheet of current running parallel to the shaft; under a south pole is also a broad distributed sheet of current, but in reverse direction.

This distributed armature current produces a magnetising force which changes the distribution of the main flux in the pole faces. In the centre of the pole there is no distributing effect, but in the centre between poles there is the maximum magnetising effect from the armature. This is where the conductors are commutated by the brush and the direction of the current reversed in passing from the zone of one pole to the zone of the next.

The magnetising effect of the armature, being a maximum midway between poles, produces a flux through the air space to the frame. The conductors in motion cut this flux, producing a voltage in the coil to be commutated.

The combined result of armature and field magnetising effect is to cause a flux to leak from the pole tip over into the armature just where the conductors are being commutated.

The two leakage fluxes are alike, and add to produce voltage in the coil which is being commutated. Thus there is a potential between commutator bars, and when these are short-circuited by the brush a local current is caused to flow in the coil under commutation. This local current adds to the line current already there. Any conductor carrying current has lines of force interlinked about itself caused by the current in the conductor. The conductors, embedded in and surrounded on three sides by iron, have a good opportunity of surrounding themselves with a lot of leakage flux. The interlinkage of leakage flux is similar to the inertia in mechanics.

The combined current (line and local) has still greater interlinkage of leakage lines and becomes more difficult to reverse. The reversing has been done heretofore by the increasing resistance of contact between the brush and the commutator bar as the latter is passing out under the brush, the rate of change of current ever increasing. This causes the reactance or kicking voltage to become higher and higher. As the bar leaves the brush, the change in current in the coil becomes so rapid that an appreciable voltage is induced and arcs through the air from the bar to the brush, or *vice versa*, thus producing what is commonly known as sparking.

The object is, then, to remove the sparking by counteracting one or all of its causes. Should we place midway between the main poles another coil, having the same magnetising power as the armature, but so connected as to magnetise in the reverse direction to the armature, there would be nothing to cause a leakage flux from the armature to the frame. Then, again, should we further excite this coil so as to overcome and balance the combined effect of armature and field forces, commonly known as distortion and leakage of the main flux from the pole tip, we would annul this troublesome cause of sparking. After the above two effects are taken care of there remains a force necessary to produce a potential sufficient to reverse the current in the armature coil.

In order to produce this potential there must be such a density of flux as will generate this required voltage by the conductors cutting the flux in revolving. The width of such magnetic density should be sufficient to embrace the conductors commutated by the brush when running in either direction of rotation.

The commutating voltage produced by the flux of the commutating pole is the accelerating force required to change the direction of current in the armature coils one by one as they come under the brush. It must be sufficient to accomplish this in the time that the coil, being connected to two adjacent commutator bars, is under the brush. When the commutator bar leaves the brush the current is already reversed, flowing in proper direction, and is of the proper amount, so there is no tendency to spark. Commutation may then be said to be perfect.

As stated before, an armature coil embedded in iron is surrounded by a leakage flux, which is caused by the current in the coil and may be said to have magnetic inertia or momentum. This is similar in mechanics to a revolving shaft bearing a mounted flywheel. The voltage induced in the coil by the flux from the commutating pole may be likened to a constant counter torque; thus counter torque serving to slow down the revolutions, stop and cause an increase in speed in the opposite direction.

It is evident that under certain circumstances the voltage induced by the commutating pole flux will vary directly as the speed; furthermore, the time that the coil is under the brush is shorter as the speed is higher, and *vice versa*; also that the time required to reverse a current is inversely as the voltage. The conclusion is that the action is entirely automatic throughout the entire range of speed with the particular condition of current and commutating pole density.

The next question is: Can the action be automatic for varying current as well as speed? The commutating pole may be excited by the main current of the motor, being connected permanently in series with the armature. The commutating pole flux will then vary almost directly as the current, which is the desired result. When the current is half, the commutating pole flux is half, and the commutating voltage corresponding thereto. Thus the action is entirely automatic for variation in current or speed, or both.

The relation between commutating pole density and current should be a straight line, rising and falling directly with the current.

It is well understood that an absolutely straight line between current and density cannot be obtained when a more or less saturated armature current, speed of motor and flux iron circuit carries the flux. In a series motor density of the whole iron circuit increases as the load comes on, and there is an increasing stability in commutation which serves to offset, partly, if not entirely, the lack of commutating-pole density on a heavy load. The combined effect is to produce perfect commutation at all loads.

Since the commutation is automatically taken care of for variations in speed and current, it is possible to change the voltage impressed on the motor through quite a range without sparking. This is thoroughly borne out by motors of 50 to 250 h.p. recently constructed in this country.

* Abstract of paper read before the Central Electric Railway Association, Columbus, Ohio.

TIDAL POWER.

The gigantic mechanical force developed by the movement of the sea has naturally attracted the attention of power-users from the earliest stages of civilisation. These movements are of three kinds: ocean currents, waves, and tides. Ocean currents are permanent features of sea-physics, and it might be thought, therefore, that they would be important sources of power, especially as they are manifestations of enormous silent strength. They are, however, slow, and never near enough to the coast line, and there is not the slightest prospect of their being utilised at present.

As regards waves, the first condition of using their lifting power to advantage is that they should be caught, so to speak, before they break. When the wave crashes down upon the beach it has work to do which can never be diverted to human purposes. Now, the lift of a wave affords greater opportunities. It is quite evident that it cannot be made useful except by making it lift a vertical shaft with a float at its lower end, and geared in some way at its upper end to some form of machinery. Here we are confronted with a difficulty which has hitherto been insuperable. The lifting power of a wave is enormous, but it is spread over a large horizontal surface. In other words, the lift is small per sq. ft. of the float, so that a big float, or a big float surface distributed over many floats is necessary to get the power out of the water. The difficulties of a huge flat float are obvious, unless it could be made like the planes we read of in text-books of mechanics, perfectly stiff, and with the vertical axis centred with theoretical prices. The difficulties of a large number of floats are, if anything, more obvious. Each will want its own rod, and friction will be multiplied beyond calculation, and what is more to the point, to an absolutely unfinancial extent.

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Hence, all attempts to utilise wave lift as a source of power for driving purposes have, so far, failed ignominously. It is reserved for a future generation, our superiors in knowledge and experience, to solve the problem. There is no ground for supposing it to be intrinsically insoluble.

Still, a brief review of some of these attempts may be of interest. It must be premised, too, that it is a difficult matter on many coasts to find a suitable place for establishing wave-worked motors. The place ought to be sufficiently shallow to afford protection to the works from storms, and yet open enough to afford free access to fairly large waves. Of the capricious way in which the power is manifested, its magnitude has always made it a tempting subject for engineers, especially in countries which have a large sea-coast, and where coal is scarce. Italian engineers, in particular, have worked largely in the matter. R. Salvadori has shown that the present methods only utilise a very small fraction of the mechanical force of the water. He puts the power obtainable at the amazingly small figure of one h.p. per kilometre of coast. It, of course, depends on the height of the waves, and the following table is the result of extensive experiments undertaken by Salvadori :—

Wave height—	Power per km. of coast—
50 cm.	0·16 h.p.
100 ,,	1·27 ,,
200 ,,	7·26 ,,

He estimates that waves 1 metre high can be reckoned on in Italy for at least half the year, and that the cost of the plant is about £200 per horse power. Experiments have been made on the English coast, and on the Pacific coast of North America, but were soon abandoned.

A wave power pump was tried without success in 1889 at Ocean Grove, New Jersey, to supply water for street sprinkling, and was the invention of N. O. Bond, of Fairfax, Virginia. A pier was built out into the surf, and on the seaward side were hung eight gates, swinging on a horizontal rod running along their tops. Each gate was 13 ft. wide, with its lower edge immersed to a depth of about 2 ft. at neaps and 7 ft. at springs, and the gates transmitted their motion to rocking arms working the plunger of the pumps.

The chief English experiments were in 1890, and the apparatus took the form of a large buoy which actuated a vertical shaft, whereby the rise and fall of the buoy were made to compress air, the compressed air in its turn working a dynamo.

Tidal action is, of course, much more regular and reliable than wave motion, but for all that it is quite erratic enough to put immense difficulties in the way of harnessing it. There must, of course, be a sufficient rise and fall. Tidal action could never be utilised at the Pacific Islands, or in the Mediterranean. When there is a sufficient ebb and flow, we are confronted with the fact that high water occurs at all sorts of different times, and that it often happens that the time between two successive high waters or, say, 13 hours roughly, is very unequally divided between ebb and flow. The flood tide may come in with extraordinary force and velocity, or *vice versa*. In all cases the speed of the tidal current is very variable, and there is almost always a slack at the change of the tide. Again the effect of the wind on the tide has to be considered. When the wind is against the tide, the rise may be much less than the normal. This may be observed at Portsmouth as well as anywhere. The tide comes out of the harbour during most of the ebb like a mill race, and if the wind happens to be blowing the reverse way an ugly sea is caused which destroys several human lives annually with unfailing regularity and alters the time of ebb very materially.

For these and other minor reasons, it is now recognised that it is hopeless to attempt to utilise the tidal motion direct, and the only system at present known that offers any chance of success is to make the rising tide fill a reservoir, which can then be emptied at any desired rate, and returning to the sea during the ebb, can actuate turbines on its way.

Here again we are face to face with several important difficulties. When a lake or a river supplies water-power, the surface of the land is already covered by the water, and has probably been so covered for thousands of years, so that there is no loss of area. The case is very different when an artificial reservoir has to be made. Its construction requires subtracting from the available dry land, a portion to be henceforth under water. Again, a reservoir for storing tidal water must be very large superficially to hold a sufficient quantity for the rise of the tide is never enough to give a great depth of water in it. We might perhaps get 30 or 40 ft. depth in the Bay of Fundy, but not the most enthusiastic of tide utilisers has ever dreamed of constructing a tidal reservoir at that classic spot. Besides, there must be at least two reservoirs, one for use while the weight of water is being renewed in the other.

All this is well illustrated by a proposal made about 20 years ago to utilise the tide in the Seine. Training walls were then being constructed to improve the scour of the river, and it was suggested that the space between the walls and the natural bank might be utilised for tidal reservoirs, as then no excavation would be required. The scheme was to have two reservoirs separated by a dam with openings each containing a turbine. The higher basin was to be put into communication with the tidal current during the last two hours, roughly, the upper third of the flood tide, and the lower basin during the lowest third of the ebb tide.

If the range of the tide is x feet, this arrangement will secure that the level in the higher reservoir would never be less than $\frac{2x}{3}$ feet above low water mark, while the level in the lower reservoir would never rise above $\frac{x}{3}$ feet, above the same datum. The available head would average $\frac{2x}{3}$, with a minimum of $\frac{x}{2}$, according to the tide and the available gross horse-power, would be roughly expressed by the product of the square of the head into one-thirtieth of the water area, and might be increased by one-third if the level of the upper basin was allowed a variation of half the tidal range. It was proposed to establish power stations of this kind on both banks of the Seine near Honfleur and Havre. On the left bank the available space was only 2,500 acres, with a tidal range varying from 10 ft. at neaps to 26 ft. at springs, giving 3,000 h.p. at neaps and 9,000 at springs. The cost for the right bank of the river was never worked out, but for the left bank it was estimated (exclusive of the expense of the training walls themselves) at £72,000 of £12 per average horse-power. It was thought that if the French Government would undertake the work, they would be well repaid by charging power consumers 32s. per horse-power (on the turbine shaft). Small factories at Havre are at an expense of about £24 per horse-power. It has been estimated by other engineers that a tidal range of 3 ft. can be made to give 600 h.p. per square mile of reservoir.

ELECTRIC SMELTING.

Great success has attended the installation of electrically heated blast furnaces at Domnarfvet in Sweden. The electric blast furnace is the latest and biggest development of arc-heating. Keller has shown that any kind of iron ore can be dealt with in the electric furnace and that either grey or white pig can be got at will, when a suitable amount of coke is used, and also that the pig contains less sulphur than pig made in an ordinary blast furnace from the same ore. Heroult has gone further and has proved that even highly sulphurous ores give a pig with a small percentage of sulphur, and that where it is cheaper wood charcoal can be used instead of coke. The electric furnaces at Domnarfvet are now turning out iron at a cost of 56s. a ton, which sells for 64s.

The height of the electric blast furnace is 25 ft. only, so that it is cheaper to build than the ordinary furnace. It has the usual bell at the top and pipes for conveying away the gases for future use. The great difference between it and the old-fashioned furnace is the size of the hearth, which is wider than even the boshes. The current is fed to the furnace at about 40 volts and 9,000 amperes. The consumption of fuel in the furnace is extremely low, but hitherto the energy required has been considerable, say, 3,000 kw. per hour. Fresh furnaces are now in course of construction with which it is hoped to bring this figure down to 2,000 kw., and so to get more than eight marks profit on each ton of iron.

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Electrical Progress at Home & Abroad.

A Review by our Special Correspondents.

TYNESIDE.

NEWCASTLE-ON-TYNE.

The Mining Electrical Engineers, the newest institution among the engineering group, is showing most remarkable activity in this area. The meetings and discussions have been of interesting and vigorous nature, and the paper by Mr. C. R. M. Young, B.Sc, of Messrs. Scott & Mountain, Ltd., on "The Relative Merits of Direct and Three-phase Alternating Currents for Colliery Work," and the discussion thereon, on Wednesday the 23rd ult., at Armstrong College, was no exception to the rule. The paper was an impartial attempt to contrast the working results of the two systems under the headings of reliability as regards risk of breakdown and danger to life, cost (both in initial outlay and in maintenance and running costs), and the flexibility of the plant to meet the various conditions. With regard to the risk of breakdown, Mr. Young thought that provided reasonable cleanliness was observed a direct current motor was quite as reliable as a three-phase machine. Concerning danger to life, he mentioned a case where a man came three times in quick succession in contact with high tension contacts due to the repelling action of alternating currents, and contrasted this with the drawing action of continuous currents. He referred to Dr. Thornton's demonstrations on explosions and thought that there was a slight advantage in favour of the alternating current system. Under initial cost a test case of a 550 h.p. installation of a compact size was taken, and costs were contrasted for direct current 500 volts, three-phase 500 volts, and three-phase 3,000 volts. The figures given were £6,290, £6,325, and £5,985 respectively for electrical plant only. Running costs were practically identical. As regards flexibility or ease with which either class of plant may be adapted to any particular duty, Mr. Young referred to Mr. Nelson's paper, "Electricity in Mines—Some Practical Considerations," and traversed some of the opinions therein expressed. The chief criticisms were that some direct current plants had been running for twenty years, showing their reliability; except in small powers and in places where they can be started up light, mine motors are not of the squirrel cage type; a typical three-phase motor will drop out of step at 100% overload, while a direct current compound and inter-pole motor can easily deal with such overloads without sparking. Other advantages for direct currents were claimed and the author concluded by considering various ways in which electric supply to collieries would be required and the system most suitable to each case.

The Discussion on the Paper.

The paper produced a strong discussion which, owing to time limit, was carried over to the next meeting. Mr. Mountain deprecated the scare existing at present as to the intention of the Home Office with regard to direct current plant in mines, as he believed this to be unfounded. He referred to the disturbance of voltage in an alternating current colliery installation when a haulage squirrel cage set is switched on. Dr. Thornton dealt with the question of electric sparks and referred to the small gap left on colliery machinery between live copper and frame-work. He also referred to the Crompton C.M.B. converter and its uses for mine work. Mr. A. M. C. Field also said that he had one of these machines working, and that it was giving excellent results, having a 93% efficiency. He was putting down a 30 h.p. squirrel cage motor with a Hele-Shaw clutch, and said that as all the haulage would be effected on the clutch the upset to voltage mentioned by Mr. Mountain would, at the worst, only happen once a shift. He also referred to the question of "potential front." Mr. Clothier thought that alternating currents were more easily controlled than direct currents. Although oil break switches for direct currents were not at present practicable he was beginning to hope that a specially designed oil break switch for such work would soon be available. Other members referred to the relative advantages of the two systems for driving high speed turbine pumps, the question of safety from leakage, the adjustment of stators to provide for bearing wear and the use of ball bearings, and the question of dirt as affecting the two systems. Mr. Young spoke briefly in reply, pending the resumption of discussion.

Electrical Mine Fatality.

In view of the Home Office enquiry upon the safety of electricity in mines, a recent fatality at South Shields may have a bearing. An electric motor man at the St. Hilda Colliery was found lying dead on the engine house floor, and a switch box carrying 3,000 volts was found open, the position of the switch box being about three yards from the position of the body. From the evidence of a technical witness at the coroner's inquest, it appears that nothing had gone wrong with the machinery, and that the man had been warned not to put his hand into the box, and had no right to open the door of the box, this being the duty of the electricians. Unless the door was opened there was no danger. Rubber gloves had been provided, but were not used. The coroner was of the opinion that the man had been examining the box out of curiosity and had touched a live part. It is valuable that this opinion has been printed in connection with the report of the inquest in the *Shields Daily News*, as otherwise another instance of alleged danger might be presumed by those who already view electricity with suspicion. It should be pointed out that the accident occurred on the surface, under such conditions as might be found in an ordinary factory supply. If any lesson may be learnt, it is probably that high tension switchgear should be so constructed that the opening of the door should be impossible until all pressure is removed from every part of the contained apparatus.

THE MIDLANDS.

BIRMINGHAM.

Local authorities and other purveyors of electricity in the Midlands are extremely active laying down new plant or seeking additional powers. The Corporation of Aston Manor, though the shadow of the Greater Birmingham proposal still hangs over the borough, has in hand a scheme for extensions of its power stations at an estimated cost of £13,550. An application has been made to the Local Government Board for power to borrow the money, but no reply has yet been received as to the date of the enquiry. The scheme includes the installation at the Chester-street station of one 2,500 kw. turbo-generator and condenser, one water tube boiler, and one 250 kw. motor generator for converting purposes, and at the Alma-street sub-station of 1,350 kw. rotary converter and one small balancer, with the necessary high and low tension switch gear at the two stations for controlling new machines. The accounts for the financial year ending March, 1910, are expected to show a handsome profit, which will not only complete the wiping out of the deficit brought forward four years ago, but will also enable a beginning to be made of a reserve fund. It is considered that a reserve of between £9,000 and £10,000 will be sufficient, and if the profits of the department continue to increase as they have done during the last two or three years, it should not be long before the electricity business begins to contribute something substantial in relief of the rates.

Walsall's Scheme.

The Walsall Town Council has withdrawn for the present its application to the Local Government Board to sanction an expenditure of £35,000 in extensions of works and

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areas of supplies in order that amended plans and estimates may be prepared in accordance with certain suggestions made by the Local Government Board. The electricity committee, however, have prepared a provisional scheme, and it is proposed to make a fresh application for sanction to the borrowing of £8,345 to enable the committee to meet the demands for current during next winter. Some extensions of the plant of the Dudley Corporation Power Station at Springsmire have just been completed. They include a storage battery of the latest type, together with a booster and motor generator. Additions to the control apparatus have also been made. The principal object of the alterations is to enable energy to be stored during the hours in which the station is lightly loaded and to steady the load on the engines while working the tramways. The Wednesbury Town Council has applied for a loan of £2,925 for various purposes in connection with the electrical undertaking, chiefly for small mains extensions. So far, there has been a loss of £4,000 on the undertaking, but there is reason to believe that the business has now got the turn and that the new business in expectation of which the proposed extensions are to be made will enable a gradually increasing profit to be shown.

Miscellaneous Uses of Electricity.

With the approach of summer the miscellaneous applications of electricity to heating and other purposes are receiving attention from the engineers of the various local stations. The Birmingham Electricity Committee will open shortly a special showroom of appliances for cooking, flat iron heating, and ventilating. The Aston Committee are also preparing a scheme of a similar nature for increasing their summer load. In Birmingham, there are already some half dozen laundries which take current from the Corporation and their experience is understood to be sufficiently satisfactory to induce the hope that further extensions of this source of revenue may be looked for. Among the firms for which the Birmingham Corporation is making connections this Easter is the General Electric Co., for whose works in Sherlock-street a supply of 100 h.p. is to be provided.

Birmingham Tramways.

The Birmingham Tramways are just completing their financial year, and the figures will be published shortly. It is anticipated that the receipts will show an increase of about £13,000. For the 51 weeks, ended March 19, the aggregate receipts were £293,813, as compared with £281,622 for the corresponding period of a year ago. This compares well with the previous year, when the increase was £4,755. In addition to the general trade improvement the Royal visit brought money into the municipal coffers both on the day and for some days in succession, when special cars were run for the benefit of those desiring to see the decorations. Some addition to revenue has come by the opening up of a new route to King's Heath. Considerable inroad into the profits will be made by additional working expenses, consequent upon the reduction of hours at the beginning of the present working year from 10 per day to 9 per day. This will mean at least £10,000 added to working expenses.

LANCASHIRE.

MANCHESTER.

A somewhat novel form of electric lighting for public streets is being carried out at Southport. During the past winter season there, the Corporation tried the effect of special week-end illuminations in Lord-street (the town's principal street) as a means of adding to the attractions. These illuminations gave great pleasure to both visitors and residents, and the Corporation has now decided to make a considerable extension by carrying them as far as Union-street. When this is done, they will extend about a mile in length, and each evening during the summer season the foliage of the trees one on side of the street will be aglow with the parti-coloured lights from the thousands of "fairy" electric lamps employed. Beautiful as the effect was in the winter, it will be much enhanced when the leaves are out. The extra load, though coming at an awkward time, will mean a substantial increase in the revenue from street lighting, but the Corporation's enterprise may be expected to bring more business to their Electricity Department by setting the fashion in illuminations. Smart tradesmen are now prepared to have signs and such like material talked to them, and no doubt many gas users will be led to change to electric light. Fancy little gas jets among the foliage of the trees! Here is an object lesson in the comparative safety of electricity and gas from the fire point of view.

Local Section Institution of Electrical Engineers.

Another successful session of the Local Section Institution of Electrical Engineers has been concluded. The annual general meeting was held on the 22nd ult. The officers and committee then elected for next session are:—Chairman, Mr. J. S. Peck; Vice-Chairman, Mr. W. Cramp; Hon. Sec., H. W. Wilson; Committee, Messrs. C. J. Beaver, A. A. Day, A. P. M. Fleming, J. Frith, T. L. Miller, S. L. Pearce, C. D. Taite, and A. P. Wood; Profs. E. W. Marchant and A. Schwartz, Drs. F. H. Bowman and E. Rosenberg. Votes of thanks were accorded to the retiring chairman, Mr. S. J. Watson, and to the Hon. Sec. for their work during the session. The proposal made by Mr. S. J. Watson at the dinner some weeks ago, that a local section conversazione should be held, has advanced a step further, and a sub-committee has been formed to consider the question. On the subject being mentioned at the general meeting it received the unanimous support of all present. The strength of the section at present is 99 members, 324 associate members, 83 associates, and 280 students, making a total of 786, against 776 the previous session. It was mentioned that although the numbers have increased, the attendances have not been so large. Both the chairman and the Hon. Sec. appealed to members intending to read papers, to prepare them in good time, as considerable inconvenience is caused to all concerned by rushing at the last minute, and members have not sufficient time to read the paper before coming to discuss it.

GERMANY.

BERLIN.

An interesting novelty in telephone and microphone membranes has recently been patented. The new membrane is an equilateral triangle, and is stretched in directions parallel to one side only, but in opposite senses. It is claimed that such a membrane will respond freely to all vibrations within its own special range.

Further Railway Electrification in Austria.

The Gmunden-Borchdorf line is to be lengthened at a cost of a million kronen, and the work is expected to occupy about a year.

Klagenfurt has commissioned the Osterreichische Siemens-Schuckert Werke to supply rails, electric wires and carriages for the street tramways at a cost of about half a million kronen.

Wireless Telegraphy and Air Ships.

Experiments carried out here and in other parts of Germany, chiefly under the auspices of our War Office, have shown fairly conclusively that wireless apparatus can be carried by dirigible balloons without the danger hitherto supposed to be caused by such a proceeding. The idea was that the sparks might cause the gas to explode, whereby, of course, the whole machine would be wrecked. It would appear that it is impossible for this to happen even when the energy employed amounts to a whole kilowatt. On the other hand, experiments have shown that wireless messages can be sent further from balloons than from fixed stations. For example, the balloon hovering over Friedrichstadt was able to send wireless signals clearly legible at a distance of 375 miles, at an expenditure of only 700 watts. The higher the balloon is above the earth the better in this connection. Again, the longer the waves are the better, within reason. The best length seems to be about 1,100 yards.

Tantalum Lamps.

It is well known that tantalum incandescent electric lights, so conspicuous for the extremely small amount of current which they require, have hitherto proved useless for vehicles, as they are rapidly destroyed, not only by the

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vibrations but by the great and sudden variations in current strength which are inseparable from rapid street transit. The Siemens & Halske A.G. have now succeeded in avoiding this difficulty. It is true that their scheme involves a larger use of current, but not more than two watts per Hefner candle, which leaves it even then at half the consumption of energy required for carbon-filament lamps. The new lamps are about 5 in. long by 2½ in their greatest diameter. They have been proved to be cheaper, with a life of 600 hours than a carbon filament lamp, although the latter last 800 hours. The new lamps not only resist current variations, but the light they give alters less on that account than is the case with the carbon-filament lamps.

Preventing Leakage of Cracked Glass Battery Cells.

An excellent plan for preventing glass battery cells from leaking should they crack, as they often do, is to cover them externally with celluloid before they crack. This is easily done by dipping them repeatedly in a solution of celluloid in acetone and letting each coat dry before the next dipping. In this way the total thickness of celluloid can be regulated at pleasure.

Company Notices.

The Voigt & Haeffner Aktiengesellschaft, Frankfort am Main-Bovkenheim, made a net profit in 1909 of 587,741 marks, including a carry over from 1908 of 54,319 marks. The net profit for 1908 was 624,164 marks. Nevertheless, a 10% dividend will again be paid. There can be no doubt that 1910 will more than make up for the falling off in 1909, as the orders handled so far in the present year represent 888,400 marks, as against 660,300 marks for the corresponding part of 1909.

The Leipzig street tramways had a better income for 1909 than for 1908, the receipts having been 6,492,355 and 6,222,280 marks respectively, including small carry overs from the previous years. At the same time, the expenses were somewhat larger, viz., 3,601,000 marks, as against 3,545,773. It will be seen that the receipts have increased faster than the expenses, a circumstance which permits the payment of a 10 % dividend for 1909, that for 1908 having been 9½%. Sixty-seven million six hundred and fifty thousand and ninety-four journeys were made by the public on the trams, an increase of roughly 5% over 1908, and the distance travelled was 19,484,891 km. This is one of the best-managed systems in Germany, and we consider it as a standing example of what a municipal undertaking of the kind should be. The Hamburg Co., we also notice, has done nearly as well. It is, of course, a much larger concern.

The Deutsche Elektrizitats Gesellschaft, which has its chief offices here in Berlin, has by general meeting unanimously approved a proposal by the directors to increase the capital from 80 to 90 million marks. The meeting was fully competent, as it represented more than half the present share capital. The new shares will be issued to a syndicate at 20% premium, and the syndicate will offer them to present shareholders at 28% premium.

The receipts of the Strassen Eisenbahn Gesellschaft of Hamburg, rose from 14,488,346 marks in 1908 to 14,942,986 in 1909. The distance travelled in the year was 43,860,303 km., as against 42,347,798 in 1908. The dividend will again be 10%. It may not be out of place to note that our smaller towns have all done well in 1909 with their electric trams.

UNITED STATES.

NEW YORK.

In the course of an article on the value of unit costs in electrical operations, the Chicago *Electrical Review* observes that by the use of unit figures time is saved in calculations, unsuspected relations between phenomena are often discovered, loose ends of operation caught up, and a closer appreciation is gained of the actual physical existence of invisible forces and their costs in application. In a station where the costs per kilowatt-hour are carefully determined and filed each week or month, the fidelity with which the figures year after year indicate the definiteness of the energy unit is most suggestive to the manager who is interested in keeping down his expenses in proportion to his output. If one month shows a notable change in the unit cost he can at once take steps to run the cause to earth; whereas, if only the totals are kept there might be a relatively small gain in output and a larger gain in total expense, which would not at once indicate that the operating efficiency was declining. The extent to which the sense of proportion is developed is in large degree a measure of one's command of a complex situation, and in the daily wear and tear of electrical production the value of reducing results to the unit basis in order to secure this idea of relative conditions and results is almost beyond exaggeration. Despite all the mistakes made in comparing operating results under diverse conditions without due appreciation of those differences, no executive can properly contrast his work with his neighbour's without cutting clear from the fogs and illusions of total figures. Neither can he approach bids for new equipment, tenders for construction work, or other propositions involving expenditures of moment with the keenest insight as to whether he is offered his money's worth unless he strips off the covering of an impressive total price and opens to view what the charge is per unit selected.

Licenses for Wiremen.

Electrical workers throughout New York State are up in arms against what they declare to be an attempt on the part of the electrical contractors to have a bill passed in the Legislature giving present contractors a monopoly of the business. The Bill is that introduced recently by Assemblyman MacGregor, which proposes to license master electricians, that is, "any person, firm or corporation engaged in the business of installing, erecting or repairing plants for furnishing electric current in buildings or other structures, or installing, placing, altering or repairing electric wires, apparatus or appliance therein for light, power, heat or signalling." Officers of the local electricians' Union see in the Bill an attempt on the part of the masters to control the business so as to make it impossible for members of their union in dull times or in case of strike to do work, lacking the master's license, and at a crowded meeting last week the union adopted resolutions condemning the proposed measure "as an attempt to monopolise the electrical business and shut out independent workers." The union men claim that the Bill is discriminatory and that as the skilled mechanics hired by the masters they should have the same privileges of a licensed electrician. But the Bill specifically states that to procure a license the person must be a master, and that means a man with a shop who hires outside electricians. The chief claim of the Electrical Contractors' Association, which is behind the measure, is that it is wanted as a guarantee against defective insulation so often the cause of fires. And it is said to be wanted by the underwriters.

Edison Battery—and After.

That New York will get rid of the several antiquated horse-car lines still operated there, and at the same time get 3-cent fare on several streets in the near future, is the prophecy made following experiments on the Twenty-eighth and Twenty-ninth street horse-car lines with the new Edison storage batteries. At the end of a day's service the readings of the engineers showed that the car had been run at a cost of approximately one-half the expense of the ordinary cars now in use. "The basis of cost is half cent per kilowatt-hour," said Supt. Ralph Beach, of the Edison company in an interview. "To be plain, this averages, per mile, one cent. There are 1,000 kilowatts in one mile, as the ordinary cars run and we, with our car, use only 648, which makes the cost about half cent per mile. Even this might be reduced on lines where not so many stops and starts are as necessary as on the lines with which we are experimenting. In the long run, it will be seen, this will materially reduce the cost of transportation of the companies, and so should reduce the price of fares accordingly. What will work more materially toward this than anything else, however, will be the durability of the new Edison battery. The common battery in use wears out within six months. Ours will last for ten or fifteen years. Three-cent fares should be the rule soon, it seems to me."

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Hydro-Electric Developments.

The new power plant of the Southern California Edison Company, to be erected in Santa Ana Canyon, will probably be begun early in the spring. The plant will have a 7,000 kw. capacity and will cost about $600,000. Plans are being made to dam the Auglaize River about two miles south of Defiance, Ohio, to secure power for industrial plants for that city. It is estimated that 2,500 h.p. can be developed. As the aggregate amount of power now used by the Defiance manufacturing plants is only about 1,500 h.p., there would be 1,000 h.p. left for other plants which might locate there. The development and improvement of water-powers of the Minnesota River and its tributaries are contemplated by the Minnesota River Improvement and Power Company, a company which has been organised by men living in the towns of the Minnesota River Valley. The company is capitalised at $1,000,000, and its object is stated as the improvement for "navigation and other public purposes, under the supervision of the Government and the State," of the Minnesota River and its tributaries in the state, and of the Lake Traverse and Big Stone, the development and improvement of water-powers for public use, the control of any work of internal improvement upon such streams, or in their vicinity, and the reclamation for cultivation low, marshy or overflowed lands adjacent to the streams. The plans contemplate three dams across the Minnesota River, at Ortonville Lac qui Parle and Redwood Falls. The incorporators say they will be able to control the flood waters of the river and save some 150,000 acres of land from inundation. Mr. James White, owner of the Star Thread Mills, has formed the James White Power Company and will expend $250,000 or more for the construction of a hydro-electric plant at Barnett Shoals. About 4,000 h.p. will be developed and transmitted by electricity for manufacturing and lighting. The chief user of this electricity will be the Star Thread Mills, which will take 500 h.p. for operating its plant, to which Mr. White expects to add largely in textile machinery. At present the plant has about 7,000 ring spindles for manufacturing yarns, and that equipment may be doubled during the summer.

New Pipe-line Departure.

The plant of the Utah Light and Railway Company in Weber Canyon is soon to be turned over to the company for operation. When completed the plant will generate 5,000 h.p. The pipe line which brings the water to the plant is a departure in generating electricity by water-power in the west. Instead of following the old plan of having the pipe line follow the sides of the mountain for several miles, and then dropping suddenly to the power plant, this line starts from a point a little over three miles up the canyon and follows, as nearly as possible, the natural drop of the river, with the exception that, instead of following the many turns of the Weber, the big pipe line takes a comparatively straight course. It goes through parts of the mountain where the river goes around; it crosses the river at a point where the water of the river drops nearly twenty feet in as many feet, and goes straight on to the power plant. The flume, built partly of concrete and partly of wood staves, reinforeed with steel bars, is nearly seven feet across at the opening and gradually narrows to about five feet. It means a clear, straight shoot of water such as has never before been secured by any power company in the west, and it is predicted that this plant will mark a new era in the building of power plants in the west.

Electricity for Canal Locks.

It is announced from Albany that electrical equipment for the operation of locks on the new barge canal is to be installed immediately in certain cases so that completed locks shall be ready for operation during the coming season of navigation. Locks on the barge canal will be twice as wide and three times as long as the old single lock; hence the change to electricity for the operation of the locking gates, filling of lock chambers, etc. The State Engineer has prepared plans and specifications under which the state department of public works will advertise for proposals for installing the electrical equipment on three locks at Whitehall on the Champlain Canal, one at Baldswinsville on the Erie, and four on the Oswego Canal. Engineers estimate that this equipment for the eight locks will cost $180,000.

Telephone Notes.

A recommendation that the capital stock of the American Telephone and Telegraph Company be increased to $500,000,000, is contained in the company's annual report issued this week. It is believed that the company purposes still greater expansion, though the report states "that none of this increase will be needed during the current year for ordinary capital expenditures." The company had a net revenue for 1909 of over $30,000,000, while the Bell system earned gross $149,914,700, an increase of $11,770,400 over last year. Net earnings for the Bell system were $48,367,500, out of which $23,910,600 were paid in dividends; $10,221,400 paid in interest and $14,235,500 placed in the surplus.

The purchase by the American Telephone Company of the 82,000 shares of its stock recently sold by the Mackay companies is announced by President Theodore N. Vail. The stock was secured at a price representing a cash overturn of between $11,000,000 and $12,000,000. It is proposed to utilise the Mackay stock in exchange for the stocks of several of the subsidiary companies which are being refinanced and regrouped in order to confine the physical property of the operating companies to established State lines. President Vail denies that there was any basis for the assertions that a rate war between the Western Union and Postal companies is impending.

Electric Railway Developments.

The Buffalo & Fort Erie Ferry & Railway Company has been formed through a merger of the Fort Erie Ferry Railway Company, the International Ferry Company, the Maple Leaf Amusement Company and the Niagara Equipment and Concessional Company, with plans for extensive improvements on the other side of the river. F. J. Weber is head of the new company. Chief among the improvements planned is an electric double-track railroad. It will have the latest equipment and will probably be operated under a traffic agreement with the Niagara and Saint Catharines road. It will have a spur to the Fort Erie beach.

The management of the Pennsylvania lines west of Pittsburg has placed an order with Allis-Chalmers Company for electric generating units to increase the capacity of the power plant at Conway, Pa., from which current for operating the shops there, and also for railway signal work, is supplied. The new machinery consists of two 750 kva., 3,600 r.p.m., 60-cycls, three-phase, 2,300 volt steam turbo-units. Of two units for exciting the alternators, one is a 25 kw., 120-volt, 260 r.p.m. direct-current generator coupled to an engine, and the other a 25 kw., 125 volt generator, direct-connected to a three-phase 60-cycle, 2,300-volt, 900 r.p.m. synchronous motor. This motor is rated at 150 kva. and, beside driving the exciter unit, will serve as an electrical condenser and thus improve the power factor of the station. Two 12 kw. flywheel type motor-generator sets will be installed in the station for supplying current for the railway signal system, each consisting of a 12 kw., 600 volt, shunt-wound generator direct-coupled to a 220-volt, 1,720 r.p.m. induction motor.

Underground Conduit Construction.

Mr. E. N. Lake, of the Chicago Board of Supervising Engineers, contributed a valuable paper on underground conduit construction to the last joint meeting in the Smoky city of the Western Society of Engineers and the American Institution of Electrical Engineers. Dealing with isolation and protection, Mr. Lake said that the best heat resisting and arc resisting material which is available on a commercial basis at this time is undoubtedly vitrified clay. In speaking of the qualities of this form of duct, it was mentioned that where material is desired for use in contact with flame or intensely heated gases as in furnaces, boiler bridge walls, flue lining, etc.; where a receptacle is wanted in which to enclose a high-tension insulator, when it is placed in kilns where material is to be subjected to the intense heat of molten metals, or, in fact, everywhere that heat and flame are to be resisted by direct contact, some form of hard, burned clay is used. Referring to the explosive qualities of water when closely confined and exposed

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to sudden and intense heat, he said that it is believed that the wall of a clay duct which might otherwise withstand the heat of a burn-out, will, if it contains a sufficient a nount of moisture, be rapidly disintegrated. Hence, vitrified clay duct is best for large power distributing systems, which will absorb the smallest percentage of moisture. As to conduit construction for telephone cables and for all cable systems where the number of heavy cables is not large and where no special consideration of the possible spread of " trouble " from one cable to another thought to be necessary, the multiple duct, on account of the economy of space and convenience in handling, is the logical choice of vitrified clay duct. For systems which carry large groups of cable, where tens of thousands of kilowatts may be concentrated upon a burn-out, and where cable separation and isolation must be given its due consideration, the single duct construction is better, and is most generally used.

Difficulties and their Remedy.

Mr. Lake went on to say that the present standard single duct construction, using 3·25 or 3·5 inch square bore duct is believed to be the best engineering practice for large power systems at the present time. This construction, when properly installed, provides two walls of about five-eighths inch each of vitrified clay between adjacent ducts, and for ordinary burn-outs this is effective in isolating the trouble. But in the case of a very severe burn-out there are certain weaknesses in this form of construction, one of these being due to the present form of the corners of the duct, which leaves a void of considerable size. Another difficulty is that unless very close supervision is exercised the joints in the duct will not be properly staggered as they are laid. The result of this is that burn-outs may occur in a duct which would affect the cables in the adjoining ducts. Three plans for the improvement in staggering joints were submitted. The first consists of installing with the present single duct in multiples with an extra separation of concrete between them. Though this construction does not overcome entirely the objection due to large voids at the corners, it has the advantage of dividing up a conduit line into unit groups which are so thoroughly isolated that the possibility of a cable failure in one group injuring the cables in an adjoining group is very remote. The next plan was the " standard single duct." For a conduit section of tiers of four ducts in width this form is effective, as it is so arranged that joints in adjacent ducts will not be nearer than a quarter of the standard length or 4·5 inches apart. Another plan was a modification of the former, in which the multiples are in longitudinal tiers, each tier being separated by a substantial layer of concrete. This form is more simple in construction, since the layer of concrete between tiers can be spread wet enough to make tamping unnecessary, and no " spading " is required. For high tension lines and for important low tension lines involving large amounts of power where a superior construction is desired, a line consisting of round bore, single ducts laid in tiers, with an extra space between horizontal ducts, would represent the highest type of construction possible at this date, but in order to secure in a large measure the advantages of two separate runs with but little increase in the cost, Mr. Lake recommended the duplex construction, which consists in dividing the conduit in a run into two sections separated by a substantial barrier of concrete.

Some Recommendations.

In conclusion, Mr. Lake made the following recommendations to apply for any new underground conduit construction in any large distributing system: (1) Make absorptive tests upon the ducts and include an absorption requirement in the duct specified. (2) Use square bore, single duct for the standard construction. (3) Enforce a rigid adherence to a definite plan of staggering the joints. (4) Have all voids between ducts, especially at corners, thoroughly filled with mortar and concrete. (5) Order all future ducts with outside corners made on not greater than a quarter-inch radius. (6) Install present form of duct in longitudinal tiers, separated by a substantial layer of concrete for important lines. (7) For extra important lines or high tension lines install round bore duct with horizontal and vertical concrete separation. (8) Construct all lines of 16 ducts or more in the duplex form. (9) For laterals use fibre protected with iron pipe on the vertical run up the pole, and protected with concrete at the bend and on the horizontal run. (10) In manholes use re-enforced shelf barriers for small groups of cables of minor importance. For larger groups of important cables use the split duct in addition to the shelves.

Another Big Chicago Merger.

Reports reach here from Chicago of another great electrical consolidation. Already there has been a merger of the Chicago City and other south side electric lines, the new consolidation being known as the Chicago City and Connecting Railways; and it is now stated that the north and west side lines, as well as the elevated roads, are to be brought into the merger, and that a plan is on foot for a consolidation of all the public utilities of Chicago, with the exception of the Chicago (Bell) Telephone Company, and including the Illinois Tunnel Company, with its valuable telephone rights, the Commonwealth Edison Company and the People's Gas Light and Coke Company, the whole to be capitalised at $400,000,000. The centre of gravity of this big combine is said to be the Commonwealth Edison, a corporation which under the direction of Mr. Samuel Insull has grown amazingly in wealth and importance, and is now supplying a large portion of the power used by the railways of Chicago. A combination alone of the Commonwealth Edison and the railways of the city would not only appear a perfectly logical proceeding, but at the same time one that could hardly fail to benefit both the stock-holders and the public alike.

JAPANESE MANUFACTURING PROJECT.

Quoting an influential native paper, the *Japan Weekly Chronicle* says that the board of directors of the Osaka Denkyu Co. (Electric Globe Co.) was to consider a scheme for the extension of the business of the company which is required by various circumstances. Messrs. Okura & Co., of Tokyo, suggest that the Osaka company should increase its capital to Y2,500,000, purchase the whole engine works of the Osaka Electric Light Co., start the manufacture of general electric machinery and appliances, thus becoming the centre of the electric machinery and appliances manufacturing industry in the Kwansai district. Meanwhile a German electric globe company has opened negotiations for a combination with the Osaka company to manufacture the " Dance Globe " in Japan, and the Tokyo Electric Globe Co., which has been in competition with the Osaka company, proposes to form an alliance for selling their goods at fixed prices and thus to develop their business. All these proposals have been made for the purpose of increasing the home production in anticipation of an advance in the price of imported goods upon the new Customs tariff coming into force. The Tokyo company has recently allied itself to an American company, increased its capital, and started the manufacture of general electric machinery, but the Osaka company commands a wider market and is said to be stronger financially. The Tokyo company now realises the disadvantage of competing in business and has approached the Osaka company. It is expected a successful agreement will be reached.

"ELECTRICUM ANABATHRUM."

Probably a good many electrical engineers, if asked what an " electricum anabathrum " was, would be momentarily puzzled to find a reply. However, a Rome correspondent answers this, for he announces that it is now possible to ascend to the dome of St. Peter's by lift. This modern innovation was inaugurated on the feast of St. Joseph, the name day of the Pope. The lift, which is worked by electricity, has been installed in the staircase designed by Michael Angelo, and has been constructed so as to harmonise with the beautiful lines of this production of the master's genius. Near the entrance to the lift has been sculptured an elegant Latin inscription, which informs posterity that by the will of Pius X. and by the work of Cardinal Rampolla, was erected what the inscription calls an " electricum anabathrum."

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TELEPHONE CIRCUITS.*

By PROFESSOR J. PERRY.

Professor J. Perry pointed out that he had published a paper in the *Proceedings of the Society* in 1893, showing how voltage v and current c are attenuated along a telephone or submarine telegraph-line, a line with resistance r, capacity k, inductance l, and leakance s per unit length; currents are of the form $\sin qt$. When lq/r is considerable the mathematical expressions become simple. It was pointed out that the introduction of l is of great benefit. The author now points out that k may be made negative by the use of inductance leaks to earth, and l may be made negative by the use of condensers in series with the line. To introduce l as Mr. Pupin has done by inductance coils at equidistant places on the line, or to introduce the other properties mentioned by placing other contrivances at equal distances, is a mathematical problem of great complexity. Contrivances placed close together have the same effect as the continuous distribution of properties, but there is considerable expense; the problem is to find how far apart the contrivances may be placed so that the effect produced shall still be beneficial. Mr. Pupin has given a rule for the spacing of his coils, but practical men dispute its accuracy; nobody has given a rule for other contrivances; the object of the author is to give an easy method of calculation which is practically correct, and which can be used when the contrivance is any network or other combination of resistances, inductances and capacities—some being leaks to earth—and it may include transformers, motors, and generators.

Suppose there are contrivances at the equidistant places A, B, etc., m miles apart in a cable which has the above-mentioned properties r, k, l and s. There is a contrivance whose terminals are A and A_0, another whose terminals are B and B_0; between A_0 and B there is m miles of cable. Let the currents in the line at A, A_0 and B be c, c_0, and C. Let the voltages at these points be v, v_0, and V. The assumption on which the whole method is based is that $V/C = v/c = \rho$. This is practically true everywhere in a long line except near the ends. Now, whatever be the nature of the contrivance we can calculate v_0 and c_0 from v and c. It is also known that

$$V = v_0 \cosh mn + \frac{r + lqi}{n} c_0 \sinh mn,$$

$$C = c_0 \cosh mn + \frac{n}{r + lqi} v_0 \sinh mn,$$

when $n = \sqrt{(r + lqi)(s + kqi)}$.

Putting V/C or ρ equal to v/c we have a quadratic to calculate ρ and therefore, V and C, and the problem is solved. Taking $c = \sin qt$ and calling it 1 then $v = \rho$. Whatever the contrivance may be, we find that $V = a + \beta\rho$ and $C = a + b\rho$, where a, β, a, and b are given in value; they are usually unreal quantities of the form $M + Ni$ where i is $\sqrt{-1}$. Solving for ρ and finding C we have two answers which are reciprocals of one another. If $\frac{1}{2}(a + \beta)$ be called P, and this is very easily evaluated, then

$$C = P \pm \sqrt{P^2 - 1}.$$

Discussion.

Major O'Meara thanked Prof. Perry for his very interesting and useful paper, and wished to assure him on behalf of a very large body of telephone engineers that they much appreciated the assistance which he and other mathematicians had rendered by their mathematical statement of the engineer's case. The equations given were of the same value to engineers as the compass was to the mariner. The only question they were in doubt about was whether all the forces that come into play had been equated. They, consequently, made a preliminary investigation of the manner in which the equations had been built up, and this convinced them that certainly the most important of the forces had been introduced into the equation. Some of them were responsible for the expenditure of large sums of public money, and the fact that they had something reliable to guide them in making their recommendations had removed a considerable amount of anxiety. As a matter of fact, at the Post Office they had for some time past actually applied the formulæ, and had obtained a considerable amount of success in doing so, so far as the introduction of loading coils was concerned. For instance, a short while back the question of a new cable between England and France was under consideration. It had been stated in foreign technical journals that the formulæ for "loaded" cables did not apply to the case of conductors covered with gutta-percha, owing to the very large electrostatic capacity introduced and the peculiarities of the insulation. Although he (Major O'Meara) had faith in these formulæ, still he felt that a practical experiment would remove all doubt, and in consequence he arranged an experiment with some old No. 7 gutta-percha wire, *i.e.*, copper wire weighing 40 lbs. per mile covered with 50 lbs. of gutta-percha per mile, which had a resistance per loop mile of 44 ohms, and an electrostatic capacity wire to wire of 0·13 microfarad per mile.

The gutta-percha wire was immersed in a tank, and experiments were conducted on lengths varying from 15 to 105 miles. They did not design special coils, but made use of some already in stock. These coils had an inductance of 83 millihenries, and a resistance of 13·4 ohms at 750 p.p.s. Admittedly, the coils were not the best for loading this particular type of cable.

Having decided to place these coils at 1½ mile intervals, that is, to insert 55 m.h. per mile, they calculated the attenuation constant which would result. It worked out at 0·0427 per mile. When the coils were inserted, and the experiment completed, the observed attenuation constant was found to be 0·0419 per mile. From this it was evident that the calculated and observed results practically agreed.

The information thus obtained enabled them to deal with the question of the new submarine telephone cable, and they decided that the attenuation constant for this cable should be 0·0147 per mile, to be obtained by the insertion of coils at one nautical mile apart. The coils have a resistance of slightly less than 6 ohms, and possess an inductance of 0·100 henry at 750 periods per second.

The cable has been manufactured and tested; the actual observed attenuation constant is 0·0140 per mile, so that this again proved the value of the formulæ.

The new telephone cable consists of 160 lbs. copper wire, and 300 lbs. gutta-percha. It has a conductor resistance per loop mile of 12·5 ohms (excluding the coils) and a wire to wire capacity of 0·12 microfarads per mile. In an unloaded state, the attenuation constant of this cable is 0·045 per mile.

Major O'Meara mentioned that the question of leakance was certainly of very great importance. It was owing to the very large part that leakance played that their first experiments were not successful. In America they had commenced to load aerial wires, and so large a part does this leakance play, that in that country telephone engineers had been obliged to abandon the use of glass insulators, and substitute the highest grade of porcelain insulators to meet the difficulties which had been met with owing to an insufficient allowance for the part this factor played. He feared that in no case could leakance be neglected, whether aerial or underground conductors were used.

Mr. A. W. Martin said that most telephone engineers in this country and America considered that a circuit should be capable of transmitting currents of frequencies varying from 100 to 2,000 p.p.s., in order that good clear speech might result. For attenuation calculations, some take 750, and others 800 p.p.s. as a mean value. Where lq and kq are great compared with r and s respectively,

$$h = \frac{1}{2}\left(r + \frac{sl}{k}\right)\sqrt{\frac{k}{l}}$$

and writing $s = 0$,

$$h = \frac{r}{2}\sqrt{\frac{k}{l}}$$

The question is not whether $s = 0$, but whether the ratio of s to k may be regarded as zero; since both are small quantities. In practice $\frac{s}{k}$ is found to be far from negligible when inductance is placed in the circuit. When inductance L with resistance R is placed in leak, and assuming R small

* Paper read before the Physical Society of London.

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relatively to Lq, the impedance takes the place of ordinary insulation resistance, and is practically equal to Lq. The transmission efficiency of the whole circuit for low telephonic frequencies would be low, and there would be an appreciable C^2R loss in the leak coils. When lq is not great compared with r, but where the insulation resistance is much above a megohm per mile, s may be neglected without causing calculated and observed results to differ materially. The expression then becomes

$$\sqrt{\tfrac{1}{2}qk\,(\sqrt{r^2+q^2l^2}\pm ql)} = g\,(+) \text{ or } h\,(-).$$

If r be high compared with ql, no great error is made by writing

$$g = h = \sqrt{qkr/2},$$

but as l in cable loops is never less than 0·001, it cannot be neglected except, say, when r exceeds 50 ohms. The difference between the values of g and h becomes great as r becomes small. A circuit tuned to a particular frequency would be useless for telephone working, but might prove of value telegraphically. The ordinary paper and wax insulated, thin lead-foil plate condenser offers resistance to the transmission of high frequency currents, and the insertion of such condensers in a telephone loop would be accompanied by a C^2R loss. Experimental results show that improvements of 370% by coil loading (Pupin method) may be obtained in telephone loops. The 18 ohm per mile cable mentioned in the paper had a measured attenuation constant of 0·045 per mile before loading. After the insertion of certain coils at 3·2 intervals, each coil having an inductance of 0·133 henry, and offering an effective resistance of 5·4 ohms at 750 p.p.s., the observed attenuation constant per mile was 0·012, which result is fairly in agreement with the value of 0·013 obtained by calculation at 750 p.p.s. from

$$h = \frac{1}{2}\left(r + \frac{sl}{k}\right)\sqrt{\frac{k}{l}} \quad \text{where} \frac{s}{k} = 80.$$

When the coils were placed at 2·1 mile intervals, calculation and observation gave the attenuation constant as 0·012 per mile. Coils with cores of properly chosen magnetic material give a higher inductance for a given effective resistance than air-core coils, and are, therefore, the better type. Experience shows that the quality of speech transmitted becomes bad when the number of coils per wave-length at 2,000 p.p.s. is less than π.

Measurements taken on various lengths of cable, the copper conductors in which were continuously and closely wound over with fine iron wire, showed that this "continuous" form of loading produces an improvement of only 60% upon the untreated condition in cases where the copper is of 2 sq. mm. area and upwards. With smaller conductors it may possibly reach 100%.

DISCUSSION.

Mr. B. S. Cohen said that the impressions obtained after reading this paper were that Prof. Perry had assumed that a telephone circuit tuned to the average telephonic frequency would as a result of this tuning transmit speech-waves more efficiently. He thought, however, that those who had studied this subject would agree that this was a misconception. He (Mr. Cohen) had previously pointed out that an average speech-wave consisted of a fundamental varying between 100 ~ and 300 ~, the highest harmonic being about 1,500 ~ and the average ~ of the whole wave 800 ~. He had also given the Fourier series obtained by analysing a number of speech-waves, and this series showed that there are a large number of odd and even harmonics ranging from the 2nd to the 11th harmonic.

So it is harmful to tune to any particular frequency. Turning to the 18 ohm cable line referred to by Prof. Perry, he gave some results worked out by Mr. G. M. Shepherd. When this cable is in the normal condition the attenuation for a wave with a value q (angular velocity) of 1,000 is 2·2%, for a value of 5,000 it is 3·1%, and for 9,000 6·4%. This covered the whole commercial speech range, so that the variation over this range for attenuation is about 300%. Using Prof. Perry's formula and taking his contrivances, adding ·593 henry per mile and a capacity of ·44 mfd. in series, it will be found that the variation of attenuation between q = 1,000 and q = 5,000 is 500%. That is to say, up to the average frequency alone the variation in attenuation is 200% more than over the whole range of speech frequency with the normal cable. But going a step further for an angular velocity of 5,550, the attenuation constant is 0 and the current at the end of the line using the formula given is 0. This means that the inductance and capacity bridge act as a shunt of infinitely low resistance. Any further increase in the frequency results in a negative attenuation, implying that an entire change in the nature of the transmission takes place. It would be of much interest if Prof. Perry would explain exactly what is the physical interpretation of this curious effect. Whatever the explanation, however, there is little doubt that the effect of this combination of bridges L and K would be satisfactory, as far as the commercial transmission is concerned, in spite of the fact that at 800 ~ the attenuation is only 33%, or an improvement for that particular frequency alone of about 15 times over the normal line. Contrasting these results with those which would be obtained by the application of the ordinary Pupin series loading coils of ·13 henry each spaced at 1-mile intervals in the same line, the attenuation at any frequency over the range of telephonic speech is 1·1%: that is to say, the volume improvement is 5, and the line acts as a distortionless one instead of amplifying the natural distortion of the unloaded line. He mentioned that this was not only calculated result, but one that was amply confirmed by everyday practice, and which included the effect of the effective resistance of the inductance. Since his paper at the St. Louis Congress, Prof. Kennelly had written a considerable number of papers on the subject of telephonic transmission, and his formulæ and methods were now adopted by many telephone engineers and were rapidly becoming standardized.

Dr. Russell thanked Professor Perry for his instructive paper. He much appreciated the methods shown of getting simple approximate formulæ for some very difficult problems. It was interesting to compare the author's solution in the case when the leakance was zero with Heaviside's solution for a distortionless circuit. The only difference in the formulæ was that the attenuation was twice as great in the latter case. The Physical Society was deeply indebted to Major O'Meara and the other speakers for the very interesting data they had given about Pupinised telephone-lines. From the theoretical point of view it was exceedingly satisfactory to find that the "loading coils" fulfilled their functions so efficiently and that their performance could be predicted so accurately.

Dr. J. A. Fleming forwarded the following communication:—The subject of Prof. Perry's paper has an interest for me at the present moment, as I happen to be giving a course of Post-graduate lectures at University College on the propagation of currents in telephone and telegraph cables. The method of representing the quantities concerned by complex quantities and their hyperbolic functions is of course very familiar to all who have paid any attention to the subject, and this method, aided by Mr. Blakesley's Tables of Hyperbolic Functions, enables arithmetic calculations to be easily made. Whilst it is quite true that the wave-form of the currents transmitted in telephony is very far from being simple harmonic, yet experiment shows that when using sine-curve currents having a frequency of about 800 or an angular velocity of 5,000, the results enable us to predict the effects with actual speech fairly well. The quantity it is important to predetermine is the current at the receiving end of a line of known length l and known constants, resistance, inductance, and capacity (R, L, C) per mile, when a receiver of known impedance $z' = R' + jpL'$ is placed at the end.

The important quantities are: the attenuation constant

$$a = \sqrt{\frac{Cp}{2}}\left[\sqrt{R^2+p^2L^2} - Lp\right],$$

the wave-length

$$\lambda = 2\pi/\beta = 2\pi \Big/ \sqrt{\frac{Cp}{2}}\left[\sqrt{R^2+p^2L^2} + Lp\right],$$

and the initial sending end impedance

$$z_0 = R + jpL/a + j\beta$$

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If Pl (where $P = a + j\text{Æ}$) is called the propagative length, and if

$$z'/z_0 = \tanh \gamma,$$

then it is quite easy to show that the ratio of the currents at the receiving and sending ends is given by

$$I_2/I_1 = \cosh \gamma \operatorname{sech}(Pl+\gamma).$$

Also that

$$I_1 = \frac{V_1}{z_0} \coth (Pl+\gamma),$$

where V_1 is the sending voltage. These formulæ are compact and easily applied in numerical calculations.

The problem with which Prof. Perry is dealing is, however, that of the loaded cable. He does not make any reference to the important paper of G. A. Campbell (see Phil. Mag. March, 1903) or to that of Hayes (see *Electrician*, Dec. 16, 1904), in which this problem is discussed. Campbell has given the following formula for the average or effective propagation constant $P' = a' + j\beta'$ for a line consisting of impedance coils of impedance z' spaced out at intervals d on a line of propagation constant P and line impedance z_0 :—

$$\cosh P'd = \cosh Pd + \frac{z^1}{2z_0} \sinh Pd ;$$

but it is not certain that this formula can be trusted to give the true attenuation constant a' of the loaded line when d is much greater than about one-eighth of the wave-length on the loaded line, and when it is less than $\lambda/8$ then the attenuation constant can more easily be calculated by considering the added inductance and resistance smoothly distributed. Professor Perry does not discuss the question of the loss of amplitude due to reflexion from the interpolated impedances when these are spaced out to large fractions of a wave-length, nor the advantages of tapering off the loading at the ends of the loaded cable to reduce the effects of these reflexion losses at the ends. As an illustration of the general accuracy of the formula for the current ratios I may give the following figures, obtained for me by the kindness of Mr. Gill, Engineer-in Chief of the National Telephone Co., in their Research Laboratory, by measurements made by Mr. Cohen. A standard line R = 88 ohms, C = ·054 mfd., L = ·001 henry, all per loop mile, had a receiving instrument of impedance 660 66° 54′ vector ohms placed at a distance of 15 miles. The ratio of the sending to the received current by the above formula was found by calculation to be 5·36, and by measurement with Mr. Cohen's barretter to be 5·3, thus showing a very good agreement. The frequency in this case is 1,000 ~. By the use of artificial loaded lines it is easy to show experimentally the enormous decrease in attenuation caused by properly loading the line. Whilst we owe to Heaviside the first insistance on the value of the added inductance, it is to Pupin we are more particularly indebted for proving that when impedance is spaced out at distances not greater than about $\lambda/8$, we have all the effects of smoothly distributed inductance but obtained more easily and with less expense.

Mr. G. M. Shepherd, in a letter to the Secretary, observed that the system of introducing inductive leaks referred to in Prof. Perry's paper, was presumably identical with what is termed "Thompson's" Compensated line. It could be shown that such a line was equivalent (proper spacing of loads assumed) to an ideal uniform line whose constants are

$$L' = L - \frac{2}{q^2 cs} \frac{(q^2 L_0 L + R_0 R)}{(q^2 L_0^2 + R_0^2)},$$

$$R' = R - \frac{2}{cs} \frac{(L_0 R - L R_0)}{(q^2 L_0^2 + R_0^2)},$$

where L, C, R are the ordinary wire constants, and L_0, R_0, the inductance and resistance of the inductive leaks, s being the spacing. It could also be shown that the rule governing the spacing was virtually the same as that formulated by Pupin for series coils. Looking at the matter from this point of view, it is seen that the effect of loading on the Thompson system is to reduce line resistance and inductance, or the inverse to the Pupin line. The two systems, however, appear to be essentially different, in that the Thompson line is really tuned or compensated, while the Pupin line is not. Hence the former is more or less subject to frequency, but the latter practically independent of it. A few cases worked out from the above formula for 18ω, ·055 mfd. cable, with a ·972 henry leak per mile, and several frequencies not far apart, give the following figures :—

~	q.	h.
1,035	6,500	·0189
1,115	7,000	·0284
1,430	9,000	·0487

This shows a wide departure from a distortionless line. Again, introducing series capacity brings in a negative inductance which is likewise a function of frequency, so that a composite contrivance of the type indicated by Prof. Perry was likely to be a very fickle aid to telephony, a conclusion fully borne out by practical tests. The insertion of series inductance originally advocated by Heaviside, and developed by Pupin, seemed to be the only natural solution for the telephone problem, and recent experience confirmed this view.

Prof. Perry communicated the following reply :—"I am glad to think that my paper has led to Major O'Meara's remarks. The results of the Post Office experiments have been freely put before as by Mr. Martin; they are of enormous value to people like myself who desire to make calculations. Such experiments are quite impossible for the ordinary student, they cost a great deal of money and the service of many assistants. I am very glad to think that these results will be published in full by the Society. I regret that Mr. Cohen did not speak at much greater length, for he has for a long time been experimenting on behalf of the National Telephone Co. and the results of his experiments would be of great value to students.

"I am afraid, however, that my paper has been a little misunderstood by these and other critics. They seemed to think that I was advocating the use of a contrivance consisting of condensers in the line and an inductance leak, whereas I mentioned this contrivance merely to illustrate my paper. What I have endeavoured to do is to show how calculations may be made by non-mathematical people to find the effect of using any contrivance whatsoever. The above abstract does not, I am sorry to say, indicate my praise of the work done by Prof. Kennelly, who by his many papers and his valuable tables of cosh and sinh functions has cleared up many difficulties. It is enough here to say that except the few lines devoted to Mr. Campbell's paper, the whole of Dr. Fleming's communication will be found to have been published by Prof. Kennelly many years ago."

TIME SYNCRONISING AT THE CAPE.—A decidedly quaint system of giving all citizens the exact time once a day prevails at Cape Town, replacing the old gun-fire from the Rock. The plan adopted now is that every night, at a given hour, the electric light is momentarily switched off from the central station, and then switched on. The universal wink of every electric light in the city, whether indoors or out of doors, tells the tale. If somewhat disconcerting to the new comer, it is certainly cheap and democratic.

STASSANO ELECTRIC FURNACE.—One of these furnaces is at work at St. Pölten, Austria. It is 250 h.p. capacity, the current being multiphase at the low periodicity of 25, instead of the usual 50. This is interesting as endorsing the claim that the Stassano furnace works independently of the periodicity. Working with a refractory charge of scrap metal, the furnace will deal with a ton of molten metal at an expenditure of about 810 kw.h.

THE ENGINEERS' CLUB, Toronto, is moving into fine new premises, large enough to permit of overtures being made to other kindred technical societies to join in having one central headquarters. The movement is somewhat similar to that initiated in New York, where fifty-seven engineering societies have offices and the use of large halls in common under one roof, and also to the desire expressed at Johannesburg that the engineering societies of South Africa should adopt a certain measure of federation.

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TECHNICAL PROBLEMS, WITH SOLUTIONS BY PRACTICAL MEN.

RULES.

Under the above heading we insert questions of a practical character relating to power stations, electrical railways and tramways, mining installations, electric power in workshops, electro-metallurgical plant, and electrical engineering work generally.

QUESTIONS.—For each suitable question we offer one shilling. Questions of a practical character stand a better chance of acceptance than those of a theoretical nature. Questions may be sent in at any time.

ANSWERS.—A fee of 10s. will be paid for the best answer, and 5s. for every other published.

QUESTION.

It is proposed to put down an electro-galvanizing plant, for galvanizing thin steel strips and small stampings. Would the deposit be thicker on the edges and on small projecting lugs than elsewhere? Strips would be up to 6 ft. long; up to 2 in. wide, and of 24 to 26 G. Stampings of same material. Output, say, 1 ton of strips and 2 cwt. of stampings per week. Describe best method and cost of working, including material and labour. Floor space required? Cost of plant?

Answer to Question No. 1216 (*awarded* 10s.)—Iron is now galvanised electrolytically to a considerable extent and with highly satisfactory and economical results. The quality of the deposit varies with the current density and the strength, acidity or alkalinity and briskness of circulation of the electrolyte. In general, the current density should be low (say 10-20 amps. per square foot, as a maximum), the electrolyte neutral and saturated, and the circulation brisk. Cyanide baths are used for zincing small articles and sulphate baths for heavier goods. The Cowper Coles process, which has of late been so successfully applied to the galvanising of iron, consists in the use of a lead anode and high current density; finely powdered zinc is held in suspension in the solution to replace the deposited zinc in the electrolyte and so prevent acidification of the bath. This "regenerative" process of electrolytic zincing is stated to be cheaper than the ordinary hot galvanising process and gives a more adherent deposit. Dipping in molten zinc frequently causes damage to the structure and strength of the immersed metal, which is wholly avoided by the cold electrolytic treatment.

The tendency to form loose deposits frequently noticeable in the electrolytic refining of zinc, is avoided by the use of a correct electrolyte composition, moderate current density and brisk circulation. The flat surfaces of the strips should be carefully cleaned or the deposit will be thinner and less coherent there than on the freshly cut edge and lug surfaces. Oxide films (formed during the rolling of the strips) must especially be guarded against: they may be removed by "pickling" in dilute sulphuric acid. If the anode and cathode be too close together in the bath and the circulation of the electrolyte be brisk, there is danger of the deposit being specially thick on the projecting lugs: under the same conditions, but with a sluggish circulation gas bubbles will adhere to the projecting points and prevent their proper coating. It must be arranged that the suspending wires or clips can be moved along the strips from time to time or bare iron will obviously be left at the points of contact. If the capital expense be not too high, long strips could be zinced in bulk by enclosure in a rotating perforated cathode cylinder. A certain amount of experimenting would be required to secure satisfactory results.

Circulation of the electrolyte by pumps or by stirring grids is very necessary for if the cathode film of electrolyte becomes deprived of metal, "gassing" commences, the efficiency of the deposition falls and the firm becomes uneven and non-coherent. A pure electrolyte is specially necessary, zinc being so strongly electro-positive that any metallic impurity such as iron or copper is electro-deposited in preference to it.

Energy Consumption and Arrangement of Plant.—No. 24 S.W.G. iron plate weighs 0·88 lbs., and No. 26 0·72 lbs. per sq. ft. Hence, for the present purpose, assume an average figure of 0·80 lbs. per sq. ft. Of this, 22 cwts. = 2,464 lbs, have to be treated per week; *i.e.*, an area of some $2 \times \frac{2,464}{0.8} = 6,080$ sq. ft. has to be zinced per week.

Assume a coating 1 mil. thick, then the volume of zinc deposited per week

$$= \frac{6,080 \times 144}{1,000} = 876 \text{ c. ins} = \underline{100 \text{ k.grms. wt.}}$$

which requires $\frac{100 \times 1,000}{0.000337} = 2{\cdot}97 \times 10^8$ amp. secs.,

and one week = $6{\cdot}06 \times 10^5$ secs. ∴ Current = 490 amps. theoretically.

Allowing an overall efficiency (dynamo to cathode) of 60%, the current must be $\frac{490}{0.6} = \underline{820 \text{ amps.}}$

This corresponds to a current density of

$$\frac{820}{6,080} = 0{\cdot}135 \text{ amp. per sq. ft.}$$

but a density of 8 amps. per sq. ft. could safely be worked to, *i.e.*, the output could be increased about sixty fold. Now, this is not required, but instead of having the whole 22 cwts. in the vats during the whole week, the employing of the higher current density enables the provision of a smaller vat capacity and the treatment of a number of batches of strips per week. Lots of $\frac{2,464}{59} = 42$, or say, 45 lbs. should be treated and, to allow for shifting from and into the tanks, assume five "plating" days per week instead of 7 as above. This will require the treatment of 39 batches of $\frac{7}{5} \times 45 = 63$ lbs. each per week.

Proceeding as above it will be found that this requires a theoretical current of 685 amps., *i.e.*, 1,140 amps., assuming 60% efficiency (giving a current density of 7½ amps. per sq. ft. of cathode). The voltage across the poles = about 2½ volts, hence the kw. at the cells = 1·14 × 2·5 = 2·85; so that an engine horse-power of 3½ to 4 h.p. would amply cover the requirements. The kw.-hours per 2,464 lbs. of strip and stampings = 344; *i.e.*, the cost of energy (at 1d. per B.T.U.) = 14d. per 100 lbs. of strip (125 strips) per 1 mil. thickness of coating.

The advantages of the second system of working are: less capital cost of plant, less space occupied, more continuous employment for attendants and less idle material in the vats. There will be about 80 strips in each 63 lb. batch. Arranging the strips horizontally and edgewise one above the other, a tank 7 ft. long, 3 ft. deep and 20-30 in. wide, would accommodate 40 strips conveniently (in four groups of 10 strips, five anode plates 4-5 in. between each). The floor space per vat is thus 12-17½ sq. ft. It is impossible to state the capital cost of the plant, but hints on a suitable tank construction may be found in the ELECTRICAL ENGINEER, August 6, 1909, pp. 161-163. Two fairly skilled men and possibly a boy will be required to tend the vats, but this work will not occupy the whole of their time even allowing for the strip pickling and scouring, which must, of course, proceed simultaneously.

Cost of Materials.—Zinc about £37 per ton (finely powdered metal, 30 to 50% dearer); lead (Cowper Coles process), £14 to £15 per ton; zinc sulphate, 2½d. to 3d. per lb. (in bulk).—"W.M."

ELECTRIC CABLE ACCIDENT IN A MINE.

At Linlithgow, Sheriff Macleod and a jury were engaged in a public inquiry concerning the death of William M'Farlane Mackenzie, electric pump attendant, who met his death in No. 3 Pit, Blackridge, belonging to the United Collieries (Ltd.) on 4th inst. The evidence showed that while Mackenize was travelling along the "dook" road in the pit he came in contact with a live electric cable and received a shock, which proved fatal. Mr. John Wilson, miners' agent, addressing the Court, asked that the jury make a recommendation that a thoroughly competent man be employed by the colliery company to examine the cables, so as to ensure the safety of workmen. The Sheriff said the introduction of electricity below ground was a new danger for the wage-earner, and was a heavy responsibility on the Home Office, on H.M. Inspectors, and on employers of labour to take all reasonable care to see that these new dangers were reduced to a minimum. He had no doubt that this duty would be undertaken in the proper spirit by the authorities. A formal verdict was returned

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Business Notes and News.

LIGHTING AND GENERAL—Home.

CROYDON.—The electricity department already having a reserve of £34,000, £4,000 out of profits have been paid over in aid of the general rates.

DUBLIN.—Mr. Cowan, Chief Engineering Inspector, Local Government Board, held an inquiry at the South Union Workhouse into an application by the Guardians for a loan of £3,000 for the purpose of lighting the Workhouse premises by means of electricity. In evidence, it was stated that the Gas Co.'s estimate for gas lighting was £1,142 on a three years' contract, the Corporation Electricity Department offered to supply current at 3d. per unit on a five years' contract, while the Ampere & Electrical Co., 6, Fleet-street, Dublin, offered to supply the Union with an electric light supply for a period of ten years at £750 per annum. At the end of ten years the installation would become the property of the Board. A report from Mr. Lawless, C.E., on the lighting requirements of the institution was then read. The report stated that 1,950 points would be lighted, and for this 2,000 lamps would be required, the lamps being of varied power according to the positions.

EDINBURGH.—The electricity department's estimate for new machinery and alterations to the existing machinery at Dewar Place station in connection with the supply of the electric current to the new tramways amounts to between £1,400 and £1,500.

ERITH.—The Council are considering an offer by the Underfeed Stoker Co. to instal their special stokers to the two boilers Nos. 1 and 2 for the sum of £460, exclusive of the provision of the air-duct, and to remove them at their own expense and leave the boiler house in its present condition if their guarantee to save 20% of the cost of coal is not sustained under working conditions.

FINCHLEY.—The District Council have decided to apply to the Local Government Board for a further loan of £10,000 for the development of the municipal electricity undertaking. The gross revenue has increased from £3,833 in 1905 to about £15,000 in the current year.

HARROGATE.—The Corporation is seeking powers from the Knaresborough Rural District Council to supply Oakdale with electricity, but the question is still in abeyance.

LEICESTER.—In spite of a falling off in the sale of units by 104,201, the net profits made by the electricity department during the past fiscal year was £1,121. The gross revenue was £14,866 and the expenditure £6,610, but £3,791 had to be paid in interest, and £4,344 towards sinking fund; 228 new consumers, for light and power, came in.

LONDONDERRY.—In the course of the Local Government Board of Ireland's inquiry into the application for powers to borrow £10,000 for electricity extension, Mr. Macrary, the electrical engineer, said that the extensions would increase the capacity of the station 66⅔%. On the inspector remarking that the rates charged were certainly very low, Mr. Macrary said that the effect of the economical metal filament lamps had been to bring back many consumers who had tried electricity and then forsaken it in the days of carbon lamps.

SANDGATE.—It is proposed to adopt the Osram lamp for all the electric street lighting.

WEYMOUTH.—The Corporation Electricity Department have made an offer to light the Workhouse and Infirmary for £80 per annum, to be reduced to £70 after three years, and to £60 after six years. This offer is to be considered after comparison with the present cost of gas.

WIMBLEDON.—The General Electric Co., Ltd., have just been successful in obtaining a contract for the supply of Osram lamp to the Corporation Electricity Department, which includes a large quantity of 200 and 300 c.p. Osram lamps for street lighting. Successful experiments have already been carried out with high candle-power Osram lamps for the lighting of streets at Wimbledon, and a large number of same have displaced arc lamps in this neighbourhood. The General Electric Co., Ltd., have also been successful in obtaining a contract for the supply of Robertson lamps to the Wimbledon Electricity Department for the forthcoming twelve months.

WOOLWICH.—The Borough Council have decided that switchgear be purchased from Messrs. Wellman, Seaven & Head, Ltd., for the sum of £38 10s. to replace that damaged by a breakdown of the supply in November.

LIGHTING AND GENERAL—Overseas.

ARGENTIERRE, FRANCE.—The new hydro-electric foundry of the Société Electro-Métallurgique Française, on the River Durand, is now in operation.

BUENOS AIRES.—Arrangements have been made between the Argentine and Uruguayan Governments for the laying of a cable between Buenos Aires and Montevideo for the use of the National Telegraph Department of the two countries.

CHRISTCHURCH (NEW ZEALAND).—The City Council has in hand important extensions to its electrical plant at its central yards in Manchester-street. A new boiler and a new Hodgkinson automatic stoker are being installed, and it is expected that the Council will soon be able to add another 500 kw. to the capacity of its plant. The chairman of the Electric Lighting Committee (Dr. Thacker) says it is absolutely necessary for the Council to go in for a larger scheme. He does not think the Waimakariri is worth harnessing. The Lake Coleridge scheme, on the other hand, may be amplified up to 10,000 h.p. by diverting into it the Harper, Acheson, and Wilberforce Rivers. The cost of an installation at the lake, including power-house and all other equipments, would be about £250,000.

LAHORE.—The new electric power house installation for providing electric power to the new carriage and wagon workshops of the North-Western State Railway at Lahore is being equipped with additional plant and machinery. And, according to *Indian Engineering*, the copper electric cables for connecting this power house with the new shops was obtained in India by *local* purchase.

MADRID.—A decree has been issued authorising the firm of "Hijos y Nieto de P. Baurier" to build a dam and make use of water from the river Ter, in the district of Masias de San Pedro de Roda, to a maximum extent of 6,000 litres a second, for the generation of electric power to be used in a cloth factory.

ROODEPOORT, MARAISBURG, TRANSVAAL.—The Town Council will shortly spend £5,000 on electric lighting plant.

SAINT-CHAMOND, FRANCE.—The new high tension aluminium cable to convey hydro generated current from Grenoble to this town is now in working order, and its operation is being watched with a great deal of interest.

WELLINGTON.—H.M. Trade Commissioner for New Zealand (Mr. G. H. F. Rolleston) reports that a firm who are building a theatre at Auckland, which is expected to be completed in October next, intend themselves to instal the electric lighting plant, which they will buy in London. Electrical manufacturers interested in theatre lighting, and particularly in auditorium and stage lighting, luminous signs, etc., might communicate with the firm in question. It would be well, adds Mr. Rolleston, in communicating to send a cable code, as there is little time to spare. The name and address of the firm may be obtained by British manufacturers on application to the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, London, E.C.

TRACTION—Home.

BELFAST.—It has been decided to complete the removal of tramway poles from the centre to the side of the streets. The general manager anticipates, apart from the convenience, a cash saving of £750 by this alteration, that is 50% of the old cost of upkeep.

HIGHGATE.—The new electric tramway constructed on the conduit system by the London County Council up Highgate Hill, from the *Archway Tavern* to the *Old Gate House Hotel*, was opened for public traffic on Good Friday. The cars are smaller than those on the ordinary London County Council lines, are fitted with powerful brakes, which work on the slot rail, in addition to the ordinary brakes, in order to ensure complete safety in descending the very steep gradients of the hill. The new line superseding the old cable way, forms a connection at the *Archway Tavern* with the London County Council lines to the City, Holborn, and Euston-road, and also forms a junction at the same spot with the Metropolitan Electric Tramway Co.'s line to Finchley and High Barnet.

LIVERPOOL.—According to the official returns of the general manager the tramway department's gross revenue for 1909 was £592,728, and the generating cost (including rental of leased lines) £400,205. Out of the gross profit of £192,522, £50,919 was disbursed for interest, £59,249 for sinking fund and repayment of loans, £54,902 placed to reserve and depreciation account, and £27,451 contributed in aid of the general rates. The net profit shows an increase of £7,779 on the previous year, while there was a decrease of £6,866 in operating out, in spite of a slight increase in the number of the staff. We are told that it has been decided to lay additional lines in Netherfield-road for the purpose of forming a belt route *via* Everton Church, Heyworth-street, Netherfield-road and the Pier head, thereby affording the inhabitants of Netherfield-road district direct tramway communication with the Pier head. Also that, after

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considerable opposition on the part of the London and North-Western Railway Co., the committee have obtained Parliamentary powers for the construction of new lines in Brownlow-hill, Holland-place, Towerlands-street, Edge-lane, Springfield-street, Edge-lane Drive, Broadgreen-road and Roby-road to Roby-park; also in Townsend-lane and Longmoor-lane, Allerton-road and Menlove-avenue.

SOUTHAMPTON.—It has been finally decided to reduce the charge to the Tramways Department to 1⅝d. per unit.

TRACTION—Overseas.

CARACAS.—A contract has been signed between the Venezuelan Minister of Public Works and Doctor A. Aveledo, A. Michaud and J. A. Mosquera for the construction and working of an electric tramway between Agua de Maiz and Los Dos Caminos. The line is to have a gauge of 1·07 metres. The work is to be begun within a year from the date of approval of the contract, and completed in 18 months. All material and plant for the work may be imported free of duty. The concessionaires have the right to extend the line to a point on the road to the river Tocome.

MINSK, RUSSIA.—The Municipality have decided to electrify their steam tramways.

ROME.—A decree has been issued authorising the "Compagnia Italo-Belga dei Trams Elettrici di Verona" to construct and work a section of electric tramway in Verona, from the Via dei Leoni by way of the Via Leoncino and Via Anfiteatro to the Piazza Bra.

COMPANIES' MEETINGS AND REPORTS.

BUENOS AYRES PORT AND CITY TRAMS.

The report of the Buenos Ayres Port and City Tramways, Ltd., states that the accounts for the year to July 31, after providing £6,325 for Debenture interest, show a loss of £1,276; to this has to be added the balance brought forward, £737; and the £1,000 sinking fund payment for 1909, making in all a debit balance of £3,013 to net revenue account.

FOLKESTONE ELECTRIC SUPPLY.

The net profits of the Folkestone Electricity Supply Co. for 1909, including £328 brought forward, were £7,691 after providing for Debenture interest and dividends on the Preference shares. A final dividend at the rate of 7% per annum is proposed on the Ordinary shares, making 5½% for the year, adding £4,300 to the depreciation fund and £200 to the reserve, writing £100 off installation account, and carrying forward £341.

ISLE OF WIGHT ELECTRIC LIGHT AND POWER.

The report of the Isle of Wight Electric Light & Power Co., Ltd., for last year, to be presented at the meeting in Ryde on the 1st proximo, states that the result of the year's trading, including £293 brought forward, shows a profit of £11,689. After paying interest on Debentures and loans, £4,967, and a dividend on Preference shares, £2,500, there remains a balance of £4,221. The directors recommend that £3,000 be placed to the renewal fund account, that £1,000 be placed to the reserve account and that a £100 be placed to a reserve for bad and doubtful debts, leaving a balance of £121 to be carried forward.

GUILDFORD ELECTRICITY CO.

In their report for the year ending December last the directors state that the company has made very satisfactory progress, the gross receipts having been £7,490 4s., as compared with £6,772 12s. 1d. for the year 1908, an increased revenue of £717 11s. 11d. There was a balance on the revenue account of £3,292 6s. 5d. (after crediting depreciation fund account with £1,000), as compared with a balance of £3,168 6s. 2d. (after crediting depreciation fund account with a like amount) on the revenue account for 1908. After making due provision for debenture interest, dividend on preference shares, and the placing of £500 to the credit of reserve fund account (being an addition of £100 on the amount for 1908), there was a balance of £1,004 10s. for distribution. The directors recommended a dividend of 5%, less tax, for the past year on the ordinary share capital, which would absorb £700 10s., leaving a balance of £304 to be carried forward. During the year two thousand 6% cumulative preference shares had been allotted and taken up. The total capital expenditure to December 31, 1909, amounted to £58,969 15s. 10d., and the total capital receipts were £54,686. There was, therefore, a balance over expended of £4,283 15s. 10d.

UNDERGROUND ELECTRIC RAILWAYS CO., OF LONDON.

In their report the directors state that the result of the past half-year shows a substantial improvement. The net revenue from investments and properties (including general interest), after deducting general expenses, amounted to £82,359, and the surplus from the power house to £21,088, making together £103,447. The service of the 5% Prior Lien and 4½% bonds of 1933 and the payment under the guarantee on Metropolitan District Assented Extension Preference stock, together absorbed £102,981, leaving a surplus of £466. This amount has been placed to a reserve, which has been applied in reduction of the accumulated revenue deficiencies. The income from investments for the six months shows an increase of £25,009, or about 45% over that for the corresponding half of 1908. The directors have every reason to believe that the sum of £160,000 due by the estate of the late C. T. Yerkes in respect of unpaid calls on shares of the company will be paid in full, the greater part within the coming year, together with interest at the rate of 5% per annum from the date of the respective calls. On account of interest accrued to December 31, 1909, the sum of £6,500 has been credited to revenue account in the last half-year.

WILLANS AND ROBINSON.

The thirty-second half-yearly report, to be submitted at the ordinary general meeting to be held at the *Cannon-street Hotel*, Cannon-street, London, on Tuesday, April 5, states that after writing off the sum of £4,245 15s. 3d. as depreciation, and after paying £4,263 11s. 6d. as interest on debenture stock, the result of the half-year's trading shows a loss of £8,282 7s. 3d. Deducting £1,015 4s. 9d., the sum carried forward at June 30, 1909, there is left a sum of £7,267 2s. 6d. now standing to the debit of profit and loss account. It is not possible to pay any dividend on the preference shares for the half-year or to meet the charge for interest on and redemption of the funding certificates. The total amount of the arrears of Preference dividend is thus brought up to £14,999 17s., and of interest on funding certificates to £1,562 12s. 7d. Debenture stock to the amount of £20,939 has been redeemed during the half-year out of the proceeds of the fire insurance fund. This has been purchased at a discount, and the profits on the transaction £4,545 4s. 4d., and interest on the remaining fire fund securities, £347 12s. 8d., have been added to the reserve fund, bringing it up to a total of £67,522 8s. 1d. Against this total has to be set a sum of £15,000, the cost of the lawsuit referred to in the previous report, and the directors propose that a further sum of £10,000, to meet certain outstanding liabilities, be also set against the reserve fund, reducing its amount to £42,522 8s. 1d. In the valuation of materials and stores a special sum of £1,729 15s. 4d. has been written off the value of obsolete or little used stock during the half-year, reducing by that amount the gross profit carried to the credit of profit and loss account. The process of special reduction in the re-valuation of stocks has been in operation for many years past, and even during the last half-year of bad trade it has not been considered desirable to suspend its operation. The state of trade throughout the year 1909 was bad. It has been impossible to secure a sufficient volume of work to keep the shops fully employed and the prices obtainable have been unsatisfactory. Some of the recently adopted lines of manufactures are now beginning to bring in orders, and with an adequate supply of work, and the more reasonable level of prices which an improvement in trade, when it comes, will bring, should enable good profits again to be earned. Mr. J. C. Peache retires from the Board in accordance with the provisions of the Articles of Association, but is eligible, and offers himself, for re-election. It has been decided to recommend the election of Mr. Frederic R. Davenport as an additional director, in accordance with the terms of the resolution to be proposed. Mr. Davenport will give the

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whole of his time to the service of the company, and it is intended that he shall act as assistant managing director, more especially in charge of the commercial part of the business. By the appointment of Mr. Davenport the directors expect to effect a substantial improvement in the position and operations of the business, and they consider that under these altered conditions it is desirable to leave the election of a chairman in abeyance.

COMPANIES REGISTERED.

BRAKEBLOCKS, LTD.—Capital, £2,500, in £1 shares. Objects: To acquire and turn to account a patent for an invention relating to the prevention and consumption of smoke, and a licence to manufacture and sell an invention under a patent relating to brake blocks, etc., and to adopt agreements (1) with Emma Blackney and others, and (2) with G. R. Archdeacon. Private company. The first directors (to number not less than three nor more than five) are: G. R. Archdeacon (managing director) and two others to be appointed by the signatories. Qualification, 20 shares. Remuneration of managing director, £150 per annum. Registered office, 49, Spring-gardens, Manchester.

H. HAINSWORTH, LTD.—£1,000 in £1 shares. Business: That of a motor garage owner, electrical, mechanical and general engineer, talking machine dealer, etc., carried on by H. Hainsworth at 9-11, Branch-road, and the Central Garage, Well-lane, Batley. Private company.

MEXICAN ZACAFECAS DEVELOPMENT CO.—Capital, £30,000, in £1 shares (15,000 Preferred Ordinary). Objects: To carry on the business of concessionaires, constructors of railways, tramways, roads, harbours, piers, wharves, canals, reservoirs, and other works, financiers, company promoters, etc., and to adopt an agreement with J. Cooper. Private company. The first directors (to number not less than two nor more than four) are: Col. H. S. Fitzgerald, C.B., A. Slatter, G. D. Perks and R. Brodie. No qualification required. Registered office, Caxton-house, Westminster, S.W.

PONTELEC WELDING PATENTS.—£30,000 (£1) (10,000 7% cumulative preference). To acquire and turn to account any invention relating to electric welding of steel and other metals, or any apparatus and machinery therefor. Agreement with the Universal Electric Welding Co. of America, L. S. Lachman, E. B. Koopman, and M. Lachman. Private.

SURFACING MACHINERY, LTD.—Capital, £10,000, in £1 shares (7,500 Preferred). Objects: To acquire and turn to account a patent owned by G. H. Alexander and C. J. Morehouse for an invention relating to improvements in the manufacture of electric rotary floor surfacing, scrubbing and polishing machines, etc. Private company. The first directors (to number not less than two nor more than five) are to be appointed by the signatories. Qualification, 100 shares. Registered office, 14, Lower Essex-street, Birmingham.

FINANCIAL NOTES.

The directors of the Melbourne Tramway & Omnibus Co., Ltd., have declared a dividend of 4½d. per share (15% per annum) for the quarter ending 31st inst.

TRADE NOTES.

Messrs. Clarke, Chapman & Co., Ltd., general and electrical engineers and boiler makers, of Victoria Works, Gateshead, have opened an office at 29, Queen Anne's Chambers, Broadway, Westminster, specially for the sale of their Clarke, Chapman water tube boilers (Woodeson's Patent), both for land and marine installations.

Messrs. Feld Bros. & Co., Ltd., have taken over the sole agency for Great Britain of Messrs. Rosenthal & Co., Bavaria, for their "High Tension Insulators."

PERSONAL.

The Royal Sanitary Institute have appointed Professor Henry Adams, of the firm of Henry Adams & Son, and Dr. Louis C. Parkes as their representatives upon a joint committee which is being formed by the Institution of Heating and Ventilating Engineers to consider the question of legislation in connection with the ventilation of public building.

An Argentine correspondent writes that Engineer Herlitzka, a director of the Cia. Alemana Transatlantica de Electricidad, has left to take up his permanent residence in Berlin. The great progress made by this Company in Buenos Aires is almost entirely due to the energy and foresight of Mr. Herlitzka.

On the inauguration of the first section of the electric tramways in Bahia Blanca, as a mark of appreciation of this further development of progress of that city, Mr. W. Harding Green, Manager of the Bahia Blanca section of the Pacific Railway, was given a banquet at which over one hundred persons were present.

DIARY.

TUESDAY, APRIL 5.

INSTITUTION OF ELECTRICAL ENGINEERS (Manchester Students' Local Section).—Second Supper and Smoking Concert.

FARADAY SOCIETY.—In the Library of the Institution of Electrical Engineers, Westminster, S.W., at 8 p.m. Professor W. W. Haldane and Mr. W. Harrison on "The Electrical Theory of Dyeing."

THURSDAY, APRIL 7.

INSTITUTION OF ELECTRICAL ENGINEERS.—At the Institution of Civil Engineers, Great George-street, Westminster. Mr. A. Gerrard on "The Progress of Electric Braking on the Glasgow Corporation Tramways."

FRIDAY, APRIL 8.

PHYSICAL SOCIETY OF LONDON.—At the Imperial College of Science, South Kensington, at 8 p.m. Mr. B. S. Cohen on "An Experimental Demonstration of the Loading of Artificial Telephone Cables."

PATENTS.

Arc Lamps.

3371.—1909. A. HOLMAN, Lanarkshire. Each of the series of carbon electrodes is carried in a holder formed of conducting material. Each holder is attached to a swinging arm formed in two parts, insulated one from the other, and mounted in brackets fixed to the base plate of the lamp. Sectors are fixed to the upper part of the swinging arm, and a wedge shape part of solid metal operates in conjunction with the sectors for separating or drawing the electrodes together.

Electric Lamp Shades.

3195.—1909. W. CROOKELL, Middleton. A helical spring encircles the lamp socket, and a ring engages projections or the lamp socket. The spring and ring are combined to form one member, and for this reason embayments are provided on one coil of the spring to enable the coil to pass over the lugs in the lamp socket.

Automatic Electric Switches.

3176.—1909. F. C. DANNATT, Blackheath. Combined with an auto-transformer is a switch having a movable member actuated by a starting coil, an auxiliary coil, and a main coil. The auxiliary coil is in circuit under light loads and the main coil is in circuit during heavy loads. The coils actuate the movable member, and automatically transfer the circuit from the auxiliary coil to the main coil when the load reaches a predetermined value.

Switch for Controlling Lamps.

3105.—1909. SIMPLEX CONDUIT, LTD., Birmingham. This switch comprises two segmental conducting bridge pieces mounted upon an actuating spindle and housed in a casing. The bridge piece makes contact with a series of four contacts connected to two separate circuits. The contacts are fixed within the casing and arranged in a circle about the axis of the spindle.

Unipolar Turbo-Dynamos.

2755.—1909. O. SCHULZ, Berlin. In this machine four disc-shaped armatures are made to serve as turbine wheels, and are enclosed in a casing, provided with a steam-tight bridge, which separates the steam chamber from the exciting coils and collecting brushes. Various other improvements are provided for simplifying the construction of the dynamo.

Switches.

2754.—1909. T. J. & E. RORKE, Barnes. In this switch an armature provided with coils, arranged in a magnetic field, carries a mercury contact tube, which short circuits or breaks the circuit of the armature coil that is closed to bring about the rocking movement of the switch.

Electrodes of Secondary Batteries.

2749.—1909. H. GARDE & A. J. ADAMS, London, W.C. This process for manufacturing electrodes of secondary batteries of the spiral roll pasted type consists in obtaining spongy lead by pasting the grids with lead oxide paste and reducing them electrolytically in the ordinary way, and then pressing them into shape while the plates are still in the spongy lead condition, and before they have lost their energy.

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Switch for Electric Currents.

373.—1909. J. J. RAWLINGS, South Kensington. The contact discs are arranged to be free to move at right angles to their axis. The conductor which unites the pair of discs is made of flexible wires, to enable easy movement of the discs.

Electric Switches.

4250.—1909. BRITISH THOMSON-HOUSTON CO., London. This is an improvement in electric switches operated by automatic means, and consists in so mounting the member carrying the contacts of the interlocking switches, that it is capable of movement through an arc of a circle. The axis of the member remains parallel to the base, from which the fixed contacts are supported during its movement, and thus permits the contacts carried by the member to come first into abutting engagement with the fixed contacts, and then to move sidewise over the fixed contacts owing to the continued movement of the member.

Rotors of Alternating Current Dynamo Electric Machines.

6477.—1909. LANCASHIRE DYNAMO MOTOR CO., Manchester. The improvement consists in the provision of non-rotating brush rests adjacent to the slip rings, a rotor short circuiting device and operating means, so arranged as to provide relative axial movement between the brush gear and slip rings. This movement transfers the brush gear from the slip rings on to the rests and closes the short circuiting device.

Electrical Depth Recorder.

6574.—1909.—D. IRELAND, South Shields. The recorder consists of a porcelain, glass or ebonite tube containing a leather piston made in two parts. A metal core runs through the centre of each piece of leather. These pieces of metal are tapped. A quantity of mercury is placed between the two pieces of the piston. Negative and positive electrodes are placed at various distances apart, according to pressure at various depths of the sea. The pressure of water forces the piston and mercury up the tube, and the mercury comes into contact with the electrodes and completes an electric circuit. Each circuit makes signals to any desired part of the ship.

Metal Filaments.

6933.—1909. A. LEDERER, Vienna. It is found that raw tungsten or other metal filaments containing 2·5% carbon lose about 2·3% if heated to a temperature of 1,000° C in very carefully dried hydrogen. If the temperature be raised to 1,300° C, only about 0·4% carbon remains, so that the filaments may be claimed to be practically free from carbon. The invention applies to other metal filaments besides those of tungsten.

Electric Switches.

8025.—1909. O. BAKER, London. This switch comprises a rotatably mounted bridge and push piece, and a cam-shaped carrier, which, upon a reciprocating movement being given to the push piece, effects the rotation of the bridge piece through an aliquot fraction of a revolution, and alternately make and break the electric circuit. The return movement of the push piece is effected by spring action.

Electric Lamp Holders.

8077.—1909. J. SEDGWICK, Morley. The horizontal part of the bayonet slot of an Ediswan type of holder is extended backward and forward sufficiently to give a quarter revolution to the lamp when swivelled on its pins. When so swivelled, the lamp carries the contact plugs free from the terminals and holds the lamp securely disconnected. To prevent the abrasion of the insulation on the leading-in wires, a rubber tube is provided, with its central part coned to fit within the screw cap. The leading-in wires are threaded through the cap and coned tube, and the cap is then screwed down on the holder, whereby the tube securely clamps the leading-in wires.

Electric Incandescent Lamp Making Machines.

8351.—1909. BRITISH THOMSON-HOUSTON, London. This is an automatic machine which cuts off the neck of a bulb to a proper length, places it in a proper relative position to a stem carrying a filament, and seals the stem into the bulb. Means are provided for smoothing the edges of the neck, and a special device is provided for protecting the filament while the bulb and stem are being placed in their proper positions.

Transmitters for Wireless Telegraphy.

8582.—1909. G. MARCONI, London, W.C. In this improved transmitter actual contact is made between the bridging pieces and the terminals, so that the oscillation circuit is momentarily completed and the spark gap is completely bridged. This may be accomplished by providing the studs on the rotating disc with spring tips, or the studs themselves may be supported by springs, so that they give on touching the terminals.

Locking Electric Incandescent Lamps.

9194.—1909. E. P. COTTIER, Liverpool. In order to prevent unauthorised detachment of electric incandescent lamps, a metal band is provided on the outer circumference of the lower portion of the holder. The band has slots which engage with studs in the holder.

Electric Fan Motor.

9706.—1909. H. HIRST and A. J. D. KRAUSE, Salford. Sheet metal parts, consisting of a central tubular portion and two end stampings fastened together, form the body of the motor. The end pieces have sleeve extensions to receive the bearings. One of the end pieces has sleeves to hold the brushes. This motor is claimed to be light, yet strong, and to be cheaply produced.

Electric Circuit Closer.

9094.—1909. J. A. KENNEDY-MCGREGOR, Birmingham. The contact arm is coupled to a main arm in such a manner that excessive pressure applied to the main arm by the operative in the process of operating the starter effects the disconnection of the contact arm and frees it from the control of the main arm. Upon a gradual movement of the main arm, however, the operating device is enabled to maintain its engagement with the contact arm until the whole of the resistances are cut out. The operative is not only constrained to cut the resistance gradually, but cannot damage the apparatus in an attempt to accelerate the movement of the starter by undue force.

Insulators for High-Tension Electricity Conductors.

1009.—1909. F. CLOUTH, Rheinische Gummiwaren fabrik m.b.H., Coln-Nippes. This insulator comprises a core formed in one or more parts, and is surrounded on all sides by an insulating composition. The central portion is enclosed between the points of an attachment of the tensile devices and by a jacket, the superficial insulation of which is not destroyed by the action of weather, and the length of which is greater than the circumference.

Protective Devices for Alternating Current Systems.

10663.—1909. H. BRAZIL, Beckenham. This is an excess pressure apparatus consisting of two or more gaps connected in series between any one pole and any other. The potential is equalised across two or more gaps in series, so that the number of gaps necessary for a given voltage is reduced to a minimum.

Metallic Conduit Fittings.

10739.—1909. C. H. PUGH and F. G. BULL, Small Heath. The tee junction fittings of metallic conduits for electric conductors are formed from a flat sheet metal blank of cruciform shape. The blank is operated upon whilst in the cold state. Two narrow end extensions of horizontal trough section are formed into a double trough section. When the blank is folded longitudinally it forms a complete fitting.

Electric Furnace Electrodes.

14858.—1909. C. BINGHAM, London, E.C. The bottom electrode comprises one or more blocks of refractory material in which are a number of holes extending from the upper face of the electrode to a space about the metal parts connected to the busbars of the electricity supply system. Cores are formed in the holes by pouring molten metal into them on to the metal connecting parts.

Locking Carriage Doors.

15475.—1909. R. C. WILSON, West Hartlepool. In order to simultaneously lock carriage doors, an electrical coupling is provided between the carriages and consists of a hooked clutch member which engages a cross pin on a second member in such a manner as to grip both members. These are connected to flexible tubes carried by the carriage provided with insulated spring strips, to which the conducting wires are attached, extending across the coupling to bear upon the contact pieces at the opposite sides.

Electric Arc Lamps.

15605.—1909. SIEMENS SCHUCKERTWERKE, G.m.b.H., Berlin. The lamp has a receptacle wherein the fumes from the arc are circulated and deposited. The receptacle forms a closed circulating path for the gases. The arc is enclosed in a chimney connected at one end with the receptacle. The fumes pass upward from the arc through the chimney and into the receptacle on to the walls of which they are deposited.

Electrical Switch.

23526.—1909. "WATT" INSTALLATION EN FÜR STARKUN SWACHSTROM C. SCHULZ, Berlin. This is an improved switch of the push-button type, and its base is grooved or undercut so that it may be secured in place in the wall by plaster of Paris.

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TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns per week.			Increase or decrease.		Miles of track open.		Accounts for past year.							Cost per car mile.
	Ending	1909-10.	1908-9.	Week.	Current year.	1909.	1908.	Ending	Total receipts.	Passengers carried.	Car miles run.	Receipts per Passenger.	Car mile.	Mile of track.	
		£	£	£	£				£						
Aberdeen Corporation	Mar. 23	1,170	1,133	+ 37	— 599	27½	27½	May 31	71,930	17,517,304	1,566,119	·98	11·02	4,940	5·93
Ayr Corporation	Sept. 18	671	562	+ 108	—	8	8	—	—	—	—	—	—	—	—
Baker Street and Waterloo Ry.	Nov.	8,141	6,070	+2,071	—	4·25	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	Mar. 20	1,018	948	+ 70	+ 357	24·003	13·52	—	—	—	—	—	—	—	—
Birmingham Corporation	Mar. 19	6,562	6,278	+ 284	—	56·792	58·52	—	—	—	—	—	—	—	—
Blackburn Corporation	Oct. 6	1,100	1,293	— 173	— 1,036	24·53	28·3	—	—	—	—	—	—	—	—
Blackpool Corporation	Aug. 26	2,152	2,050	+ 102	+ 732	—	—	—	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams	,, 8	2,304	2,309	— 24	—	—	—	—	—	—	—	—	—	—	—
Bolton Corporation	Oct. 10	2,416	2,337	+ 79	— 259	42	42	Mar. 31	117,799	25,492,902	2,492,147	1·1	11·34	2,804	6·50
Bournemouth Corporation	July 21	1,681	1,723	— 42	— 23	29½	29½	,, 31	86,225	13,991,328	1,766,068	1·47	11·71	2,912	7·22
Bradford Corporation	M r. 19	4,686	4,237	+ 449	+ 11,634	98	54·81	,, 31	235,258	47,839,569	5,331,007	1·17	10·59	2,378	—
Brighton Corporation	Mar. 27	1,034	710	+ 324	+ 3,080	9·5	—	—	—	—	—	—	—	—	—
Bristol Tramway Company	Mar. 25	5,497	4,782	+ 715	—	57	51½	Dec. 31	265,362	46,652,389	5,756,842	—	—	—	—
Burnley Corporation	Mar. 26	1,632	1,149	+ 483	—	19½	19½	Mar. 31	64,261	12,355,958	1,202,330	1·23	12·83	5,971	7·92
Burton Corporation	Mar. 20	236	230	+ 6	— 16	6½	6½	,, 31	14,918	3,221,595	430,913	1·04	8·30	1,460	5·85
Cardiff Corporation	April 3	2,000	1,957	+ 43	—	—	—	,, 31	109,979	25,058,146	2,497,169	—	10·57	—	—
Carlisle Tramways Company	June 19	170	175	— 5	— 89	—	—	—	—	—	—	—	—	—	—
Central London Railway	Mar. 19	5,786	5,782	+ 4	— 403	6·32	6·32	Dec. 31	350,150	41,898,373	1,456,781	2·01	5·769	55,404	30·27a
Charing X, Euston, & Hamp. Ry.	Nov.	6,822	6,092	+ 730	—	7·75	—	—	—	—	—	—	—	—	—
City and South London Railway	Mar. 13	3,307	3,373	— 66	— 701	7·26	7·26	—	—	—	—	—	—	—	—
Colchester Corporation	July 14	200	219	— 39	— 8	—	—	Mar. 31	10,983	2,308,721	349,539	1·09	7·74	1,477	6·56
Cork E. T. and L. Company	Mar. 17	479	416	+ 63	+ 239	9·89	9·89	Dec. 31	24,044	5,737,478	896,945	—	6·43	—	4·43
Croydon Corporation	Mar. 11	1,639	1,139	+ 500	+ 9,590	11½	—	Mar. 31	74,132	16,277,418	1,884,137	1·06	9·56	3,703	7·109
Darwen Corporation	Oct. 1	239	256	— 17	— 201	7·23	7·23	,, 31	13,899	2,557,654	245,584	1·30	13·68	1,922	9·40
Dover Corporation	Sept. 18	230	252	— 22	— 395	7	—	,, 31	11,593	2,697,672	316,754	·98	8·78	—	—
Dublin and Lucan Electric Ry.	Mar. 25	127	111	+ 16	— 10	7	7	—	—	—	—	—	—	—	—
Dublin U.T.	Mar. 18	5,341	4,918	+ 442	+ 2,440	54½	54½	—	—	—	—	—	—	—	—
Dundee City Tramways	Oct. 6	1,332	1,305	— 27	— 569	—	26½	May 15	60,573	16,367,911	1,281,552	·875	1·9	2,371	7·46
East Ham Corporation	Mar. 19	959	873	+ 86	+ 5,864	15	15	Mar. 31	47,430	15,355,703	1,091,586	·73	10·26	—	6·96
Glasgow Corporation	Mar. 19	17,271	16,407	+ 864	— 1,206	191	185	May 31	907,494	226,948,290	20,766,722	·96	10·49	5,080	5·89
Gloucester Corporation	Oct. 6	395	425	— 30	+ 535	15	—	—	—	—	—	—	—	—	—
G.N., Piccadilly and Brompton	Nov.	13,429	9,354	+ 4,075	—	9·25	—	—	—	—	—	—	—	—	—
Halifax Corporation	—	—	—	—	—	52·574	37	Mar. 31	81,872	20,378,672	1,786,390	11·40	11·13	1,528	8·40
Huddersfield Corporation	Dec. 4	1,613	1,357	+ 256	+ 2,663	28	28½	,, 31	84,704	16,200,020	1,960,329	1·29	10·37	2,421	5·10
Hull Corporation	Mar. 26	2,706	2,509	+ 197	+ 7,729	29	26	,, 31	128,722	30,964,254	3,022,844	1·	10·22	—	6·04
Ilford Corporation	Feb. 12	451	391	+ 60	+ 1,969	10	10½	,, 31	25,328	6,385,466	634,446	·87	9·58	2,066	6·42
Ilkeston Corporation	Mar. 16	114	119	— 5	— 287	4	4	,, 31	7,214	1,968,850	198,415	9·1	7·9	1,803	7·04
Kirkcaldy Corporation	Sept. 5	259	266	— 7	—	7½	7½	May 15	14,993	4,874,199	459,066	·711	7·838	1,856	5·26
Lancashire United Tramways	Mar. 23	1,139	1,256	— 117	+ 183	39	39	Dec. 31	68,904	12,554,593	2,244,344	—	—	—	—
Leeds Corporation	Sept. 18	6,896	6,624	+ 272	+ 3,662	108	96½	Mar. 31	340,368	75,734,083	7,694,989	1·06	10·62	3,527	5·51
Leicester Corporation	Sept. 11	2,162	2,130	+ 32	—	—	—	—	—	—	—	—	—	—	—
Liverpool Corporation	Nov. 6	10,803	10,687	+ 116	— 1,977	109	104	Dec. 31	572,822	124,043,239	12,231,799	1·108	11·24	5,508	7·94
Liverpool Overhead Railway	Mar. 20	1,275	1,189	+ 86	— 29	6·65	2·40	June 30	79,004	11,171,515	1,106,386	—	—	—	—
London County Council	Mar. 12	40,007	31,805	+ 8,202	+ 146649	131½	121½	Mar. 31	1,274,660	279 166,461	25,591,028	1·08	11·74	—	6·79
Lowestoft Corporation	Dec. 11	155	150	+ 5	+ 30	3½	—	Sept. 30	11,399	2,646,206	370,320	1·03	7·36	2,279	6·12
Maidstone Corporation	Mar. 6	157	100	+ 57	—	7·4	—	—	—	—	—	—	—	—	—
Manchester Corporation	Sept. 11	15,631	15,297	+ 334	— 2,871	183	181	—	—	—	—	—	—	—	—
Metropolitan District Railway	Mar. 19	11,062	9,794	+ 1,268	+ 11,832	24	24	—	—	—	—	—	—	—	—
Metropolitan Railway	Mar. 27	15,600	15,485	+ 115	+ 6,627	24½	24½	June 30	680,357	99,846,735	—	1·46	—	—	—
Nelson Corporation	Oct. 16	151	131	+ 20	+ 7	2½	2½	Mar. 31	7,362	2,060,712	204,740	·85	8·63	1,907	—
Newcastle-on-Tyne Corporation	Mar. 19	3,683	3,702	+ 19	— 1,232	60½	59½	,, 31	211,085	46,203,164	4,411,745	1·10	11·48	3,504	6·36
Newport (Mon.) Corporation	Oct. 9	663	638	+ 25	— 311	14½	14½	,, 31	35,531	8,174,003	798,029	1·04	9·89	2,450	7·21
Oldham Corporation	Jan. 24	1,778	1,516	+ 262	— 386	—	—	—	—	—	—	—	—	—	—
Portsmouth Corporation	Oct. 10	2,046	1,809	+ 237	—	28½	28½	Mar. 31	97,741	21,247,048	2,309,439	1·10	10·15	—	—
Reading Corporation	Mar. 17	528	490	+ 38	+ 214	13½	13½	,, 31	32,769	7,933,572	915,481	—	8·93	—	4·65
Rochdale Corporation	Dec. 26	1,240	1,126	+ 114	+ 746	20·9	20·93	,, 31	56,558	10,196,148	1,252,925	1·32	10·88	2,693	6·47
Rotherham Corporation	Feb. 4	555	587	— 32	—	—	—	—	—	—	—	—	—	—	—
Salford Corporation	Sept. 27	4,096	4,662	— 66	— 3,326	78	74½	Mar. 31	244,065	45,771,611	5,486,150	1·25	10·67	3,185	—
Scarborough Tramways Co.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Sheffield Corporation	Mar. 13	5,786	4,992	+ 794	+ 8,837	39½	37	Mar. 25	289,745	17,568,686	7,065,380	·896	9·842	4,225	5·04
Southampton Corporation	Mar. 16	944	834	+ 109	+ 728	18	18	,, 25	52,647	10,121,887	1,157,451	1·25	11·33	—	7·30
Southend-on-Sea Corporation	Aug 21	995	557	+ 438	+ 1,483	—	—	—	—	—	—	—	—	—	—
Stockport Corporation	—	—	—	—	—	25	25	Mar. 31	52,004	9,155,172	1,335,911	1·34	9·842	1,830	4·75
Sunderland Corporation	Jan. 27	1,310	1,336	— 26	— 7,984	—	—	—	—	—	—	—	—	—	—
Swindon Corporation	Dec. 11	126	114	+ 12	—	—	—	—	—	—	—	—	—	—	—
Torquay Tramways	Aug. 26	630	647	— 30	—	8·41	—	Dec. 31	15,065	2,880,420	353,297	1·40	1·023	—	—
Wallasey U.D.C.	Mar. 19	837	767	+ 69	+ 1,021	12·68	12·45	Mar. 31	43,823	8,331,038	891,540	1·2	11·79	3,453	7·72
Warrington Corporation	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
West Ham Corporation	Mar. 17	2,294	1,915	+ 378	+ 8,933	27	14·7	Mar. 31	122,881	35,502,836	2,556,854	·789	10·95	4,417	6·79
Wolverhampton Corporation	Nov. 3	841	823	+ 18	— 206	21½	—	,, 31	44,432	9,440,369	975,714	—	10·929	2,190	6·509

a Train Miles. h Half-year's figures.

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THE
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WITH WHICH IS INCORPORATED "ELECTRIC LIGHT."

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NOTES.

ELECTRICITY IN THE FIELD.

Sir Oliver Lodge appears to be well content with his experiments in promoting the growth of crops by electrifying the air above the plants. His method is to have a network of very fine iron wire, stretched some 10 yards apart and 18 feet above the ground. This network is connected with a transformer, which steps up the current (either from a dynamo or the city supply) to about 100,000 volts. In this way a continuous discharge of negative electricity takes place, electrifying the atmosphere. This process is prolonged in proportion to the dulness and coldness of the weather. Apart from the main experimental station at Bevington Hall Farm, Evesham Valley, where Sir Oliver has had the co-operation of Mr. J. E. Newman and Mr. R. Bomford for over five years, several other of his field equipments have been installed in different parts of the country. Mr. Lionel Lodge says that matters are sufficiently advanced to permit of definite figures being got out. Striking an average, it has been found that the increase in "electrified" crops is quite 30%. Now, for a farm of ground fruit of 24 acres, the equipment would cost £300. The annual upkeep works out thus: Interest, depreciation and repairs at 15%, £45; fuel for a one h.p. oil-engine, running 12 hours a day, for 180 days, £9; labour, two hours a day, £9; or a total of £63. Taking £36 as a fair average revenue per acre, then an increase of one-third would mean £12, from which one-third should be deducted for cost of picking and handling the extra amount. This leaves £8 per acre, or, multiplied by 24, £192 as the result of electrification, so that if we deduct the £63, we arrive at a net profit on the scheme of £129.

GENERAL ELECTRIFICATION.

Such results are assuredly very tempting. But we shall have to have more extended experiments before the theory can be generally adopted. If Sir Oliver's work is borne out in general practice, then it would certainly open up a splendid outlet for the electricians' energies—whether in the matter of the supply of independent generating sets, or in supplying current from central stations. Here, indeed, would be a demand that would more than counterbalance a hundredfold improved metal filament lamps. There remain certain points to be considered, however. What effect on the general meteorology would such a universal dispersal of electricity in the air produce? By the way, why do not some of our Agricultural Colleges take the matter up? For the moment it would be well if Sir Oliver or Mr. Lionel Lodge would kindly answer three questions: (1) Do plants grown under the scheme produce fertile seeds, say, for two seasons? (2) Has any effect been noticed on trees or shrubs? (3) Are the crops specially free from pests?

FORESTRY AND HYDRO-ELECTRIC.

Perhaps a rather more remote connection of electricity with agriculture was alluded to by Mr. Saint-Hill Eardley-Wilmot, C.I.E., late Inspector-General of Forests, when lecturing on "Indian State Forestry" before the Royal Society of Arts the other day. He was alluding to the fact that one of the chief aims of forestry in a country like India was to regulate rainfall and water distribution. By means of forests, those extremes, disaster by flood and drought, could be avoided or mitigated, and in this way an impulse might be given to the "industrial development of the country by rendering possible the further use of the enormous hydraulic power now running for the most part to waste. For until we regulate the flow of our rivers to some extent they cannot be remuneratively harnessed for commercial purposes. The subject is a wide one and full of interest, but there is no time to dwell on it to-day. Suffice it to say, that perhaps we are already on the road to satisfactory developments in this direction. Hydro-electric works are, I believe, in process of erection on the Jumna and Sutlej rivers, and are actually in working in Native States on the Jhelum and Cauvery; while the protection of catchment areas is receiving attention in Kashmir, in the North-West Frontier Province, in the Punjab, in the United Provinces, in Bengal, and even in Burma." This is an interesting phase of irrigation work to which we have referred more than once, but the importance of which scarcely yet seems to be realised either here at home or in our other possessions and colonies.

SHIP PROPULSION.

Invigorated by his recent field-day in connection with the Naval Architects' Conference, Mr. Durtnall is carrying on the campaign of enlightening people on the claims of electricity for ship propulsion with the utmost energy. In one of our daily contemporaries he urges the use of electricity for the main propulsion of vessels upon the Admiralty. In another he advocates this method as an effective remedy against the dwindling profits earned by steamship companies. He asks that the matter should be given immediate and earnest attention by British boards of directors, because, among other things: "Already the engineers of vast firms in America are discussing the possibilities of this type of vessel, and recently, at the American Institution of Naval Architects, of electrically-driven vessels up to 28,000 h.p., and have shown that a tremendous economy is to be made in fuel and operating costs of high-speed vessels, as are to be found in the Atlantic trade."

A HINT AND A WARNING.

Our New York correspondent transmits the interesting information, based on a circular issued by the Board of Manufacturers at Washington, that an American consul in England has forwarded the names of seven towns in his district which have an electric car system, together with the total authorised mileage, mileage under operation, and the money invested. The consul states that much of the equipment of these lines was purchased in the United States, and as the companies are from time to time extending their service, making repairs and renewals, and linking up existing tracks, it is suggested that American firms follow these developments and endeavour to secure further orders in that district. This is very thoughtful and considerate of the American consul, but it is quite possible that English firms may not be altogether unable to look after these orders on their own account.

RAILWAY ARCHES.

An unpleasant experience befel the South London Elevated Railway section of the Brighton Co., when trains were held up for a long time as the result of a fire breaking out in a railway arch in the Rotherhithe-road, let as a rag warehouse. It is high time that the bad policy of letting these archways should cease. We have known them to be let to printers and binders, to carpenters and to other traders with pretty big fire risks. If they must be let, greater discrimination should be observed.

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INCORPORATED MUNICIPAL ELECTRICAL ASSOCIATION.

FIFTEENTH ANNUAL CONVENTION.

The Fifteenth Annual Convention of the Incorporated Municipal Electrical Association will take place at Glasgow from June 14 to 17, inclusive, and the preliminary programme has now been issued.

On the first day proceedings commence by the opening of the Convention by the Hon. A. McInnes Shaw, Lord Provost of Glasgow, in the Large Hall of the Institute of Engineers and Shipbuilders in Scotland, Elmbank Crescent. The Presidential Address will be delivered by Mr. W. W. Lackie, Chief Electrical Engineer, Glasgow Corporation Electricity Department. This will be followed by a paper on "Commercial Progress," by Mr. A. C. Cramb (Croydon), and Mr. H. Collings Bishop (Newport), with discussion. At 1.15 p.m. luncheon will be served at the City Chambers to members and delegates, by invitation of the Tramways and Electricity Committees. Then at 3 p.m. brakes will leave City Chambers to visit the following works:—(a) Springburn Sub-station of the Electricity Department; (b) Pinkston Power House of the Tramways Department; (c) Port Dundas Electricity Works of the Electricity Department. The busy day will be closed by a reception and conversazione at the City Chambers, by the Lord Provost, Magistrates and Town Council of the City of Glasgow, commencing at 7.30.

On the second day, members and delegates leave Glasgow (Central Station) by special train at 8.45 for Edinburgh, where a meeting will take place in the Freemasons' Hall, 96, George-street, at 10. The Hon. The Lord Provost of Edinburgh will be present to welcome the Convention to Edinburgh. The following papers will then be read and discussed:—(a) "Mixed Pressure Turbines" by Mr. Ashton Bremner (Burslem); (b) "Exhaust Steam Turbines," by Mr. F. A. Newington (Edinburgh); (c) "Chemistry in the Boiler House," by Mr. A. R. Sillar (Colchester). Luncheon follows at 1.15 at the North British Hotel, by invitation of the Corporation of Edinburgh. After this, at 2.30 p.m., conveyances will take members to the works of the Electricity Department. The return train to Glasgow will leave at 8.30.

On the third day, at 10 a.m., there will be a meeting in Large Hall of Institute of Engineers and Shipbuilders, Glasgow, when the following subjects will be taken for discussion: (a) "Advantages of continuous records of Costs and of Steam Consumption"; (b) "Cheapening of the cost of Mains and Services." A table d'hôte luncheon will be served at the Windsor Hotel. Brakes will leave Windsor Hotel at 2 to visit the following works:—(a) St. Andrew's Cross Electricity Works of the Electricity Department; (b) Coplawhill Works of the Tramways Department; (c) Electricity Works of the Govan Electricity Department. An alternative series of visits will be:—(a) Electricity Works of the Partick Electricity Department; (b) Power Station of the Clyde Valley Electric Power Co., at Yoker; (c) The Shipbuilding Works of Messrs. Beardmore, Ltd., Dalmuir. The annual dinner will take place at the Windsor Hotel at 7.30.

On the fourth and concluding day, the annual business meeting takes place at 10, at the Large Hall of Institute of Engineers and Shipbuilders, Elmbank Crescent. In token that all business is over at 12 noon, members and delegates will leave Glasgow (Central Station) for a sail on the Clyde.

A special programme for ladies has been arranged, and includes the following items:—

First day: Ladies will be present at the opening meeting, the luncheon in City Chambers, the visits to works, and the reception and conversazione in City Chambers in the evening.

Second day: Ladies will travel to Edinburgh with the Convention and spend the day there visiting, according to a programme to be hereafter arranged.

Third day: Broughams will leave the Windsor Hotel at 10 o'clock, to take the ladies on a tour of inspection through the city to the following places: (a) City Chambers; (b) Glasgow Cathedral; (c) Kelvingrove Art Galleries. Ladies will return to Windsor Hotel for table d'hôte luncheon at 1 o'clock. In the afternoon special cars will convey the ladies to Rouken Glen, where afternoon tea will be served. The Tramways Department Band will be present and discourse a programme of music. The times for leaving for and returning from Rouken Glen will be definitely announced later. Alternatively, any ladies wishing to do so may accompany the Convention on their visits to works, but the Secretary will require to be notified in writing by those who intend to go to Rouken Glen, so that sufficient car accommodation may be provided.

It should be noted that the headquarters will be at the Windsor Hotel, Glasgow, where rooms should be booked at once. The following works will be open for inspection during the Convention, and members are requested to notify the Secretary at once if they wish to visit any of these works, so that adequate arrangements can be made: (a) Messrs. Mavor & Coulson, 47, Broad-street, Mile End, Glasgow; (b) Messrs. Babcock & Wilcox, Renfrew; (c) Messrs. The Craigpark Electric Cable Co., Flemington-street, Springburn, Glasgow; (d) The Electricity Works of the Greenock Corporation; (e) The Electricity Works of the Paisley Corporation; (f) Messrs. D. Bruce Peebles & Co., East Pilton, Edinburgh.

A detailed official programme will be issued in due course, and in the meantime all communications should be addressed to Mr. C. McArthur Butler, Staple Inn Buildings, Holborn, London, W.C.

INFLUENCE OF ELECTRICITY ON INDUSTRY.

It is both encouraging and highly significant to find the official organ of the Machinery Users' Association referring appreciatively, in no half-hearted way, to the benefits that must accrue to various branches of industry as they avail themselves of electricity. Opening a lengthy article on "Electric Shaft Furnaces: Advantages over the ordinary blast Furnace," we read: "It may be taken for granted that the electric furnace, with its very high temperatures, is destined at no distant date to supersede all other metallurgical furnaces in the production of high-grade steel. Generally speaking, all refining operations can be carried on more rapidly and thoroughly with higher temperatures: consequently, steel made in an electric furnace should possess superior properties to steel produced either in a crucible or by the open hearth process."

When, however, referring to the furnaces for the reduction of ore to pig iron, our contemporary suggests caution, so far as home practice is concerned. For, "while it is yet too early to say anything definite about the economical aspects of the matter, or to speak of it as a commercial success, we should bear in mind that only a quarter of the heating power of the fuel is developed around the blast tuyeres, and if one-half of this could be replaced by electrically-generated heat, an economy of 50% on the fuel bill should be within measurable approach. These furnaces are scarcely likely to be required in this country, where the cost of power has no advantage over former processes. A great future, however, should await them in our colonies and dependencies, in situations which are difficult of access, devoid of cheap fuel, and rich in iron ores and water power."

Turning to another page we find the electrification of textile factories under consideration, and this is the opinion given to by these experts in machinery equipment and management: "When once the British textile trades appreciate what electric driving means to them the demand for plant will tax the resources of the whole electrical manufacturing industry for several years."

LIGHT RAILWAYS ORDERS.

The Board of Trade have recently confirmed the undermentioned Orders made by the Light Railway Commissioners: (1) Axholme Joint Railway (Hatfield Moor Extension Light Railway) Order, 1910, authorising the construction of a Light Railway in the West Riding of the County of York, being a deviation of part of Railway (No. 1) authorised by the Axholme Joint Railway (Hatfield Moor Extension Light Railway) Order, 1905; (2) London and North Western Railway (Dyserth and Newmarket Light Railway) Extension of Time Order, 1910, reviving the powers granted by the London and North Western Railway (Dyserth and Newmarket Light Railway) Order, 1908, for the compulsory purchase of lands and extending the periods limited by that Order for the same and for the completion of the Light Railway and works thereby authorised

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DUNDEE AND ITS ELECTRICITY STATION.

Although Dundee was one of the first towns to adopt the municipal supply of electricity, it is only within recent years that the business has developed to any great extent. Yet, it forms a splendid centre, for, situated on the north bank of the river Tay, it has within its area of 4,881 acres a population of about 170,000 inhabitants. Moreover, it is the chief seat of the jute industry in Great Britain, importing roughly 220,000 tons of jute annually. There are about 100 mills and factories, having an aggregate h.p. approximating 60,000. Then, again, iron foundries and shipbuilding hold a big place in the local industries, and, as our readers will remember, the Admiralty within the last year have leased a portion of the Harbour and Docks and have formed a submarine base. All this means immense possibilities for the employment of electricity for both lighting and power.

The supply was started on March 15, 1893, for lighting and power purposes, and from then up to 1900 slow but steady progress was made. In the latter year the Corporation took over the horse and steam tramways from the City and District Tramway Co., and gradually electrified the whole system. Extensions have since been made to the tramways, and at present the line opened for traffic amounts to 14½ miles. The price charged to the tramways for current has been steadily reduced from 1½d. to 1⅛d. per unit. To meet the increasing demand from private consumers, combined with the extra load caused by the conversion of the tramway system, large extensions were made to the plant at the generating station.

Within the last few years, however, the business has grown to such an extent that it was felt serious attention would have to be given to still further extensions to the plant, notwithstanding the fact that the generating station had been practically remodelled directly Mr. H. Richardson, M.Inst.C.E., M.I.M.E., the present Chief Engineer, took up his duties, so that the best possible results could be got from the plant then installed.

After reports and estimates from Mr. Richardson, and after consultation with Mr. J. F. C. Snell, M.I.C.E., the Council proceeded with the work, placing the responsibility for the design and execution of the whole system in the hands of their own Electrical Engineer, who advised the adoption of an extra high tension generating station with sub-stations. In 1907, the building of an extra high tension alternating current, 3-phase, station was started, for generating current at 6,600 volts with a periodicity of 50 cycles per sec., together with 3 sub-stations, where it would be converted to direct current and fed into the low tension systems, either 3 wire with 400 volts across the outers for lighting and power, or at 550 volts for tramways.

This system, which has cost over £100,000, has now been partly in operation since July last year, and so far has proved eminently satisfactory in every way. The official inauguration of the new system, as it will be remembered, took place on February 23, 1910, when the mian generating station was opened by Prefossor J. A. Ewing, C.B., F.R.S.

With a capital expenditure of £242,552, the revenue last year from the sale of current was £36,975. Although the accounts have never shown profits of large dimensions, still the fact must not be lost sight of that for several years now it has been the custom of the department to steadily reduce the capital debt of the undertaking. This has been done by transferring large sums annually from capital to revenue, and with the cost of the large alterations which were carried out earlier, and which were also paid out of revenue, the sum of £31,500 has been paid out of the revenue account during the last 5 years, a splendid average of £6,300 per annum.

GENERAL PLAN.

The main generating station is situated at Carolina Port, about 1½ miles from the centre of the city, and 560 ft. from the river Tay. The site occupies an area of roughly 1 acre, but there is ample ground in the vicinity for extensions.

The present main buildings average 120 ft. long by 132 ft. wide, and consist of a steel framework filled in with brickwork on three elevations, a temporary corrugated iron screen wall forming the west elevation to allow for easy extension. The roof is of wood and slates supported on steel principals, 15 ft. apart, and has large top lights running the whole length of the building. Distinctive features of the buildings are the large windows in the north and east elevations. In the boiler house especially, the large amount of light, together with the white glazed bricks of the boilers and economisers give a pleasing effect, which must be conducive to good work on the part of the boiler house staff.

FOUNDATIONS.

The ground upon which the station is built was reclaimed from the river some 20 years ago. A large percentage of the sub-soil is the refuse of the local gas works and of no use whatever for bearing any permanent weights. Numerous borings were made, and good rock was found 30 to 33 ft. below the surface. It was ultimately decided to strengthen the whole foundation with reinforced concrete piles, grouping them where the heavier weights had to be carried, and then throwing a reinforced concrete raft over the whole, constructed to the various levels required. The work was started in December, 1907. Over 300 reinforced concrete piles were driven down to the rock, and a raft varying in thickness from 4 ft. to 4½ in. constructed.

BUILDINGS.

The whole of the structural steelwork of the main buildings was supplied and erected by the Clyde Structural Iron Co., and the brickwork by A. & T. Craig, a local firm.

The Engine-Room is 120 ft. long, 50 ft. 1½ in. wide, and 49 ft. 9 in. high from the lower floor level to the eaves. The upper floor is of reniforced concrete on the Columbian system, and is 14 ft. 9 in. above the lower floor. This floor does not extend the whole length of the engine-room, as will be seen from Fig. 2, the part at the extreme east end of the lower floor being used for sub-station machinery.

The Switch House is 120 ft. long, 15 ft. 3 in. wide, and has four floors, of which the E.H.T. switch gear occupies three and a battery the fourth. A part of this house at the east end is reserved for rooms for the station superintendent and staff. The boiler house is 105 ft. long and 40 ft. wide, and 53 ft. 9 in. from the ash basement level to the eaves. Provision in height has been made for thermal storage should conditions warrant the adoption of this in the future.

The bunker house is 105 ft. long and 20 ft. wide, and 65 ft. high from the ash basement level to the eaves. The firing floor is 4 ft. above the ground level, this allows of windows in the ash basement to give light and ventilation. An inclined roadway at the north door of the boiler house provides easy access to the firing floor for carting coal in case of emergency as well as for handling plant.

A small workshop, store and lodge are situated at the north-east corner of the site, and a weigh house and locomotive shed are also provided.

As far as practicable, the unit system has been carried out in the design of the work. The station, as at present put down, is complete and symmetrical on either side of its north and south centre line.

In the arrangement of the buildings, the possibility of future use of gas engines and gas generators, if they become more reliable and smaller, has been kept constantly in view.

COAL HANDLING.

A railway branch line is brought into the site at the average level of the ground. This line passes over a 20 ton weighing machine, where the wagons are weighed, then leads through a large ring tippler situated over a receiving hopper. In the tippler the wagons, after being clamped down, are turned completely over, coming back to the original position. The tippler is driven by an electric motor of 4 b.h.p., and the time taken to make a complete revolution is 2 min. The rings are weighted at the top to give a central centre of gravity when turning with a wagon, and an ingenious lock prevents the tippler being turned without a wagon being in position.

The wagons are handled by an electric locomotive supplied by the British Thomson-Houston Co., Ltd. This locomotive takes its current from overhead wires by two trolley arms. There are two motors, and the locomotive is capable of pulling a load of 20 tons up an incline of 1 in 60 at 6½ miles per hour. The receiving hopper into which the coal is dumped has a capacity of 18 tons, and it is built of steel plates ⅜ in. thick, stiffened by tees and angles. A tray conveyor carries the coal from this hopper to the main gravity bucket conveyor, which lifts it to the overhead bunkers. This tray conveyor carries the coal a distance of 45 ft., and is driven by a 2 b.h.p. motor; it discharges the

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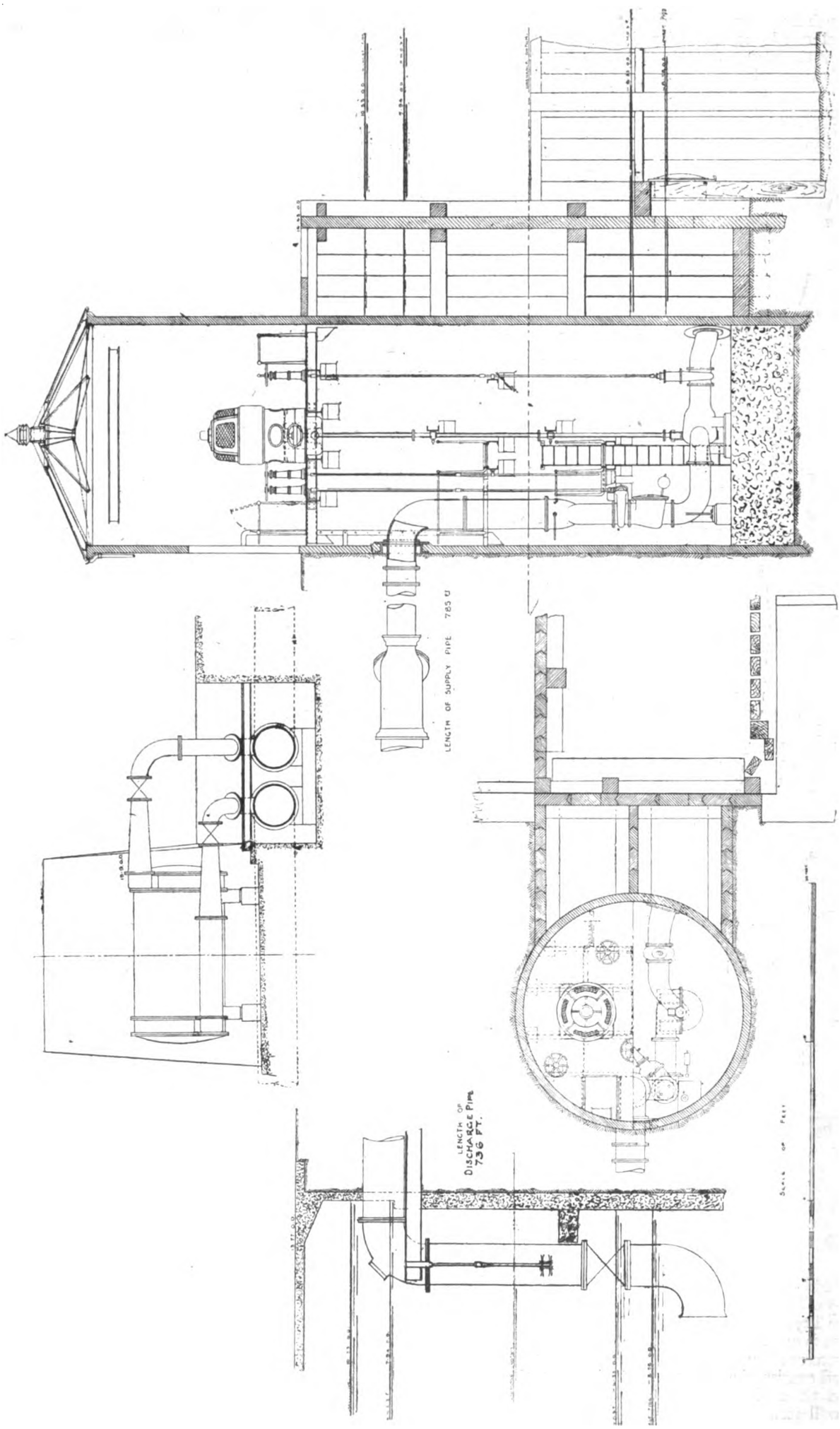

FIG. 1.—PLAN AND SECTION OF PUMP ROOM, WITH DIAGRAM OF PIPE LINE, SHOWING RELATIVE LEVELS.

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coal into a rotary filler, which feeds the buckets of the main conveyor while they are in motion. The gravity bucket conveyor, supplied by Babcock & Wilcox, Ltd., is about 326 ft. long and has a vertical lift of 62 ft. This conveyor is driven by a 6 b.h.p. motor and the conveyor runs at a speed of 50 ft. a min. The buckets are each stamped out of a single piece of steel, and have only the side brackets and tipping lugs riveted. The coal is tipped into the bunkers by means of tippers, of which there are two to each bunker.

The measuring machines run on rails, suspended from the bunkers, but the shoots are fixed. Coal may be taken from either of two bunkers to either of two boilers in a battery.

BOILERS.

At present there are four Babcock & Wilcox water tube boilers, each having a heating surface of 6,182 sq. ft., and rated to evaporate 20,000 lbs. of water per hour, with a working pressure of 180 lbs. per sq. in. The boilers are each fitted with a Babcock & Wilcox improved superheater of

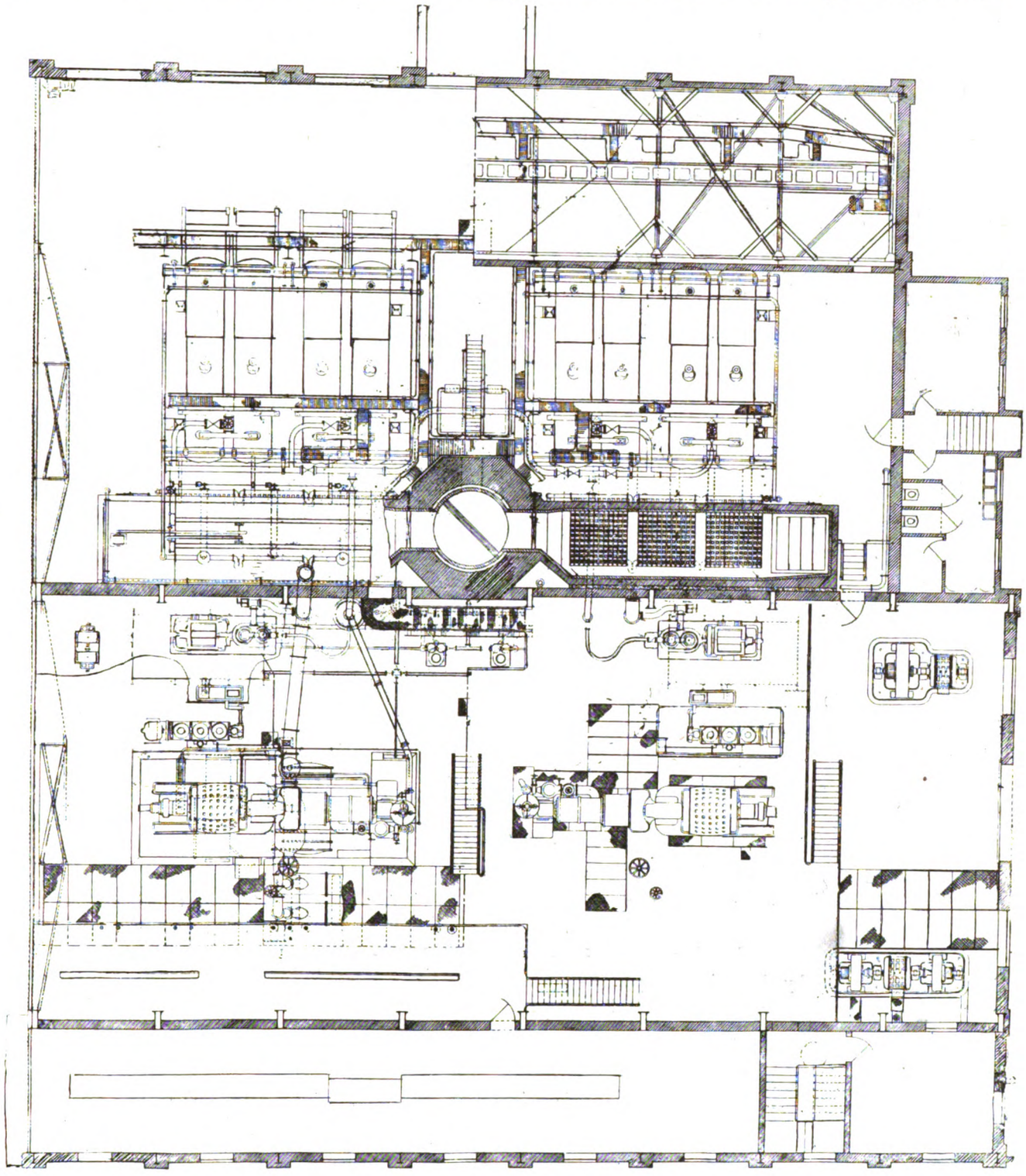

FIG. 2.—PLAN CAROLINA PORT GENERATING STATION.

The overhead coal bunkers have a capacity of about 700 tons, and are situated above the firing floor. They are built of steel plates, stiffened by angles and tees, the bottoms are $\frac{3}{8}$ in. thick, and the sides and bulk heads $\frac{5}{16}$ in. Special attention was given to the riveting to have the bunkers as far as possible watertight.

The coal passes through a valve at the bottom of the bunker into measuring machines, where the amount is registered, then by way of shoots to the stoker hoppers.

1,389 sq. ft., heating surface, giving a superheat of about 150° F. Each superheater is fitted with the usual flooding and draining arrangement. There are two chain grate stokers to each boiler, with a total grate area of 120 sq. ft., and are driven by means of chains from a shaft in the ash basement. The driving motors are situated between the batteries of boilers in a room at the ash basement level. These are 8 b.h.p. each, and are controlled from the firing floor, each motor being capable of driving the eight stokers.

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The ashes are discharged through dumping doors at the back of the chain grates to the ashpits underneath, from which they are allowed to fall to the ash basement floor. After they are cooled, they are taken by the mian conveyor to the ash bunker. The ashes are then discharged through shoots either to railway wagons or carts as may be desired.

FLUES AND ECONOMISERS.

Special attention has been given to making the flues as short as practicable, with easy curves and rounded corners. To facilitate the cleaning of the flues, sliding doors have been provided in the bottom of the main flues, so that the soot may be dropped into barrows at the ash basement level and taken to the main conveyor. There are two economisers of 360 tubes each, situated on either side of the chimney, one for each battery of boilers. They are erected above the main flues so that the gases travel upwards from the flues through the economisers to the chimney. When the economiser is not in use the main flue discharges direct to the chimney. All the dampers are of the horizontal butterfly type. The soot pit under each section of the economiser is formed with a double slope leading to a trough at the bottom, where a screw conveyor driven by means of a clutch from the scraper gear, discharges the soot into trucks, it is then taken by the main conveyor to the ash bunker. The economiser scraper gear is driven by a 4 b.h.p. motor situated at the level of the top of the economiser.

CHIMNEY.

There is one chimney 9 ft. internal diameter and 200 ft. high above firing floor. It is built of brick and has a fire brick lining and centre division inside to a height of 26 ft. above the firing floor. In the boiler house there are a Simmance Abady combined CO_2 and draught recorder, large illuminated dial steam pressure gauge giving the steam pressure in the main steam pipe and a recording steam pressure gauge.

FEED PUMPS.

Two steam driven Weir feed pumps are situated on the engine-room lower floor in front of the chimney. Each pump is capable of delivering 80,000 lbs. of water per hour against the boiler pressure of 180 lbs. per sq. in. Besides the ordinary stop valve at the pump there is a valve with a long spindle extending through the chimney to the boiler house with which the firemen can regulate the speed of the pump. Above the wheel on this spindle in the boiler house is a gauge showing the pressure of the feed water, and on this gauge the strokes of the pump can be plainly observed.

As the pump exhaust is not free from oil it is not allowed to mix with the turbine exhaust, but is passed through a coil in the hotwells where the otherwise waste heat is taken advantage of to heat the feed water and the condensed steam is run to the drains.

STEAM PIPING.

The main and branch steam pipes to the turbines are of mild steel 8 in. diameter with branches and flanges riveted on. The main steam header is securely anchored at two points, viz., in the middle of each battery of boilers and an expansion bend is fitted between the batteries. In erecting this pipe the expansion pipe was sprung cold by an amount equal to half the maximum total expansion when working. There is a mild steel steam separator for each turbine situated on the engine-room lower floor, with a Poole trap discharging the condensed steam either to the hotwell or to the drains.

TURBINES.

The main steam plant consists of two Willans-Parsons steam turbines each having a nominal capacity of 2,000 kw. (2,700 electrical h.p.), but each is capable of dealing with an overload of 25% for 2 hours and 50% for ½ hour.

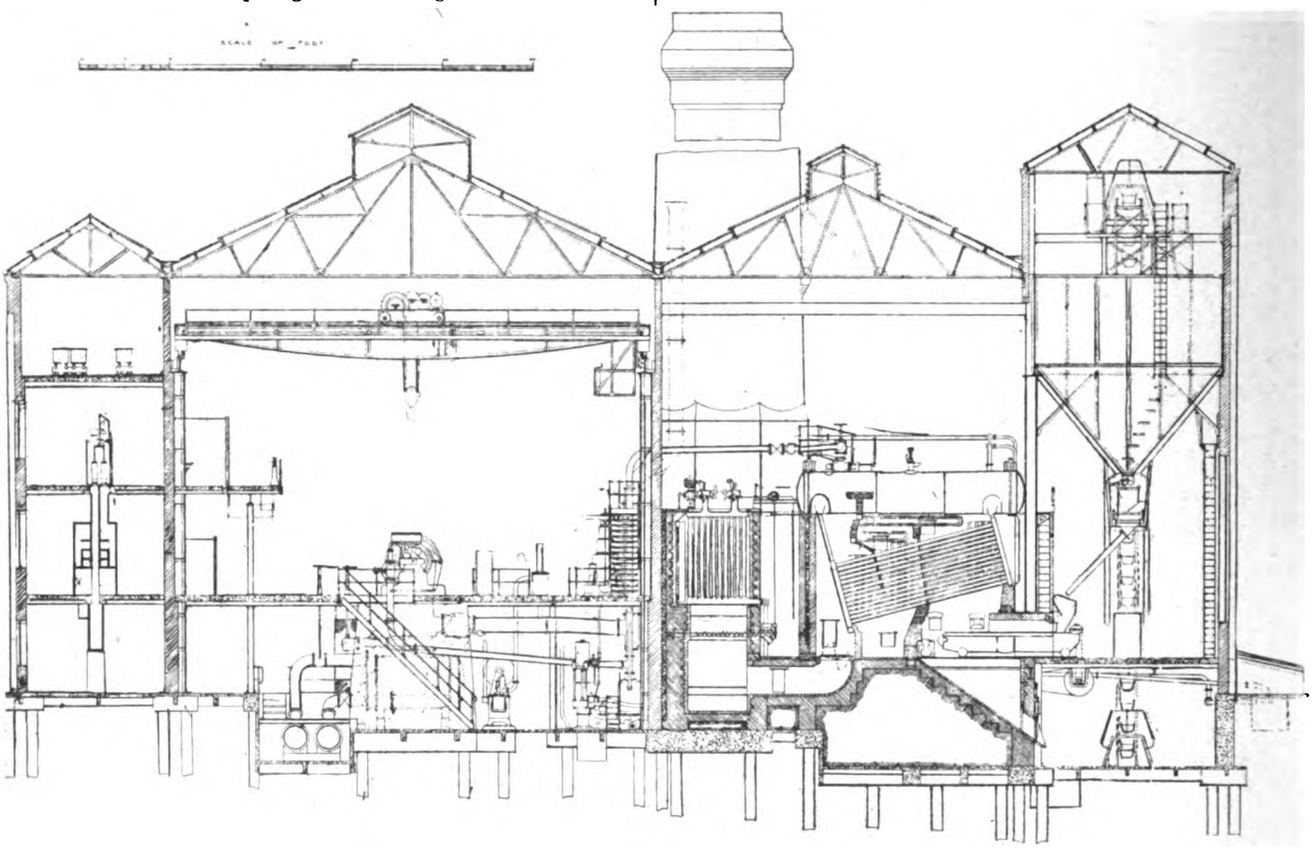

FIG. 3.—CROSS SECTION CAROLINA PORT GENERATING STATION.

Each turbine is fitted with a hand operated overload valve, which admits high pressure steam to the second expansion rings, governor with electrical control, oil pump and tachometer. A hand oil pump is also provided to flush the bearings before starting.

CONDENSING PLANT.

Immediately underneath each turbine is a contraflow surface condenser of 3,400 sq. ft. cooling surface. To allow for expansion and prevent distortion of the turbine body the condenser rests on springs and is not rigidly fixed. Each condenser is provided with a three throw Edwards' air pump driven by an electric motor. On the end of the air pump crank shaft there is a force pump which lifts the discharge to a Lea Recorder on the upper engine-room floor where the steam used per hour is continuously recorded, the water is then allowed to gravitate to the hotwell.

CIRCULATING WATER.

The circulating water for the condensers is taken from the river Tay. The maximum rise and fall of the tide in the river amounts to nearly 18 ft. To reduce the power required to circulate the large amount of water and also to avoid the necessity for constant regulation due to a varying head on

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the pumps, it was decided to use a closed system of piping and arrange the outlet of the discharge pipe below water level. The condensers are well above highest water level, and consequently the internal pressure is less than atmospheric pressure especially at low tide. Hence it would have been preferable to lay as much of the pipes as possible below low water level, and thus reduce the chances of air leakage and also volume of air in the pipes should the syphon break. The expense of doing this was, however, so great that the pipes had to be laid at such a depth that they are only partly below water level at the highest tide. The

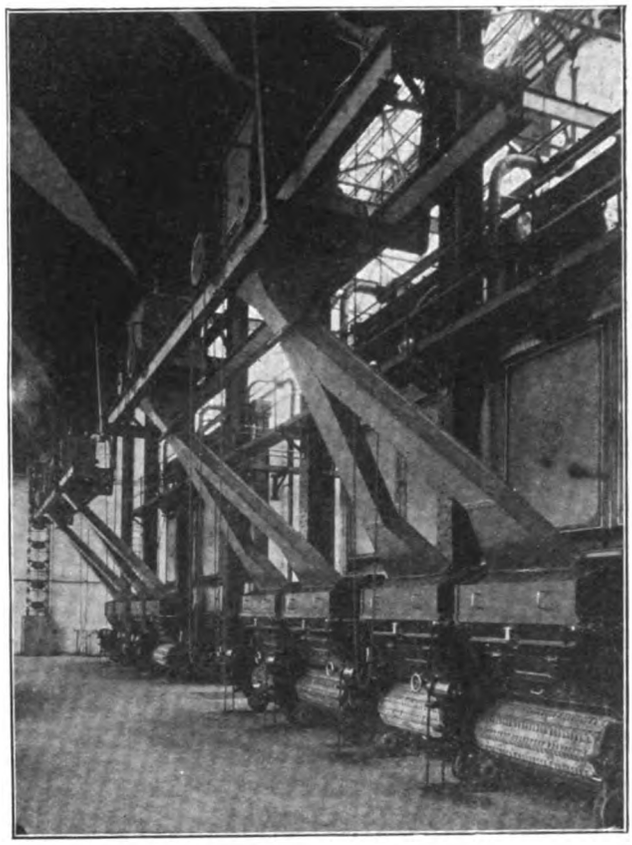

FIG. 4.—BOILER HOUSE AT CAROLINA PORT, SHOWING OVERHEAD BUNKERS AND MAIN CONVEYOR.

outlet pipe passes through the concrete wall of the Eastern Wharf and then turns vertically downwards, ending with a short bend in a horizontal direction. The top of the mouth of this bend is 2 ft. below lowest water level. The top of the economiser is 19·9 ft. above O.D., and on test a mercury gauge showed a vacuum of 22·8 ft. of water, while the tide was 22·7 ft. below this level. The measurements could not be made very exactly owing to fluctuations, but they show that the pipe was running full bore. Some months later, during a specially low tide, a gauge connected to the main pipe in the engine-room showed a vacuum of 20 ft., while the tide was actually 20·1 ft. below this point. In the main supply pipe in the engine-room at the same level the vacuum was 12 ft. of water. The difference of 8 ft. is about the normal frictional head, so that the full effect of the return flow is utilised. To make sure that water can always be obtained in emergencies the pumps are arranged below lowest water level and can be speeded up to deliver the full quantity of water should the syphonic action fail altogether. Automatic reflux valves are fitted at the pumps enabling all ordinary control operations to be carried out from the power station. At first these valves closed with considerable shock, but this was greatly lessened by fitting a small valve on the main one, opening in the reverse direction and closed with a spring.

A pump-room constructed of reinforced concrete was sunk at the water-side. This pump-room is 14 ft. internal diameter and 27 ft. deep from the ground level to the bottom floor. On the river side of the pump-room are two settling tanks constructed of reinforced concrete and having removable covers for cleaning. In these settling tanks the change in velocity of the water precipitated the mud, etc, which may have been carried through the gratings on the inlets. The pump-room is equipped with two 16 in. diameter vertical spindle centrifugal pumps situated on the bottom floor below the lowest low water level and driven direct by two vertical electric motors of 63 b.h.p. each at the ground level. The motors are started and controlled from the engine-room, and have a wide range of speed regulation. The main circulating water pipe from the pump-room to the engine-room and from the engine-room to the river is cast iron 30 in. diameter $\frac{7}{8}$ in. thick having spigot and faucet joints where laid in the ground and flange joints in the engine-room. The pipes rest on a reinforced concrete raft supported on reinforced concrete piles and the greatest precautions were taken to protect the pipes from corrosion. The pipes were coated internally and externally with Dr. Angus Smith's solution, then asphalted $\frac{1}{8}$ in. thick and covered with 6 in. of puddled clay after they were laid. At the highest point of the system a single throw Edwards' air pump is connected by means of a barometric pipe, to deal with the air that has been carried in with the water.

GENERATORS.

There are two main generators, each 2,000 kw., 3-phase, giving 50 ~ at 6,600 volts when running at 1,500 r.p.m. Each is capable of carrying an overload of 25% for 2 hour and 50% for $\frac{1}{2}$ hour. The stator body is in one piece and is arranged to slide lengthways along the shaft to give access to the rotor. The rotor has 4 poles and is very strongly constructed. Natural ventilation is used, cold air being drawn through air passages from below. Direct coupled to each generator is an exciter of 18·5 kw. at 125 volts. There are two auxiliary direct current generators coupled to two Willans central valve I.I. type of engines, used as a stand-by for exciting the main generators or driving the works motors. The generators are of the Siemens bipolar type, giving 600 amps at 200 volts. A small booster situated on the upper engine-room floor, consisting of a 23 b.h.p. motor and 15 kw. generator, is used for charging the battery.

There are two motor generators situated on the lower engine-room floor. One is a single ended machine consisting of a 3-phase 6,600 volt motor coupled direct to a 300 kw. continuous current generator generating at 400/460 volts. The other is a double ended machine consisting of a 3-phase motor in the centre, driving two continuous current generators of 150 kw. at 200.230 volts. These motor generators are used for feeding the district round the main station and for the works motors, etc. In the engine-room there is a 25 ton, 3 motor travelling crane supplied by Alexander, Jack & Co., Motherwell.

BATTERY.

The battery is situated on the 4th floor of the switch house, and consists of 102 Tudor cells in lead lined wood boxes supported on glass oil insulators. Special care was taken in the construction of the battery room floor to make it acid proof. Blue Adamantine clinkers were laid on cement and grouted with bitumen.

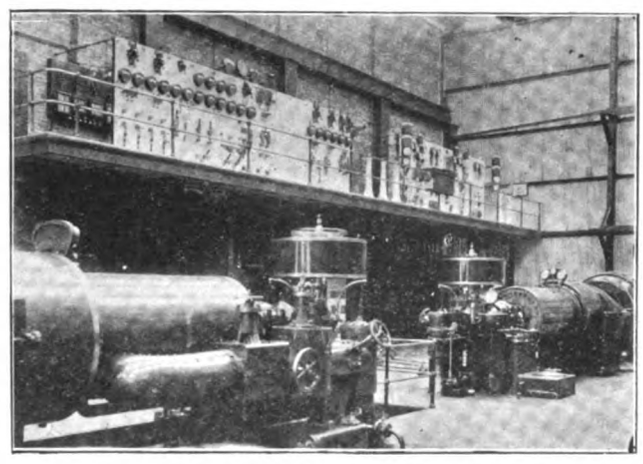

FIG. 5.—ENGINE ROOM AT CAROLINA PORT.

SWITCH GEAR.

The extra high tension switch gear is contained in a separate building, as shown in Fig, 3. and occupies 3 floors. The ground floor is occupied by the cables dividing boxes, static dischargers, and isolating switches. The bus-bars are on the first floor and the oil switches on the second, so as to be free and get-at-able. The whole of the E.H.T. switch

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gear is contained in moulded concrete cells, no brickwork of any kind being used. The bus-bars are in duplicate, and the two sets can be paralleled through an oil switch. Each bar is isolated in a cell by itself, and saving only connection to its own phase, the risk of a breakdown on any part spreading is greatly reduced. Static dischargers are provided on the outgoing feeders. The oil switches have two breaks per pole, and each of the 3-phases is contained in a separate cell. The opening and closing of the switch is effected by the release of powerful springs. The mechanism is so arranged that after the switch is either opened or closed, the motor coils up the spring ready for the next operation.

The whole of the switch gear was supplied by the British Thomson-Houston Co. The alternating current control board and the direct current main board are situated on a gallery 11 ft. above the engine-room upper floor level. The boards are of white marble. On the alternating current control board indicating lamps show whether the oil switches are in or out. A synchroscope with indicating

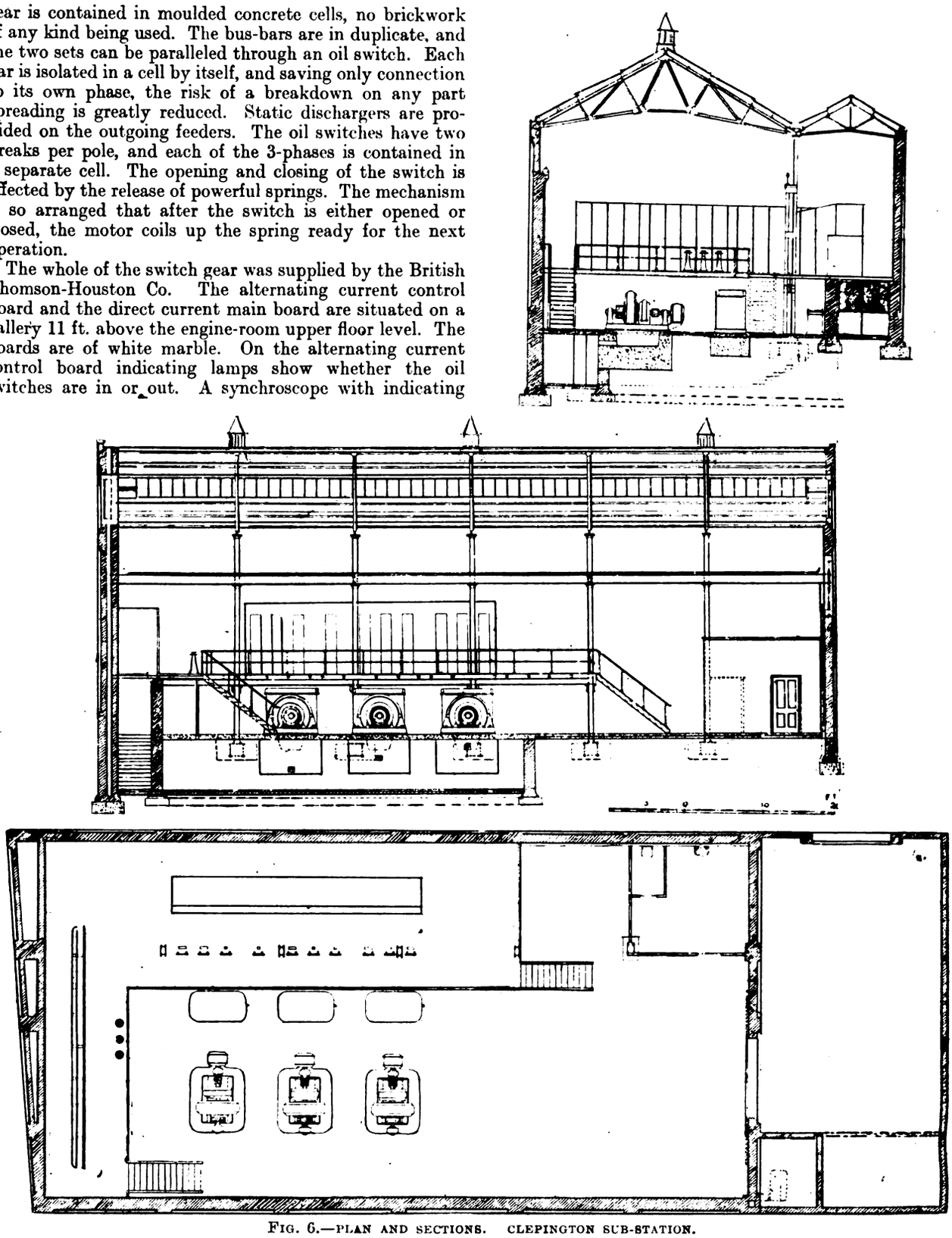

FIG. 6.—PLAN AND SECTIONS. CLEPINGTON SUB-STATION.

lamps is mounted at either end of the board on swing panels in full view of the operator. Triple pole time limit overload relays are used on the feeder and motor generator panels, and Andrews' reverse power relays for the generators. A Tirrill regulator is installed for keeping the voltage constant in spite of the variable tramway load. Special attention was given to earthing the framework, etc., in a very substantial manner.

SUB-STATIONS.

There are three sub-stations besides the part of the main station allotted to sub-station machinery. These are situated at Clepington, Lochee, and Dudhope. Lochee and Clepington sub-stations are similar in construction, except that the former is built of stone lined with brick, while the latter is all brickwork. Dudhope sub-station is part of the old generating station altered to suit. The general arrangement of the sub-stations is as shown on Fig. 5. The buildings are plain and lighted from the roof, while the whole of the floors are finished in Terrano.

The transformers and rotary converters are on the ground floor, while the high and low tension switch gear is situated on a gallery 7 ft. 8 in. above the floor level. The E.H.T. switch gear is in similar moulded concrete cells to the switch gear of the main station, but the oil switches are mechanically operated. The bus-bars are so arranged that various sections may be separated if desired. On both incoming and outgoing E.H.T. feeders static dischargers are provided, while reverse current relays are in circuit with the incoming feeders. In the Clepington sub-station there are at present two rotary converters supplied by the British Westinghouse Co., each of 550 kw. By means of a double throw switch on the machines these may be made either shunt machines and suitable for lighting loads or compound wound machines suitable for running on traction. Each

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rotary is combined with an alternating current booster. which boosts the low tension volts up or down so that the machine is capable of giving any voltage from 400 to 550 volts on the direct current side. A 610 k.v.a. 3-phase to 6-phase oil-cooled transformer is provided for each machine. In Dudhope there are three 550 kw. – 400/550 volt rotary converters, and in Lochee there are two 250 kw. 400/550 volts all similar to the machines described above. On the direct current switch boards reverse and overload circuit breakers are in circuit with the machines.

CABLES.

The extra high tension cables were manufactured and laid by the British Insulated & Helsby Cables, Ltd., Prescot. The cables are 3 core, paper insulated, lead covered, double steel armoured, and jute protected cables with B.O.T. earthing strip below the lead and insulated from it by a strip of paper. The cables on being completed at the works were subjected to the following tests :

Each length of cable after 24 hours immersion in water was tested for 15 min. with an alternating E.M.F. of 20,000 volts between cores and 13,000 volts between cores and sheathing.

The cables after being laid and jointed were tested to a pressure of 13,000 volts between cores and between each core and earth.

From the generating station ·1 sq. in. three core cables are laid in duplicate to Clepington and Dudhope sub-stations and ·05 sq. in. three core cables in duplicate between Dudhope and Lochee. The total length of E.H.T. cables connecting the generating station and the sub-

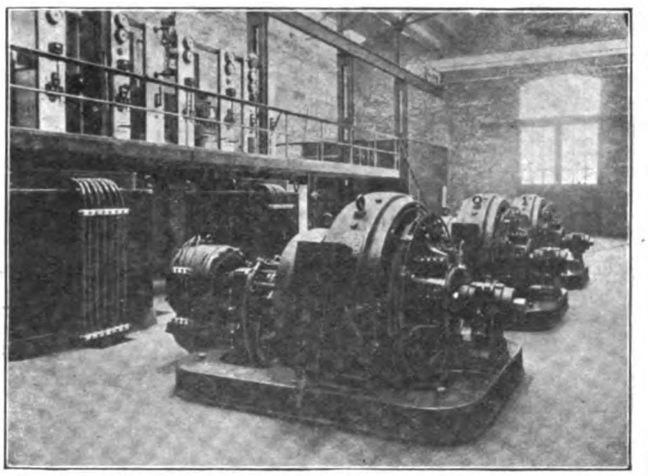

FIG. 7.—SUB-STATION AT CLEPINGTON.

stations is about 12 miles. The cables for about ¾ of a mile from the main generating station are laid in creosoted wood troughing. the troughing being covered with 2 in. tiles, where the cables pass under the lines of the Dundee and Arbroath Joint Railway they are drawn into 6 in. fireclay conduits laid with a slight fall to either end to carry off any water which might accumulate through condensation, etc. The conduits are embedded in concrete. At each side of the crossing special manholes were built with damp proof walls. The remainder of the cables are laid direct in the ground at an average depth of 4 ft. 6 in. and 18 in. apart. After being laid they were heavily coated with a preservative compound and then covered with a specially shaped tile 2½ in. thick, with skew ends for jointing. Where the cables leave the main generating station, and where they enter the sub-stations, they are supported on heavy wrought iron brackets keeping the cables 12 in. apart. The brackets are placed at 3 ft. centres. The joints are of the usual extra high tension type, each phase stepped. The B.O.T. strip, lead and armour is electrically continuous throughout. The joints, after being completed, were troughed and run in solid with bitumen. After a series of tests the sheathing of the cables where found necessary was bonded to the city water pipes.

From this description and our illustration, it will be possible to gather some idea of the importance of these, not only as regards their magnitude, but their excellent planning and the exceptional character of their equipment. Undoubtedly the city of Dundee possesses a most valuable property in its Electricity Works, which not only prove an aid to the civic finances and a comfort to the citizens, but a very real help and stimulus to local industry.

When chronicling the opening of the extensions two months ago, we ventured to congratulate Dundee and Mr. Richardson. It will be seen that those congratulations were thoroughly well deserved.

WESTINGHOUSE PHASE ADVANCER.

At the invitation of the British Westinghouse Electric & Manufacturing Co., Ltd., a number of persons visited the Trafford Park Works, Manchester, in order to inspect a very promising machine invented by Mr. Miles Walker, M.I.E.E., whose two recent papers on large units at high speed in central station work attracted so much attention. The problem that Mr. Walker has set himself to solve is a big and no easy one. The manufacturers justly remark that engineers responsible for the operation of plant in alternating current systems where the power factor is low are familiar with the troubles caused by wattless currents. While these currents load up the generators and mains, they have a demagnetising effect upon the field magnets calling for increased power for excitation and rendering it difficult to maintain the pressure, and in some cases prevent the full output being taken from the engine turbines, or other prime movers, thus making it impossible for the most economical use to be made of the generating plant. One cause of a low power factor is the presence of induction motors on the system ; nevertheless, a big motor load is a possession which every engineer is striving to obtain in order to have a good day load for his plant. Now, as these lagging currents are caused by induction motors, the question arises whether it is possible to provide a means at the motor itself of compensating for these lagging currents. It is this question to which Mr. Miles Walker has addressed himself, with the result that he has placed before electrical engineers the phase advancer inspected, and described below.

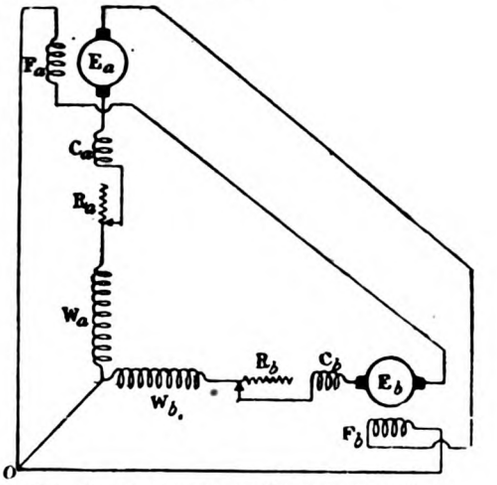

FIG. 1.—EXCITERS FOR 2-PHASE ROTORS.

The phase advancer may be regarded as an exciter connected in circuit with the rotor winding of an induction motor. It generates magnetising currents alternating at a low frequency (the frequency of the slip). If these magnetising currents are great enough to create the magnetic flux in the motor, the motor will run at unity power factor. If they are greater than are necessary to create the flux, then the motor will run on leading power factor.

In order that the current in the rotor can exercise a magnetising effect, it must lead in phase on the E.M.F., generated by the rotor slip. To get a leading current it is necessary to introduce a leading E.M.F. The leading E.M.F. is generated by means of an armature somewhat similar to a direct current armature revolving in a magnetic field which is excited by a leading current. The leading exciting current is obtained by using the current in one phase to excite the field coils and produce flux which generates E.M.F. in another phase. The method can be most easily followed when applied to a rotor wound for two phases each of which is connected to a separate exciter, as shown in Fig. 1.

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In Fig. 1, W_a and W_b represent the windings in two phases of the rotor. E_a and E_b are the armatures of the two exciters. These exciters would be made like single-phase series motors, provided with compensating windings. The current from the phase W_a passes from the collector ring through the compensating winding C_a through the armature E_a, and then through the field F_b of the exciter in phase B, and thence to the star-point O. The current from phase W_b passes through the compensating winding C_b through the armature E_b, and then through the field F_a of the exciter in phase A and to the star-point. The induction motor can be started up by means of the resistances R_aR_b, the exciters being short-circuited. When the motor is running, the armature E_a has generated in it an E.M.F. which is in phase with the current in phase B, and if the polarity of the poles is properly arranged, this E.M.F. will be leading 90° on the current in phase A. Similarly the armature E_b can be made to supply an E.M.F. whose phase would lead by 90° on the current

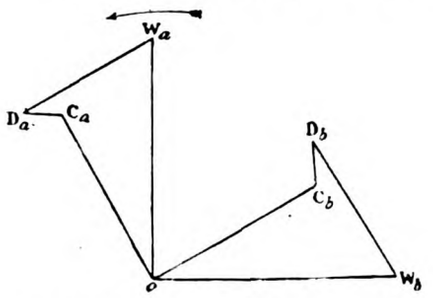

FIG. 2.—DIAGRAM OF ELECTROMOTIVE FORCES IN CIRCUITS OF FIG. 1.

in phase B. This has the effect of making the currents in the rotor take up a phase in advance of the E.M.F. produced in the rotor; so that not only can the magnetic field of the induction motor be created by the rotor currents, but the current in the stator can be made to lead on the E.M.F. of the supply. The graphic diagram, Fig. 2, shows the phase relations between the various currents and the E.M.F.'s. OW_a represents the E.M.F. generated in the rotor circuit by the slip. W_aD_a represents the E.M.F. generated in the armature of the exciter. D_aC_a represents the reactive drop in various parts of the circuit, and C_aO represents the drop in the resistance of phase A of the rotor windings. The current in phase A has, of course, the phase position OC_a; thus it is leading on the E.M.F. OW_a, the clock diagram being supposed to be rotating in the direction indicated by the arrow. It will be seen that the line W_aD_a is parallel to the line OC_b because the current in phase OC_b excites the armature in phase A. Similarly the E.M.F. W_bD_b is parallel to the line OC_a. By increasing the speed of the exciters the E.M.F. at right angles to the current can be increased, and the lead of the rotor current increased more and more.

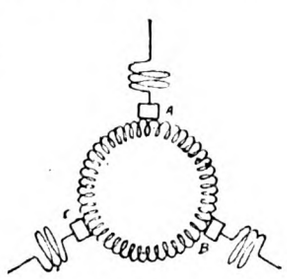

FIG. 3.

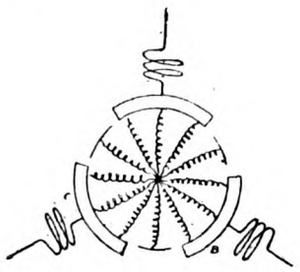

FIG. 4.

It is desirable in practice to combine the two armatures E_a and E_b, shown in Fig. 1, into one machine, and also to work with three phases instead of with two.

In making this combination for use with a commercial motor, it must be remembered that the current to be commutated will in general be large and the voltage low and that it is desirable to collect the current in each phase only once, and not twice, as shown in Fig. 1. This leads us to two alternative methods of connection within the armature, as indicated in Figs. 3 and 4, in which A, B and C represent the brushes in the respective phases pressing upon the commutator. In Fig. 3 we have an ordinary D.C. armature, and the result is a mesh connection. In Fig. 4 we have an open coil armature, and this results in a star connection. The star connection offers two advantages over the mesh connection. First, it enables very wide brushes to be used, so that a very large current can be collected from a comparatively small commutator, and secondly, the direct series connection between armature coils and field coils gives more control over the phase of the exciting current, so that one is able to avoid a condition of instability which arises in the case of the mesh connection.

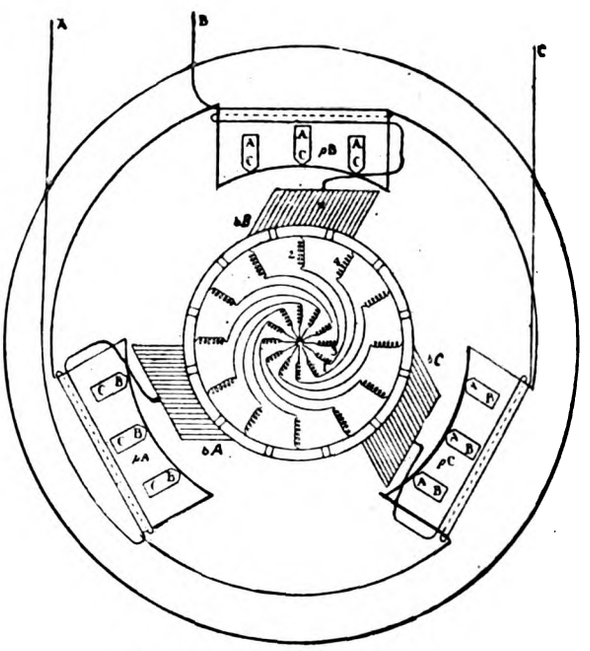

FIG. 5.—THE PHASE ADVANCER.

In the phase advancer shown in operation, the electrical connections are equivalent to those shown in Fig. 5. The main difference is that this machine, as built, has six poles instead of three. In each phase we have two poles and two sets of brushes in parallel.

The armature core resembles an ordinary direct-current armature core, and the coils are like the coils of an ordinary railway motor, except that they have in the case illustrated in Fig. 5 a span of 120° instead of 90°. One end of each coil, which we will call the inner end, is connected to a star-point. Each outer end is connected to one bar of the commutator. The armature in this way resembles in principle Elihu Thomson's arc-light generator, except that in this case there are a greater number of coils. On the commutator are three brushes which bear upon the segments connected to coils which are for the time being passing under a pole. Each pole is provided with a compensating winding placed in slots in the pole-face, the winding being arranged so that the ampere-wires per inch along the pole-face are equal, or slightly greater, than the ampere-wires per inch of periphery of the armature. If we follow one of the armature circuits, commencing from the star-point along coil 1, 2, it will pass under the pC, then under pole pB, and it will make as many turns in front of the poles pC and pB as are necessary to generate the required voltage. It then passes to brush bB and on to the series exciting coil on pole pB, then it passes to the compensating windings marked A in the slots pC and pB, and from these to phase B of the rotor of the induction motor. The currents in the other phases pass through similar circuits.

It will be seen that as the part of the coil 1 is under the pole pC, the E.M.F. generated in coil 1, 2, will lead in phase on the current flowing to brush bB. Moreover, as the part of the coil 2 is under the pole pB, there is generated in the coil 1, 2, an electromotive force in phase with the current flowing to brush bB. This gives a boosting effect in the rotor circuit which tends to reduce the slip. By reversing the polarity of the poles, or by reversing the direction of rotation, this boosting effect can be reversed so as to increase the slip, so that the speed on an induction motor can be changed through certain limits, depending on the voltage of the phase advancer, without wasting power in a rheostat in circuit with the rotor.

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The motor is started up on a rheostat in the ordinary way, and the only extra switch gear required is a three-pole knife switch for throwing in the advancer. If the advancer should break down (a very unlikely accident with a machine operating at 20 volts), it can be cut out, and the motor then operates just as it would do if the advancer had not been installed. It will be seen that the commutation is perfect and the commutator cool, so that the machine will run for many months without any attention being paid to the carbon brushes. The peripheral speed of the commutator being only 2,500 feet per minute, the wear of the brushes is exceedingly small, and the commutator takes a bright polish.

Taking a slip-ring induction motor having a power factor of about 92% on full load, it is possible by means of the phase advancer to alter this so that instead of a lagging current, the motor may run at unity power factor, or even be caused to take a leading current up to 30 to 40% power factor, so as to compensate for lagging current taken by other motors, etc., in the system.

It is explained on a separate leaflet that the phase advancer is a special form of exciter connected in circuit with the rotor winding of the induction motor to which it supplies magnetising current generated at a low frequency and low voltage.

Under these circumstances, the amount of idle power required for magnetising is only a small fraction of that required when the magnetising current is supplied at the full frequency and full voltage in the stator winding.

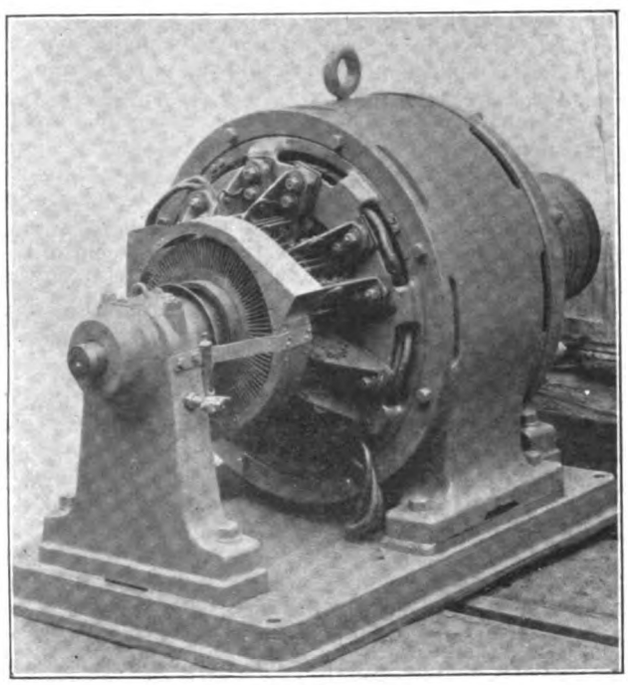

FIG. 5.

This will be appreciated when it is considered that a 750 b.h.p. three-phase 50-per. 2,000-volt 590 r.p.m. motor requires in the stator 50 amperes per phase as magnetising current, or an idle power of 175 k.v.a. When fitted with a 6 k.v.a. phase advancer, the same motor will run at unity power factor and requires no idle power from the mains.

If the motor were fitted with a 12 k.v.a. phase advancer, it could be run at a leading power factor of 0·7, when, in addition to pulling its ordinary load, it could compensate for the lagging currents produced by other motors to the extent of full kw. rating of 600.

Again, by building a similar motor, but with a larger percentage of copper in its windings, it would be capable of supplying magnetising current to three motors of the same size when a total power of 3,000 b.h.p. would be obtained with the line working on unity power factor, the only cost being that the 12 k.v.a. phase advancer and additional copper to the one motor.

In such an installation with motors having a power factor as high as 92% and a voltage drop in the line of 10% without phase advancers, by the use of the latter a saving in the line losses amounting to about 40 kw. could be made.

Further, a generator specially designed to take a load at unity power factor would be smaller and cheaper, and would have all day losses reduced by about 30 kw. This would give a total saving in generation and transmission of 70 kw., against which must be set off losses in the phase advancer and in the windings of the over-compensated motor, which, however, would amount to not more than 6 kw.

The above case relates to high-speed motors having a good power factor.

If, however, we consider slow-speed motors which would have a power factor as low as, say, 0·7, the saving in the line and generators would be not less than 220 kw.

In this case two phase advancers would be used, two motors being over-compensated to provide the wattless current taken by the other two, and accordingly in this case the losses in the exciting circuit would amount to about 12 kw.

An important consideration in connection with the use of the phase advancer is the following :—

Suppose a large motor with a low power factor at the end of a long feeder. By installing a phase advancer in conjunction with the motor, the feeder would be relieved of wattless current, and thus its copper set free. Accordingly, new consumers might be connected to the feeder at the end adjacent to the motor, and the revenue obtained from the cable correspondingly increased.

Another use for the phase advancer is in conjunction with induction motors under conditions where a large slip is required. Such as for winding purposes or for driving rolling mills. This slip is at present obtained by inserting resistance in the rotor circuit, which means a large loss of energy. By means of the phase advancer the slip required may be obtained and the power returned to the line instead of being wasted (see paper by Mr. Miles Walker referred to above).

A further advantageous use for the phase advancer is in connection with induction generators.

Such machines have the important advantage over the ordinary alternating current generator with continuous current excitation, that they may be run up to speed and switch on to the busbars without synchronising.

This class of generator has not been very much employed, even in cases where it appear to present certain advantages, because the ordinary induction generator required to be supplied with magnetising current from the line, and, furthermore, it is incapable of generating any wattless current to supply to induction motors or other apparatus requiring wattless lagging currents. If an ordinary induction generator is connected to a distribution system in parallel with synchronous generators, the synchronous generators have to supply not only the wattless currents required by their share of the load, and the wattless currents required by the rest of the load, the true watt part of which is carried by the induction generators, but they are also called upon to supply further wattless currents to magnetise the induction generators. So that instead of being a help in that part of the load which is most trying to every generator, the induction is overcome actually a further drag on the system. By means of phase advancer this drawback to the induction generator is overcome, and we are enabled to build an asynchronous generator which not only supplied its own magnetising current, but is able to supply wattless currents to other parts of the system.

Such machines should be particularly useful where it is intended to feed power into a system of mains, as from a waste heat station or from a small isolated water power station, and where it is undesirable to connect a synchronous machine to the system, or further in a station having synchronous generators driven by reciprocating engines the use of an induction generator in conjunction with an exhaust steam turbine and a phase advancer should be of great service.

Asynchronous generators may be of great service for light loads in towns liable to fogs in the winter months. Due to such fogs coming quickly, it often happens that the load increases more rapidly than the attendants can parallel synchronous generators in rotation. In such cases there will be no difficulty in starting up simultaneously induction generators, which could be thrown on to the circuit through choke coils, the latter being afterwards short-circuited.

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A further use for induction generators is in connection with slow speed gas engines, such as are fed from coke oven gas and for use on 50-cycle circuits.

The irregular turning moment of these engines and the great number of poles make parallel running rather difficult, particularly if the generators have to run in parallel with other machines to which they are connected by means of long lines.

In such cases some at least of the generators could be advantageously made of the asynchronous type, and by means of phase advancers can be made to take their share of the wattless currents.

In general phase advancers are designed for low voltage, and a comparatively large current. They are fitted with compensating windings and commutate perfectly at all loads. Consequently, no sparking or burning takes place at the brushes and the commutator remains bright, requiring practically no attention.

The brushes are of carbon, and wear very slowly, so that they will only require to be renewed after a long period of continuous service. The phase advancers are designed either for direct coupling or for separate driving by belting, etc.

For starting purposes, in conjunction with a motor, the only addition to the arrangement is a three-pole double throw switch, which is required to throw on the advancer after the motor has been started in the usual way on its resistance.

SUMMARY.

The general advantages to be obtained from the use of phase advancers are summarised below :—

A. Advantages obtained from the use of a Phase Advancer in conjunction with an Induction Motor.

1. Instead of taking a lagging current, the motor may be run at unity power factor, or it may be caused to take a loading current to compensate for lagging current taken by other motors, etc.
2. The motor will give an increased output.
3. The full load torque of the motor is increased.
4. The losses in the cables are reduced in consequence of which a better regulation is obtained and copper in the cable is set free for the supply of energy to additional consumers.
5. Where step-up and step-down transformers are employed the losses are decreased and better regulation is obtained.
6. The losses in the generator are reduced and a considerable reduction is made in the power required for excitation.
7. In many cases additional capacity in the prime mover will be set free for supplying energy to additional consumers also, frequently the existing load may be carried with fewer generating units.
8. Where an induction motor is required to have a comparatively large slip (*i.e.*, speed reduction), this may be obtained without wasting power in resistance.

B. Advantages from the use of Phase Advancers with Induction Generators.

Induction generators may be connected directly to the system without synchronising and when used in conjunction with phase advancers they are rendered capable of taking their share of wattless current and further may be used to give a leading component, thus assisting other generators to maintain unity power factor at the bus bars.

It may be mentioned that the machine was tested at the time of the demonstration by running it in conjunction with a 750 b.h.p. slip ring induction motor.

This motor is rated at 750 b.h.p., 3-phase, 50 per., 2,000 volts and forms the motor end of one of two motor generator sets which were run loaded back upon each other, the speed of each set being 590 r.p.m.

The following table shows the readings obtained :—

Reading.	Volts.	Kw.	Power Factor.	Remarks.
1	1840	280	86% lagging	Phase advancer not running.
2	1840	300	Unity	,, ,, running.
3	2200	375	Unity	,, ,, ,,
4	2600	375	50% leading	,, ,, (increased speed)
5	2000	20	50% leading	,, ,, (speed as before)
6	2600	312	40% leading	,, ,, (increased speed)
7	2560	20	5% leading	,, ,, (speed as before)

The voltage was regulated by hand to be constant for readings 1 and 2.

A comparison of readings 3 and 4 shows a rise in the generator voltage due to the phase advancer having substituted leading and magnetising for lagging and demagnetising currents.

HIGH TENSION MISHAP.

According to a Swiss correspondent, an extraordinary accident occurred at St. Aubin, in the Canton of Neuchatel, where the communal electrical engineer, having come into contact with a live wire, had a wonderful escape from death.

While making some repairs, he inadvertently touched a wire with his head, and he was immediately gripped by the current and suspended in mid air in a most extraordinary, contorted position. Securely held by the current, the unfortunate fellow's body was bent almost double, and he could not move a finger to help himself ; but he managed to cry for help, and a number of people came running to the scene of the accident.

The first arrivals were some women, and they loudly called for help ; while the engineer kept on repeating, in tones which became weaker every instant, that they must hurry to the switch and cut off the current.

The horror of the situation was increased when it was discovered that the suspended man had the key of the case in which the switches were securely kept under lock and key in his pocket. Nobody dared to approach too near him, much less to touch him, lest the current should grip them also, and (says the *Alpine Post*) the unfortunate man must inevitably have perished had not somebody happily remembered that a duplicate key of the case was in the keeping of a man who lived near.

This man was at once sent for, and immediately he arrived the case was unlocked ; and when the current was cut off the engineer fell in a crumpled heap to the ground. He lay there for a few moments and then he got up, staggering like a drunken man, and walked away without assistance.

He appears to have escaped from what seemed like certain death with wonderfully slight injuries. He was well enough to resume work the next day.

WORKS AT SCHAFFHAUSEN.

An electrically-driven surface water pump at Schaffhausen presents many points of interest. It is erected over a dried-up river bed, the underground water, as a rule, stands a few inches higher than the Rhine surface, and the water is very pure, although hard. The water is pumped up through four galvanised iron tube-wells about 300 ft. deep, and slotted over their lower half to admit the water. The amount of water obtainable is about 2,000 gallons a minute. The water is pumped by two centrifugal pumps coupled direct with the motors, and can be taken from all or any of the wells at pleasure. The pumps can be worked independently or together. On starting, the pumps are freed from air by a small ejector worked by the pressure of the water in the reservoir into which the water is pumped. This is 200 ft. above the level of the pumps.

The electric locomotives provided by the Felten and Guilleaume Lahmeyer Werke A.G. for the Saarbruck mine of Von der Heydt are rendering excellent service. The ore is at present drawn by them about a mile and a half, but the distance will soon be doubled. The gauge is 28 in. and the locomotives weigh 5 tons each. They have two driving axles, each worked by cog wheels from a motor of 7½ h.p., and can go at 70 miles an hour. The driver has, of course, efficient brakes at his command. The accumulators rest on rollers to facilitate removal from the locomotive for recharging. In drawing 25 trucks, the batteries have to be changed for every six miles travelled, and the change is effected in two or three minutes. The recharging takes two hours and a half. A comparison of the cost with that of the horsed trucks formerly used cannot fail to be interesting. The work of one horse in an eight-hour shift was 52 km.-tons, at a cost of 27·3 heller, while a locomotive on a shift of the same length does 175 km.-tons, at a cost of 7·3 heller only. Of the 7·3 heller, the cost for current (at 3 heller per kw.-hour) is 1·2 heller.

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THE NEW ERA.

It may be advantageous to pass under brief review a few of the more salient features of the new Electric Lighting Act, which came into force last Friday. It must be conceded that the first clause does confer a boon on the electrical industry, for now, with the consent of the Board of Trade, "undertakers" can acquire the privilege of compulsory purchases of the necessary site for a generating station as well as easements. The Land Clauses Act, with suitable modifications, apply in these cases. This removes a very real grievance, which often sadly hampered "undertakers," and not the least so in the matter of easements connected with transmission of electricity in bulk. It is to be noted that the Act empowers the Board of Trade to refuse consent for the erection of a generating station on any land taken over by agreement. At the first blush this seems a very hard provision, but it apparently aims at securing a limited control for the Government to protect public property, as, for instance, in the case of the Greenwich Observatory. The power does not extend to any station for transforming, converting or distributing energy. The advance made in the industry since the passing of the previous Acts is liberally enough recognised, as we see by the clauses relating to supply in bulk, supply of electricity to railways, tramways and canals, partly outside any area of supply, supply of premises outside an area, and the breaking up of streets outside an area of supply. As regards bulk supply, the Board of Trade may now authorise any local authority or company to undertake this work, and to arm the "undertakers" with all the necessary powers as regards wayleaves, breaking up streets and so on. Moreover, such Order may confer the right to supply in bulk to any other "undertakers." The Board of Trade, however, may refuse such powers if it is deemed that the scheme is of such an important character that its powers should only be granted by way of a Private Act of Parliament. There is sound sense in this, for it

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simplifies procedure and enormously reduces expense for the smaller undertakings, less able to bear heavy initial outlay, while safeguarding the public by placing the onus of sanctioning vast schemes on Parliament. Clause 5, empowering the Board of Trade to authorise any local authority, company or person to supply railways, tramways and canals outside their area with electricity, is a step in the right direction, tending to promote the interests of electricity. Some heart-burning has been felt that this privilege should have been extended to local authorities, but it is difficult to see how in justice they could have been excluded. Another welcome provision is that empowering the Board of Trade to sanction, under a special Order, the supply of premises outside of an area of supply. This should be read in conjunction with clause 18, which enables "undertakers" to "refuse to supply energy to any person whose payments for the supply of electrical energy are for the time being in arrear (not being the subject of a bona fide dispute), whether any such payments be due to the "undertaker" in respect of a supply to the premises in respect of which such supply is demanded or in respect of other premises." And, again, clause 23, which provides that "where in any area a local authority, company, or person is authorised to supply electricity under Act of Parliament, or under license or Provisional Order granted under the Electric Lighting Acts, it shall not, after the passing of this Act, be lawful for any other local authority, company or person to commence to supply or distribute electricity within the same area, unless such supply or distribution is authorised by Act of Parliament, or by license or Provisional Order, granted under the terms of the Electric Lighting Acts. Provided that this section shall not prevent any company or person from affording a supply of electrical energy to any other company or person where the business of the company or person affording the supply is not primarily that of the supply of electrical energy to consumers. Provided also that this section shall not prevent any company, who at the passing of this Act are empowered by their memorandum of association to generate electrical energy from affording a supply to a, railway company for purposes incidental to the company's undertaking other than the conveyance of public traffic." Certainly, this is an important section of the Act, conferring very substantial benefits on "undertakers." It is sufficiently elastic to enable two "undertakers" to come to an understanding, with the approval of the Board of Trade, as to which of them can more economically serve outlying portions of areas. Presumably, also, it protects manufacturers who generate their own power and who may desire to supply current for lighting or power to tenants. It seems difficult to know what the position would be of, say, the owner of a building estate, or the managers of a "Garden City," within a supply area, desiring to generate electricity and supply it to their tenants. A point that has been much disputed, but which seems to be in the real interests of electrical progress, is that covered by clause 8, which runs thus: "The Board of Trade may, with the concurrence of the Local Government Board, by Provisional Order, make such provision as appears to them necessary or expedient, by the constitution of a joint committee or joint board or otherwise, for the joint exercise of all or any of the powers under the Electric Lighting Acts, or this Act, or any Provisional Order, by two or more local authorities, in any case where it appears to them that the joint exercise of those powers would be expedient and any such Provisional Order may contain such provisions as may appear necessary or proper for adapting any of the provisions of the Electric Lighting Acts, or this Act, or any such Provisional Order, to the case of any committee or board so constituted." On the other hand, the provision prohibiting the association of any two or more companies or persons in the matter of exploiting an area of supply (otherwise than by one company or person supplying another current in bulk, as specially laid down in this Act), is maintained. The expression "to supply electricity in bulk" is defined as the supply of electricity (*a*) to any local authority, company or person authorised to distribute electricity to be used for the purpose of distribution; or (*b*) to any local authority authorised by any general or special Act to undertake or contract for the lighting of streets, bridges, or public places, to be used for the purpose of lighting streets, bridges and public places. There is nothing in the Act which can be construed as hampering private enterprise and certainly nothing (if we except clause 8) specially favouring local authorities.

IMPORTANT TUNGSTEN DEVELOPMENT.

In the course of a despatch received just as we go to press, the New York correspondent of the ELECTRICAL ENGINEER says: "Announcement has just been made of what is believed to be the most important scientific development which has been achieved since the introduction of the metal filament in incandescent electric lighting. As mentioned in previous letters, Dr. W. R. Whitney, superintendent of the laboratory at Schenectady of the General Electric Co., has been at work for many months investigating, with the aid of his new type of electric furnace, the metallurgical conditions of tungsten.

"After many experiments he has at length been able to bring tungsten to so perfectly ductile a condition that it can be drawn into wire of extraordinary fineness and of a tensile strength hitherto declared to be impossible. The wire thus produced is capable of manipulation in any form, and the tests to which it has been subjected show that it can withstand very rough usage.

"Dr. Whitney is confident that although the process of manufacture in this experimental stage has been somewhat prolonged, it is only a question of a few weeks, or perhaps days, before the process can be adopted to commercial manufacture on a large scale. In any circumstances it has been satisfactorily demonstrated that tungsten filament can be produced which is no longer fragile."

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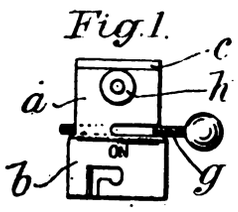
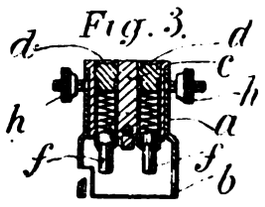
PUBLICITY.

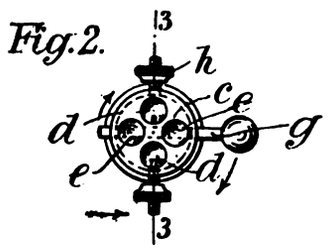
In this Section of "The Electrical Engineer" we give Publicity to New Inventions and Specialities.

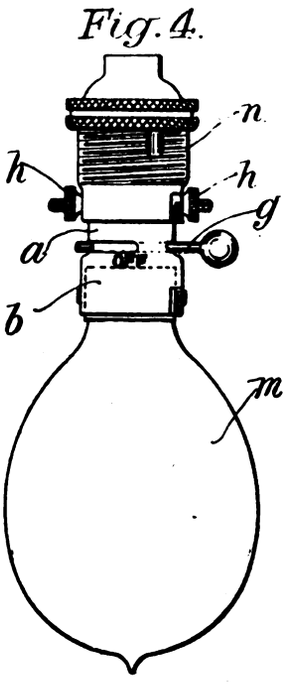
Switch Adaptor.

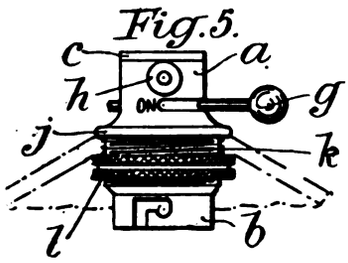
One of the most healthy signs for the future of electric lighting is the great attention being paid by inventors to the problems of wiring and the improvement of fittings generally. It is in perfecting such details that electricity is brought within the reach and popularised among all classes of the community. An excellent example of this trend of work is found in Wright's Patent Switch adaptor, which embodies a happy idea cleverly carried out. With the aid of this simple little device an ordinary bayonet lamp-holder is quickly converted into a switch lamp-holder, and this is done without detracting from the appearance of the lamp or entailing any alteration in the wiring.











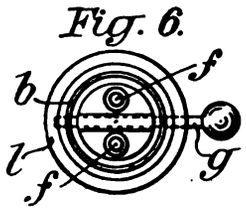


FIG. 1.—SIDE ELEVATION OF THE ADAPTOR.

FIG. 2.—PLAN.

FIG. 3.—SECTIONAL ELEVATION.

FIG. 4.—ADAPTOR IN USE.

FIGS 5 & 6.—ELEVATION AND UNDER PLAN, MODIFIED FORM COMPRISING SHADE, ALSO A LAMP HOLDER.

The system may be briefly described. The adaptor consists of a metal tube having a plug section with pins for insertion into the bayonet socket of the lamp-holder and a bayonet socket to take the lamp. A cylinder of insulating material is made to rotate within the plug. This cylinder has spring contact plungers within the socket, communicating with depressed contacts, which engage the spring plungers in the lamp-holder.

A handle projecting through slots in the tube or barrel enables the insulating cylinder being rotated through 90° thus breaking the circuit at four points. In the "on" position the switch is lightly held by the contact plungers being forced into the depressed contact plates, while in the "off" position this is effected by providing blind depressions in the insulating cylinder.

Now let us follow the application of these principles by referring to the figures. It will be seen that the barrel is divided into two parts, a plug section *a* fitting into the socket of the holder *n*, and a socket section *b* to take the lamp *m*. The plug *a* has screwed pins, with nuts *h*, engaging with the bayonet slots of the holder, the nuts serving to hold the adaptor from rotation when inserted in position. As we have said within the plug section *a* is an insulating cylinder *c* with a shoulder to hold it in place. This cylinder has two spring plunger contacts *f* making contact to the lamp, and communicating with depressed contact plates or studs *d*, which make contact with the plunger contacts of the lamp holder. The adjusting handle *g* passes through a hole in the cylinder *c* and through two slots in the barrel, and we see how this can be turned through 90°, at the same time preventing vertical movement of the cylinder *c*. An ingenious contrivance, which will be very popular, is in Figs. 5 and 6, where a shoulder *j* is formed on the barrel and part of the barrel is screwed to take a nut as at *k*, so that a lamp shade may be used although provision may not have been made for a lamp shade on the lamp holder.

It will be readily understood that this "Switch Adaptor" will be found most useful for metal filament lamps, because it forms a double-pole switch with a smooth switch action. Then, again, it will be found serviceable for isolating electric lamps which have been connected to wall brackets, electroliers, or cluster fittings, and, as is frequently the case, the wiring so arranged that more than one lamp is controlled by one switch. Standard lamps also may be fitted with the "Switch Adaptor," a great convenience inasmuch as it does away with the necessity of extinguishing the electric light by pulling out the wall plug or adaptor connecting it to the fitting, which is often the case when standard lamps have been fitted with ordinary lamp holders. A point to observe is that the plain switch adaptor increases the length of the lamp holder only about half an inch.

The inventor of this contrivance, which we believe is assured a wide vogue, is Mr. E. B. Wright, of 15, Bartlett's-buildings, Holborn Circus, London, who has granted the license to manufacture to the General Brass Fittings Co., Ltd., of Leeds, and 4, Oat-lane, Wood-street, London, E.C.

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ALDEBURGH AND ELECTRICITY.

A special meeting of the Aldeburgh Town Council was held at the Moot Hall for the purpose of considering a report of the Paving and Lighting Committee with regard to the electric lighting of the borough. The Lady Mayor (Mrs. Garrett-Anderson, M.D.) presided.

The Paving and Lighting Committee reported that a letter, dated February 22, was received by the Town Clerk from the Rural Electricity Supply Co., Ltd., 11, Victoria-street, Westminster, London, stating that "This company having been approached by several residents in Aldeburgh, and invited to consider undertaking the supply of electricity in the borough, decided, after inspection and careful consideration, that it would be possible to carry out such an undertaking to the advantage both of the company and the residents provided the Corporation accorded their support in the matter of wayleaves for overhead wires. To meet any question that might possibly arise in regard to the subject of overhead wires for electric lighting and power purposes, my directors would inform you that so far as public safety is concerned there is absolutely no more risk than in the case of telegraph and telephone wires such as are already used in Aldeburgh. Further, overhead lighting wires are in use at Diss, Felixstowe, Stowmarket, and Southwold, in your immediate neighbourhood, and in several other towns such as Burgess Hill, Bude, Wedmore, and Keynsham, in other districts. The company would carry out their work in strict accordance with the very stringent regulations made by the Board of Trade, and would, further, be prepared to submit their plans to your surveyor for his approval before proceeding with any work in the public thoroughfares. The company would, in view of receiving the Corporation's support, be prepared to enter into a contract giving the Corporation the power of purchasing the company's undertaking in Aldeburgh on somewhat similar terms to those provided for in the Electric Lighting Acts, 1882–1888, and the Consolidated Act, 1909. The company would further be prepared to enter into a contract for the public lighting of the streets upon the basis of an annual charge for each lamp, the company providing the standards, fittings, lamps, cleaning and maintaining the same for an inclusive charge of 35s. per lamp per annum, the lamps being fixed to the poles upon which the overhead wires run. In comparing this figure with the present cost of street lighting, it should be borne in mind that the company proposes a service all the year round from dusk to 11 p.m. It is estimated that this proposal will result in a saving in the lighting rate of over one penny in the £. (The main passing along the front would be put underground.) With regard to other public services, and particularly the sewage works, the company would be prepared to supply electrical energy for driving the pumps at a price which would result in a very large saving on the present cost of doing the work.

"The committee, after giving great consideration to this communication, decided that it was expedient to seek the advice of an expert, and consulted Mr. G. A. Bruce, M.I.E.E., the engineer to the Lowestoft Corporation Electric Supply Department. Mr. Bruce duly attended a meeting of the Committee, and after a long conference with him, and also after the advantage of an interview with Mr. Bernard P. Gibbons, the managing director of the Rural Electricity Supply Co., the Committee decided to recommend: (1) That the Corporation make application to the Board of Trade for the grant of a Provisional Order under the Electric Lighting Acts, 1882 to 1909, for the supply of electricity in the borough, including the districts of Thorpe and Hazlewood, and subject thereto (2) That the Corporation enter into an agreement with the Rural Electricity Supply Co., Ltd., granting them the necessary wayleaves for the supply of electric light in their streets and streets under their control, subject to the regulations of the Board of Trade."

Councillor Ganz moved the adoption of the clause in the report as to making the application to the Board of Trade for the grant of a Provisional Order, etc. He remarked that the Provisional Order would safeguard the interests of the inhabitants and ratepayers of the borough, otherwise they might find themselves on some occasion in the same predicament as they were with regard to the Gas Co.

Councillor Rudrum seconded the motion, which was carried unanimously.

With regard to the second clause recommending that the Corporation enter into an agreement with the Electric Supply Co., etc.

The Town Clerk pointed out that a new Act of Parliament came into force that day, which would make the resolution as it stood *ultra vires*, because it did not comply with the requirements of the Act as to the transfer of the powers of the Corporation, and if they adopted the resolution as proposed in the report the Board of Trade would not entertain the Provisional Order for the reason that the Corporation had already acted. He suggested that the form of the resolution should be as follows:—"That the Committee submit to the Board of Trade for its approval the Rural Electricity Supply Co., Ltd., as the company to be named in the clause to be inserted in the Provisional Order, to accept a transfer of the powers of the Corporation, and to execute the works under the Order, subject to such provisions, stipulations, and conditions as may be approved by the Board of Trade."

In view of the Clerk's ruling, the consideration of the scheme was referred to a Committee.

SOUTH AFRICAN FARM TELEPHONES.

According to the *African World*, in connection with the inquiries set afoot by the South African National Union with reference to farm telephones in the various South African colonies, the Acting Postmaster-General of the Transvaal gives the following further details of proposed extensions in that State: It is intended to erect main trunk lines, to communicate with Pretoria and the Rand from Klerksdorp, Volksrust, Belfast, Zeerust, and Pietersburg. Connected with these man routes will be a large number of subsidiary trunk lines, and when the whole are erected it will be possible to speak easily from one end of the Transvaal to the other. Few farms will be far removed from a line when this programme is completed, and connections with farms will be given to the nearest available point on the lines. All connections will be taken to an exchange. The exchange fixed charge of £7 10s. per annum will be payable by all subscribers, and the only addition to this for farmers will be 10% of the cost of their lines outside the exchange areas, existing lines being used as far as possible to minimise this cost. If, for instance, a farm is 10 miles from an exchange, a trunk line from the exchange passing within two miles of the homestead, the charge would be £7 10s. for the exchange service, covering a line of one mile from the exchange as centre; for seven miles the circuit would be carried on the existing line, and for the remaining two miles a light line would be run across-country to the homestead, 10% of the cost of this construction outside the exchange area being added to the subscription of £7 10s.

CANADIAN CABLES AND THE EMPIRE.

A most important item of news has come through from Ottawa. Mr. Lemieux, Postmaster-General, in introducing in the Dominion House of Commons a Bill to control the rate facilities of ocean cable companies, a Bill which was promptly passed, declared that he had discussed the matter in London with the Postmaster-General. It was then agreed to promote this Bill, which brought the cable companies under the jurisdiction of the Dominion Railway Commission in the same way as the telegraph, telephone, and railway companies. It was expected that by similar legislation in England and Canada the cable companies could be brought to establish a schedule of rates, urgent messages being charged 1s. per word as now, semi-urgent or deferred telegrams 6d. per word, and Press telegrams 3d. per word. This was the next best step to a Government-owned cable between Great Britain and Canada. At the Imperial Conference a feeling was expressed in favour of cheaper cable communication with a view to the dissemination of news from the heart of the Empire, thus to bind more closely the Mother Country and the Colonies. When this legislation was supplemented by British legislation an arrangement could be made both ways.

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Electrical Contractors' Section.

A Survey of New Things and Business Prospects.

NOTICE.

Contract and Miscellaneous Advertisements should reach this Office by Mid-day on Wednesday. For rates apply to the Manager, 169, Fleet Street, London, E.C.

CONTRACTS.

URBAN DISTRICT OF LITTLEBOROUGH.

ELECTRICITY SUPPLY.

The Littleborough Urban District Council are prepared to RECEIVE TENDERS for the SUPPLY and LAYING of ELECTRIC CABLES and the SUPPLY and ERECTION of PLANT as follows:—

Contract No. 1.—High-tension Feeder Cables, Low-tension Distributors, Road Work, etc., for private lighting.

Contract No. 2.—Transformer Kiosk, with Transformers and Equipment and Switchgear in Sub-station.

Persons tendering are at liberty to tender for either or both contracts, but not for part of a contract.

Copies of the specification, with forms of tender, general conditions, and plan, may be obtained from the undersigned on depositing a £5 Bank of England note, which will be returned as soon as the contract has been awarded, excepting in the case of the successful tenderer, whose deposit will be retained until the contract has been sealed.

The works are to be carried out in accordance with plans and specifications which may be seen at, but not obtained from, the offices of Messrs. Hawtayne & Zeden, 9, Queen-street Place, London, E.C., consulting engineers to the Council, from whom further information can be obtained.

The contractor whose tender is accepted will be required to enter into a formal agreement under seal with sufficient sureties for the due performance of his contract.

Tenders, sealed and marked, "Tender for Electricity Supply Plant," must be addressed to the Clerk to the Council, Council Offices, Littleborough, near Manchester, and be delivered to him there on or before the 2nd day of May, 1910.

The Council do not bind themselves to accept the lowest or any tender.

GEORGE H. WILD, Clerk to the Council.

Council Offices, Littleborough,
30th March, 1910.

COUNTY BOROUGH OF ROCHDALE.

ELECTRICAL ENGINEERS' DEPARTMENT.

CONTRACT A. 45.

ACCUMULATOR ROOM AND STORES, ETC.

The Electricity Committee of the above Corporation invite TENDERS for the construction of an UNDERGROUND ACCUMULATOR ROOM and ABOVE GROUND STORES, ETC., at their ELECTRICITY WORKS.

Plans and General Conditions may be seen at the Electrical Engineers' Dept., Dune-street, Rochdale, on application to C. C. Atchison, M.I.E.E., Engineer and Manager, from whom copies of quantities may be obtained on receipt of a deposit of One Guinea, which will be refunded on the return of the quantities, together with a *bona-fide* tender.

Additional copies of the quantities may be obtained on payment of 5s., which amount will not be returned. Sealed Tenders, endorsed "Accumulator Room and Stores, etc.," must be delivered to me not later than noon on Wednesday, the 13th of April, 1910.

Persons tendering who intend to sub-let any portion of the Contract must submit with their tender a list of the proposed Sub-Contractors. The Corporation will not be bound to accept the lowest or any Tender, and the placing of the Contract is subject to the Corporation obtaining sanction from the Local Government Board to borrow the necessary amounts therefor.

WM. HENRY HICKSON, Town Clerk.

Town Hall, Rochdale,
April, 1910.

CONTRACTS OPEN.

HOME.

ABERDARE.—Urban District Council.—(*a*) Generating station building; (*b*) two high-speed reciprocating engines, direct-coupled to direct-current generators (200 kw. and 100 kw.), balancer, booster, switchboard, steam and exhaust piping; (*c*) battery of accumulators (500 ampere-hour capacity); (*d*) cables, street work, junction boxes, switch pillars, etc. Specifications, £1 1s., Clerk. Drawings (L.), S. Sellon, 36, Victoria-street, Westminster, S.W. April 9.

COLWYN BAY.—Urban District Council.—Cables, stores and metres for electricity department. Particulars from Clerk. April 9.

DOVER.—Harbour Board ask for tenders for an electric-worked jib-crane. Particulars (5s.) from Mr. M. Mowll, Register, Castle-street, Dover. April 16.

EGREMONT.—Wallasey Urban District Council.—Annual supplies for electricity supply works at Liscard. Particulars from Engineer, Seaview-road, Liscard, Cheshire. April 18.

LITTLEBOROUGH.—Urban Council invite tenders for the supply and laying of electric cables and the supply and erection of plant as follows: (1) High tension feeder cables, low tension distributors, road work, etc., for private lighting; (2) transformer kiosk, with transformers and equipment and switchgear in sub-station. Specifications (£5) from Mr. G. H. Wild, Clerk to the Council. May 2.

LONDON.—London County Council invites tenders for the wiring and fitting for electric lighting of the two under-mentioned schools, namely, Shelburne-road Elementary, Torriano-avenue Elementary. Persons desiring to submit tenders may, on and after April 4 in the case of Shelburne-road, and on and after April 11 in the case of Torriano-avenue school, inspect the drawings and obtain the specifications, bills of quantities, form of tender, and other particulars on application to the Chief Engineer of the Council, Mr. Maurice Fitzmaurice, C.M.G., at the County Hall, Spring-gardens, S.W., upon payment to the Cashier of the Council of the sum of one pound (£1) in respect of each school. This amount will in each case, after the Council or its Committee shall have come to a decision upon the tenders received, but not before, be returned to the tenderer, provided he shall have sent in a *bona-fide* tender and not have withdrawn the same, but in no case will the fee be returned unless a *bona-fide* tender is submitted. Full particulars of the work may be obtained on application at the County Hall before the payment of the fee for the specification, etc. Each tender is to be delivered at the County Hall, in a sealed cover, addressed to the Clerk of the London County Council, Spring-gardens, S.W., and marked as the case may be "Tender for Electrical Installation at the Shelburne-road Elementary School," "Tender for Electrical Installation at the Torriano-avenue Elementary School." No tender received after 11 a.m. on Wednesday, April 20, 1910, will be considered.

MANCHESTER.—Chorlton Guardians.—Wiring, etc., for electric light at West Didsbury Homes. (Specifications, 10s., Ch. Clegg & Sons, 21, Spring-gardens). April 11.

PERTH.—Town Council invite tenders for the supply of 3,500 tons of small coal during the period ending May 15, 1911, delivered free at their electric lighting station. Forms of tenders from Mr. J. Lambert, Borough Electrical Engineer, Perth. May 11.

ROCHDALE.—Corporation Tramways.—Gears and pinions; cast-iron and malleable iron castings; brass castings; iron and steel; springs, overhead materials; and general stores. (Particulars, 5s., General Manager, Mellor-street). April 11.

ROCHDALE Borough invite tenders for the construction of an underground accumulator room and above ground stores, etc., at their Electricity Works. Plans and general conditions may be seen at the Electrical Engineer's Department, Dane-street, Rochdale, on application to C. C. Atchinson, M.I.E.E., Engineer and Manager, from whom copies of the quantities may be obtained on deposit of one guinea. April 13.

OVERSEAS.

ANTWERP.—Lower Scheldt Works.—Electric lift for vehicles on floating pier. Dep., £320. Specification No. 19, 2d., plans 1s. 5d., Direction du Service Spécial de l'Escaut Maritime. June 16.

BREMEN. — Electric cranes (April 12). Particulars from Bauinspection für Zollan Schlussgebeit, Bremen.

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CONTRACTS.—continued.

DOVER HARBOUR.

ELECTRIC CRANE.

The DOVER HARBOUR BOARD invite TENDERS for the CONSTRUCTION, SUPPLY and ERECTION upon rails provided upon the deck of a Landing Stage at Dover of an Electric-worked JIB CRANE.

Printed forms of Conditions of Contract, Specification and Tender can be obtained upon application at my Office on payment of 5s. for each copy. Tenders, from British manufacturers only, will receive consideration.

Sealed Tenders, marked "Tender for Crane," to be sent to my Office on or before SATURDAY, the 16th April, 1910.

The Harbour Board do not bind themselves to accept the lowest or any Tender.

MARTYN MOWLL,
Register, Dover Harbour Board.

Castle-street, Dover,
29th March, 1910.

PATENTS.

S. SOKAL, Chartered Patent Agent,
AND
Certified Austrian Patent Attorney (Patentanwalt), Specialist for German Patents and Patent Litigation.
55, CHANCERY LANE, LONDON, W.C.

THE PROPRIETORS OF THE PATENTS Nos. 7637 of 1907, 7642 of 1907, for "Improvements in and relating to Filaments for Incandescent Electric Lamps," are desirous of entering into arrangements by way of license and otherwise on reasonable terms for the purpose of exploiting the same and ensuring their full development and practical working in this country. All communications should be addressed in the first instance to HASELTINE, LAKE & Co., Chartered Patent Agents and Consulting Engineers, 7 and 8, Southampton Buildings, Chancery Lane, London, W.C.

BRISBANE.—Postmaster-General.—(*a*) Six sections of a common battery switchboard and other additional equipment; (*b*) wire, jumper, twin wire, jumper triple, light lead-covered silk and cotton insulated cable. June 8.

BUDAPEST.—H.M. Consul-General at Budapest (Mr. Esme Howard, C.V.O., C.M.G.) reports that tenders are invited by the Municipality of Pécs for the building and working of an electric railway in that town. Tenders will be received up to noon on June 6, by the "Pécs varos gazdasagi tanacsnokanak, Varosi Székhaz," Pécs, Hungary, from whom also detailed conditions and forms of tender may be obtained at a cost of 2 kronen (1s. 8d.). The plans and other documents can be examined on personal application at the Engineering Office of the town of Pécs.

HERTOGENBOSCH, HOLLAND.—Tenders are invited for the installation of an electric lighting and power plant, including the laying of underground cables, etc. Tenders should be sent to "Heer Administrateur der Godshuizen, Gasthuisstraat, 9," Hertogenbosch, at which address they will be opened at 11 a.m. on April 19. Plans and specifications may be purchased from the same official on payment of 12 gulden (20s.).

MADRID.—The official *Gaceta* of March 25 notifies that an application has been lodged with the "Direccion General de Obras Publicas, Ministerio de Fomento," Madrid, by Don José Paredes Pastrana, for a concession for the construction and working of an electric tramway in Cadiz from the Plaza de Loreto to the Barrio de San Seneriano, and that a period of one month from the date of publication of the *Gaceta* is allowed for the presentation of competing offers at the "Direccion." Local representation is necessary.

TRANSVAAL.—Tenders will be received, up to noon on April 18, by the Agent-General for the Transvaal, 72, Victoria-street, London, S.W., for the supply to the Department of Posts and Telegraphs of 119 miles of covered wire and 8,000 iron tapered telegraph poles. Tenders, marked "Tender for the supply of Covered Wire," or as the case may be, should be addressed to the Agent-General for the Transvaal, 72, Victoria-street, London, S.W., from whom specifications, etc., can be obtained. In the event of shipment of any of the above-mentioned stores by steamer from any port of the United Kingdom, or from ports on the Continent of Europe between Bordeaux and Hamburg (both inclusive), the contractor will be obliged to ship the goods by any line or lines of steamers with which the Administration may have made arrangements for the conveyance of the Administration's material and stores; information in regard to this can be obtained on application to the Agent-General for the Transvaal, 72, Victoria-street, London, S.W.

TENDERS ACCEPTED.

MAIDSTONE.—The Urban Council have accepted the tender of the Craypark Electric Cable Co., Ltd., at £428 10s. for a cable in order to supply energy to Turkey Mills.

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WIRES & CABLES
IF YOU HAVE NOT HAD OUR LATEST PRICES IT WILL PAY —— YOU TO GET THEM. ——
WE HOLD A LARGE STOCK OF 600 MEGOHM CABLE MADE TO THE SPECIFICATION OF THE BRITISH ENGINEERING STANDARDS COMMITTEE.
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New Series No. 1.
JUST PUBLISHED.
"LIGHTNING CONDUCTORS,"
By ALFRED HANDS, F.R.Met.S.
Author of "Scientific Protection," "A Guide to the proper Application of Lightning Conductors," "Lightning and the Churches," etc.
PRICE THREEPENCE.
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PLATINUM UTENSILS, SCRAP, LAMP TOPS.—Best prices given by DERBY AND CO., LTD., 44, Clerkenwell Road, London, E.C. N.B.—Platinum Sold.

SITUATIONS VACANT.

A COMMERCIAL ASSISTANT fully experienced in Electrical business, required for leading Electrical firm in India, Correspondence, Tendering for House Wiring and Electrical supplies of all kinds, Advertising and usual Office work. Offers till 10th April, to Box A, c/o. ANDERSON, 133, Jermyn Street, London, W.

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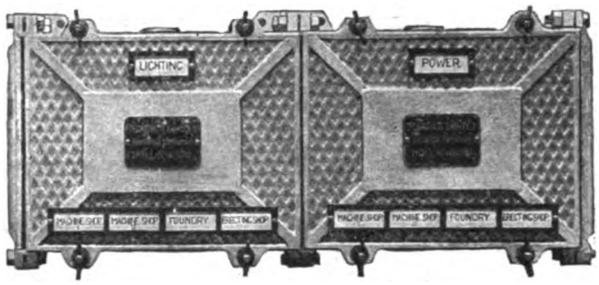

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NO EXPENSIVE "SPARE" WAYS.

Additional Sections can be added in a few minutes.

FOSTER
Metal Lamps

are now reduced in price.

These lamps are made throughout in our own works. The filaments are securely anchored and every lamp carefully tested before despatch. Hence, only reliable ones are supplied. FOSTER METAL LAMPS do not blacken and are remarkable for their long and useful life. A special feature with us is PROMPT DELIVERY.

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Liberal Discounts.

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(DEPT. A), **LONDON, S.W.**

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ACCUMULATOR MAKER, thoroughly experienced with Accumulator Plates, Lead Burning, Celluloid Box making, Assembling forming, &c. Box C.S.P., c/o. THE ELECTRICAL ENGINEER, 149, Fleet Street, London, E.C.

SWITCHBOARD AND CONTROLLER WORK.—Advertiser requires situation, age 25, used to work from drawings. Box F, c/o. THE ELECTRICAL ENGINEER, 149, Fleet Street, London, E.C.

ELECTRIC LAMP WORKS ADVERTISER.—Experienced with Carbon Metallic Filament lamps, desires situation in exhausting dept. Box H.N., c/o. THE ELECTRICAL ENGINEER, 149, Fleet Street, London, E.C.

NOTES.

DRAW-IN SOCKET FOR CONDUIT WIRING.

For the purpose of providing a cheap and neat watertight junction box to meet all ordinary requirements, Mr. Leonard Milne has devised a simple arrangement which is now being introduced. The junction box is in reality a draw-in socket consisting of a length of tube having a bore of the next size larger than the size of conduit with which it is to be used. Either or both of its ends are reduced in diameter and threaded internally. The corresponding end of the conduit run in which the socket is to be inserted is expanded and screwed externally to fit the female threads on the reduced ends of the socket, the diameter at the base of the threads being slightly in excess of that of the normal external diameter of the remainder of the conduit. It will thus be seen that if the tube be attached to a length of conduit formed with an expanded end, it can be screwed sufficiently far to become released entirely from its engagement with the threads, and since its internal diameter is sufficient to allow it to pass freely over the expanded and screwed ends of the conduit, the socket may be pushed along until a gap is left in the run almost equal to its whole length. It is obvious that if both ends of the sliding junction box are restricted and screwed, and both ends of the exposed conduit are expanded and screwed, the act of rotating the socket will cause it to travel along one end of the conduit and recede correspondingly from the other. As soon, therefore, as it has cleared itself from the threads, it will be released altogether at one end and free to slide over the conduit at the other end. The form in which the socket and connections are made can be accomplished in various ways. A straight socket can be made use of, with reducing nipples or enlarging sockets, or the ends of the sliding box may be enlarged and those of the adjacent conduit restricted, so that the tube may slide inside the latter instead of outside. The same principle can be adopted for the drawing-in or inspection of cables at bends and tees, the sliding socket in the former case being of flexible tubing, or a rigid tube formed in two lengths of approximately the same curvature but of different diameters, so that one could slide over the other, the connection being made by a screwed nipple or socket. In the case of T connections, the most favoured method of applying the sliding tube is by a solid T piece, with sliding tubes attached to one or all the arms. If the sliding tube is inserted in one arm only, it should be that one containing all the leads, so that the latter branch out after leaving the inspection point. To facilitate tapping off from the main leads at T's, porcelain connections of a special pattern have been designed. In these, the brass terminals are entirely embedded in porcelain, and cannot possibly come into contact with the tube or each other, while the body is so shaped that it lies in the enlarged bore of the sliding box, and does not restrict the capacity of the conduit.

Among the advantages claimed for the draw-in socket are its neatness, cheapness and simplicity. The points can be made as watertight as at any other point in the conduit system, while electrical continuity is assured. There is

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PLANT FOR SALE.

Advertisements under this heading: Twenty-four words, 1s. per insertion; three insertions for 2s. 6d.; or each additional line of eight words, 4d.

ELECTRIC GENERATING SETS, Willans & Robinson's engines, Holme's dynamos, 110 volts, 350 amperes. Box No. 30, c/o. THE ELECTRICAL ENGINEER, 149, Fleet Street, E.C.

ELECTRIC MOTOR, by Parker, 15 b.h.p., No. 20, open type, for 460 volts, 40 amperes, 600 revs. continuous circuit; £75. Box 31, c/o. THE ELECTRICAL ENGINEER, 149, Fleet Street, E.C

FOR SALE, 20 h.p. Suction Gas Plant and 14 b.h.p. Engine; also 10 h.p. Vertical Boiler and 6 h.p. Vertical Steam Engine.—Box C.E., c/o THE ELECTRICAL ENGINEER, 149, Fleet-street, London, E.C.

LANGDON DAVIES ELECTRIC MOTOR; alternating current, 16 h.p.; 100 volts.—Box G.S., c/o THE ELECTRICAL ENGINEER, 149, Fleet-street, London, E.C.

ELECTRIC MOTORS.—Two 15 h.p., 500 volts; one 20 h.p., 100 volts; one 10 h.p., 460 volts; tramway controllers.—Box W.G., c/o THE ELECTRICAL ENGINEER, 149, Fleet-street London, E.C.

no danger of "kinking" the cables, or of damaging the insulation, since they can be inserted or pulled out almost in a straight line. This is of special importance where heavy or lead covered cables are involved. As the socket can be made very cheaply, sliding tubes can be inserted at frequent intervals, thus simplifying the running of cables.

FOSTER METALLIC FILAMENT LAMPS.

We give herewith a representation of an exceedingly effective advertising coloured post card which is being used by Messrs. The Foster Arc Lamp & Engineering Co., Ltd., to their trade customers. It is worth while securing a supply of these. By the way, from the first of this month

FOSTER METALLIC LAMPS
COLLECTOR: 'ULLO! METER'S BADLY REGISTERED SINCE LAST QUARTER.
SERVANT! THAT'S THESE 'ERE FOSTERS HASTEN'S GETTIN' NOW.

this firm have reduced the prices of their metallic filament lamps. The following are the revised terms, subject, we understand, to exceedingly liberal discounts: 100–135 V. lamps, 16, 25, 32 and 50 c.p., 2s. 9d.; 200–260 V. lamps, 25 and 32 c.p., 4s.; 50 c.p., 3s. 9d.

"PLANIA" CARBONS.

To a casual observer there is little attractiveness about carbons; to the contractor, however, they form a class of goods which are apt to cause endless worry and trouble if insufficient attention has been given to their quality. Messrs. H. G. Mayer & Co., of 67a, Aldersgate-street, London, E.C., have just introduced some new carbons of the well-known "Plania" brand, which possess several notable features. The Plania flame arc lamp carbons just introduced can be used as positive or negative, and are suitable for alternating or direct-current circuits. These are two important considerations, as will be seen, for they get over the trouble of having to stock assorted carbons. Moreover, these carbons permit six lamps to be run in series on 220 volts, or three on 110 volts without the use of a steadying resistance. The firm have also introduced

VULCANITE
YOUR NEXT ENQUIRY WILL BE APPRECIATED.
F. CARSON & EVANS.
3A FENCHURCH BUILDGS. LONDON, E.C.
EBONITE

a new carbon of intense hardness for use as an electrode in electro-chemical work, the electrical properties of which has been tested for a considerable period at 1,500 volts in acid, without being affected. This is a satisfactory result, and we understand that experiments are now being conducted to make the material of such a size to enable it to be used for furnace electrodes.

CONTRACTS WORTH WATCHING:—

Ashcott.—Cottam & Sampson, architects, Bridgwater, School.

Ashton-under-Lyne.—E. Marshall & Sons, Ltd., Cockbrook, Ashton-under-Lyne. Schools.

Barrow-in-Furness.—E. M. Young, 90, Duke-street, Barrow. Shops and warehouses in Hague-street, Walney.

Bexhill.—J. B. Wall, architect, 13, Devonshire-road, Bexhill. Skating rink in Western-road.

Birkenhead.—Peter Rothwell, 174, Conway-street, Birkenhead. Catholic schools.

Birmingham.—H.M. Office of Works, Birmingham. Alterations to the Head Post Office, Birmingham.

Birmingham.—Mansell & Mansell, 47, Temple-row, Birmingham. Fire station in Moreley-road, Highgate.

Bootle.—J. H. Farmer, Town Clerk, Bootle. Council school.

Bristol.—F. B. Bond, Star Life Buildings, St. Augustine's parade, Bristol. Cold storage warehouse in Jervis-street.

Cardiff.—E. Turner & Sons, Penarth road, Cardiff. Church.

Cove.—W. J. Taylor, County Surveyor, The Castle, Winchester. School.

Dalmuir, N.B.—W. Beardmore & Co., Ltd., Glasgow. New Ordnance Works.

East Riding of Yorks.—Building Surveyor, County Hall, Beverley. Teacher's house and school extensions.

Eccles.—N. Brookes & Son, Patricroft, Manchester. Additions to the Electricity Works.

Edinburgh.—P. R. McLean, 24, St. Andrew's-square, Edinburgh. Coach works.

Glasgow.—J. Burnett & Sons, architects, 239, Vincent-street, Glasgow. New theatre.

Hazel Grove.—C. T. Adshead, architect, Leinster Chambers, 4, St. Anne's-square, Manchester. Elementary school.

Heywood.—H. Littler, County Architect, 16, Ribblesdale-place, Preston. Extension of the Technical School.

Hull.—Wellsted, Dosser & Wellsted, Waterloo Chambers, Hull. Villa residence in Newland-park.

Isleworth.—J. G. Carey, architect, Council House, Hounslow. Schools and cottage in Twickenham-road.

Maryport.—J. Henney, architect, 29, Senhouse-street, Maryport. Office, laboratory, storehouse and smiths' shop, at Resihow.

Nuneaton.—S. C. Gibson, Borough Electrical Engineer, Coton-road, Nuneaton. Electricity Works extensions.

Plymouth.—F. A. Clark, architect, 83, Old Town-street, Plymouth. Alterations to the *Golden Lion*.

Preston.—J. T. Gabbot, Preston. Offices, workshops, etc.

Selby.—Irwin & Co., Selby. Mills.

Shrewsbury.—John Barnsley & Son, 102, Ryland-street, Birmingham. Secondary school.

MESSRS. SIEMENS BROTHERS & Co., LIMITED., Caxton House, Westminster, S.W., inform us that they are compelled further to increase the prices of their India-rubber tapes and solution, as from to-day.

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Electrical Progress at Home & Abroad.

A Review by our Special Correspondents.

TYNESIDE.

NEWCASTLE-ON-TYNE.

Work upon Tyneside is becoming larger in volume owing to a considerable number of orders having been received by the shipbuilding and engineering firms in the area. Among these may be mentioned that Messrs. Palmers Shipbuilding & Iron Co., Ltd., of Jarrow, has, it is reported, received orders for two cargo boats, one of which is to be proceeded with at once, while the other will be taken in hand shortly. This firm, as a matter of fact, with general work and that for the Admiralty on the *Hercules* is now pretty busy, and the electrical trade, as well as other allied industries, naturally profit thereby. Messrs. Walter Runciman & Co., Ltd., of Newcastle-on-Tyne have also just placed an order for two large cargo boats with Messrs. John Redhead & Sons, Ltd., of South Shields, while another Newcastle firm, known as the Glen Steam Coasters, Ltd., have given an order to Messrs. Hepple & Co., Ltd., of South Shields, for a coasting vessel. In addition to this the latter firm are building an ice breaker for Vladivostock, and it is rumoured that a considerable amount of shipbuilding will shortly be in progress in connection with a Canadian enterprise.

Other Industries.

Associated with marine engineering are other industries which equally well affect the Tyneside area, and among these may be mentioned Messrs. Armstrong Whitworth & Co., Ltd., at Elswick, where it is stated by the *Newcastle Chronicle* that armaments for the Australian and New Zealand battleship cruisers have been placed with Messrs. Vickers and the Elswick firm, each firm obtaining the order for the armament, consisting of eight 12 in. guns in four turrets, together with a secondary armament of 4 in. guns. The vessels themselves are being built elsewhere. Another important order which has come to the area and which is reported in the same journal, is a bridge contract to Messrs. Dorman Long & Co., Ltd., of Middlesbrough, which will involve 6,000 tons of steel work and comprising 400 bridge spans varying from 7 ft. to 125 ft. in length, in connection with the South Manchurian Railway between Su-chai-tun and Dalny. As both these firms are among the large power users of the electrical power in bulk supply system in this area it is easy to see that the placing of such large orders as this will immediately affect the prosperity of electrical industries in this area.

Conversion from Gas to Electricity.

Although electrical extension work is not proceeding rapidly at the present time in this area, one interesting example is that of Messrs. Henry Watson & Sons, Ltd., brass founders, of High Bridge Works, Walker Gate, who are changing over their fitting shop from gas to electric drive. The work is being done by Messrs. Robson & Coleman, of Haymarket-lane, Newcastle-on-Tyne, and involves the use of 3-phase Westinghouse motors, the supply being obtained from the mains of the Newcastle-upon-Tyne Electric Supply Co., Ltd.

Proposed Electric Club.

An interesting development in this area is the proposal to form a social club for electrical and allied industries, to be known as the "Electric Club." The arrangements are, I understand, at present tentative, but it is proposed to form an initial guarantee fund of £500, of which over one-third has already been promised, and premises in Northumberland-street have been inspected with a view to acquisition. Should the scheme be taken up it is proposed to make the club a social meeting place for members of the electrical and allied industries residing in Northumberland, Durham and North Yorkshire, and arrangements are to be made, by means of electro-harmonic concerts and other festivities, to stimulate the lighter side of electrical engineering. This certainly needs some light relief. The subscription for town members is proposed at £1 1s., while country members, such as those having interests in the area, but living in other centres (London, Manchester, etc.), will be admitted at an annual subscription of 10s. 6d. It is proposed to have the club in practical working order probably by September next.

THE MIDLANDS.

BIRMINGHAM.

Birmingham Tramways accounts have not yet been made up, but the returns for the fifty-second week of the year confirm the anticipation that the year's trading would show a substantial advance upon that of the preceding twelve months. The increase in the receipts is estimated, in round numbers, at about £12,000. The increase in working expenses and the growth in the charges for interest and sinking fund, more than counterbalance the increase in the receipts, so that the contribution in relief of rates is not expected to exceed by much the sum of £25,000. In the meantime the ratepayers are benefiting in another way by the improved traffic returns. The Tramways Committee is by far the largest customer which the Electric Supply Department has, and its little bill shows a large increase every year. In 1907-8 the tramway consumption was 11,192,776 units, in 1908-9 it was 11,782,409, and in the year just concluded the twelfth million has been passed. The present scale of charges for tramway consumption is up to 4,000,000 per annum, 1½d. for the next four millions, 1¼d.; and above eight millions, 1d. In 1907-8 the sum charged to the Tramways Committee was £59,136 and in 1908-9 it was £61,385. The time when a revision of the terms of supply may be considered is not far distant.

Handsworth's Bill.

The Bill, which has been promoted by the Handsworth District Council is being proceeded with in spite of the talk of annexation to Birmingham, and is expected to be before the House of Lords Committee shortly. It is an omnibus Bill, but is largely concerned with tramway and other electrical projects. Several new routes are provided for, chiefly with a view of connecting existing lines or of providing feeders to them from parts of the districts at present without tramway communication. One of the new lines is to run from the present cable route at Stafford-road and form a circular route by way of Grove-lane. This will serve the large residential district in the neighhourhood of Oxhill-road and Handsworth College. Another important proposal is a line along the Birchfield-road, which will serve a large district between the cable route and the old Perry Barr line, which is at present without tramway facilities. The Council has been urged by many of its constituents not to proceed with this tramway scheme pending the settlement of the Greater Birmingham question, but the matter is considered urgent from the point of view of the Handsworth Electrical Undertaking, which is seriously handicapped as compared with its neighbours in economical working and consequent cheapening of supply to lighting consumers by the absence of a sufficient day load. There has been, however, a steady development, though on a comparatively small scale, of the power supply business of the undertaking, owing to the outgrowth into the district of the Birmingham jewellers' quarter, several large factories having recently been erected on the Handsworth side of the border.

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Electricity in Mines.

The inquiry by the Home Office Departmental Committee into the question of revision of the Electricity Rules for Mines, is being regarded with great interest by the colliery managers in the Midlands. At a recent meeting of the Council of the South Staffordshire, Warwickshire and Worcestershire Branch of the National Association of Colliery Managers, the President of the branch, Mr. Arthur Hall, was appointed to give evidence before the Committee, and he has already been examined. The matter was the subject of some references at the Annual Dinner of the branch, held in Birmingham on Saturday last, and a provisional report was also confidently made by the President at the annual meeting. The general feeling of colliery managers in the district is represented by some remarks made at the dinner by Mr. J. W. Liddell, who thought that the expense that was being incurred in the inquiry and in the collection of evidence, would, as far as electrical apparatus in coal mines was concerned, be well repaid. No doubt his fellow managers would remember, as he did, that ten or a dozen years ago anything that had something in the nature of tape about it was thought sufficient to carry electricity down a mine. No doubt some of them, like himself, had had some sad experiences with regards to the use of electricity in mines, and he personally would be very glad if the Committee now sitting should be able to bring out the best means of safeguarding the use of this power. Anything that would benefit the workmen in coal mines and tend to their safety, would be welcomed by colliery owners and managers. Any improvement with regard to safety that could be brought about as the result of the inquiry would be to the advantage not only of those immediately concerned but of the community generally, as enabling those concerned to take fuller advantage of the facilities which electricity afforded in working coal mines economically.

Aston's Small Consumers.

The supply of electricity in Aston Manor to small consumers, which has already claimed to be one of the cheapest in the Kingdom, is to be further cheapened. The Council at its meeting this week, adopted on the recommendation of the Electrical Committee the following revised scale: The maximum charge for current for lighting purposes to be 3d. per unit instead of 3½d., the rates being apportioned as follows: For consumption under 1,000 units per quarter 3d., over 1,000 and under 1,500 units per quarter 2¾d., 1,500 and upwards 2½d. The charge for current for heating and cooking purposes to be 1d. per unit instead of 1½d., with a charge for meter rent, where the consumption is less than 5s. per quarter. The charges for power purposes were also revised, the maximum being 1½d. per unit instead of 2d., and the scale of charges being: Under 100 units per month 1½d., over 100 1d.; for consumption of over 50,000 units per annum ⅞d.

SCOTLAND.

GLASGOW.

The Clyde Valley Electric Power Co. have made a successful start with a new system of charging for tenement lighting in the Clydebank district. They have reason to anticipate that many more tenements, which are at present being erected, will be connected to their mains. The houses in question are two rooms and kitchen with bathroom. The lighting consists of a 22 c.p. lamp in the kitchen, 10 c.p. lamp in the bathroom, 10 c.p. lamp in the lobby, 2-15 c.p. lamps in the parlour, and one 15 c.p. lamp in the bedroom, or roughly, 90 c.p. in all. The charge for this is 2s. 3d. per month all the year round, and the consumer is bound to get his lamp renewals either from the company or from an agent appointed by them. It was thought by some that this system of charging would not pay the company, as the consumers would be likely to take advantage of the liberty for unlimited supply at the fixed rate, but experience so far has shown that the rate charged yields a respectable margin of profit to the supply authority. The Clyde Valley Co. are adopting a forward [illegible] in all their publicity work. They lose no [illegible]ing their wares before the public in the wide area covered by their operations. For instance, at Bellshill, a mining township some miles from Glasgow the company had a stall the other day in a bazaar in connection with a local Orange Lodge. The exhibits shown in the stall were mostly heating and cooking devices of the most up-to-date types.

Stair Lighting.

The Cleaning and Lighting Committee of Edinburgh Town Council are very sensibly trying to get electricity applied to stair lighting for the high tenements in the centre of the city. The cost of incandescent gas is 17s. 6d., and the Electricity Committee offer electricity at 22s. 6d. per 5 c.p. lamp. The Lighting Committee are to try to get the Electricity Committee to lower their price to the extent of 1s. 6d. The Glasgow price for stair lighting is 14s. but it may not be comparable with Edinburgh.

Electricity for Colliery Works.

There is no branch of industry to which electricity by its flexibility and its general convenience in confined spaces, more readily commends itself than to mining work of all kinds. Almost every week sees extensions to electric plants in collieries. At the Canonbie Colliery, Dumfriesshire, the Duke of Buccleuch has just had carried out an important series of improvements, the object of which is to recover the good coal below the level of the pit bottom, which had to be abandoned 20 or 30 years ago owing to lack of mechanical means of haulage and pumping water. The works now installed include a vertical high speed engine with direct coupled dynamo, 550 r.p.m., 87 amps. capacity at 500 volts. The current is carried down the shaft by doubled armoured special conductors to a distance of 600 yards, and drives a haulage which brings the coal up in rakes to the level of the pit bottom, from whence it is conveyed by horses. An electrically driven three throw pump deals with the water.

Turbines for Colliery Work.

In several collieries in Scotland a point has been reached when more power is wanted. In one case, for instance, a colliery has available 20,000 lbs. of exhaust steam per day of 8 hours. The other 16 hours of the day they have available 7,000 lbs. of exhaust steam. The intention is to further exploit that exhaust steam and the mixed steam turbine seems to present the readiest means of doing this. When the high pressure steam has been utilised for the haulage, fans, winding, pumping and other auxiliary engines, it is available for the mixed steam turbine which takes exhaust steam with an infusion of high pressure steam. In this way the extra power for electric drive is being obtained. Both in Fifeshire and Lanarkshire, which are the two principal coal areas in Scotland, several installations are either now in process of being carried out or are in contemplation. There is a 500 kw. set going in at the Blairhall colliery in Fifeshire and tenders are being sent in in connection with a Lanarkshire colliery, the particulars of which are so far not made public.

The Incorporated Municipal Electrical Association.

The Incorporated Municipal Electrical Association are to hold their Annual Convention in Glasgow this year, and elaborate preparations are on foot to make the function worthy of the traditions of the Association.

GERMANY.

BERLIN.

A curious point in German law has recently come to our notice with reference to current stealing. A man convicted of illicitly connecting an incandescent lamp with the street main was sentenced to three days' imprisonment and a fine, not for theft, but for fraud.

Marble Switchboads.

Marble is often used as a material for switchboards, but does not insulate equally well at all times, and German researches have proved that damp has a great influence on them. Losses to earth have occurred with such boards even with the low potential of 110 volts, that were very considerable and could be referred only to dampness of

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the marble. It was noticed that boards attached to damp walls were especially subject to loss of insulation. Sudden falls of resistance from 300,000 to 2,500 ohms have been observed, and there is no doubt that there was a large escape to earth first through the moisture of the marble, and then through the wall itself. Hence such boards should be carefully protected from contact with any damp surface. The damp has the further injurious effect of corroding the metal connections. The best protection to put between a marble switchboard and a damp surface consists of paraffined wood, the wood being, of course, thoroughly dried before impregnating it with paraffin wax. Such impregnated wood is a good insulator as well as being impervious to moisture. It is also of importance to ensure that the marble itself is thoroughly dried by heat before being fixed. As an additional precaution, it is well to put porcelain insulators between the wood and the marble to ensure a free circulation of air at the back of the board.

Agriculture and Electricity.

Saxony has just instituted an advisory board to promote the more extensive use of electricity in agriculture in the kingdom It is placed at the service of every farmer in the country. Questions requiring but short answers are replied to free by letter, as are also verbal enquiries, provided that they are preferred at the offices in Dresden, Leipzig, or Chemnitz. If, however, far reaching enquiries are made, fees will be charged on a regular scale. This is a most important experiment, and we feel sure that all agriculturalists, whether here or outside Germany, will wish it such success that it will be the forerunner of many other undertakings of the same kind.

Electric Battery.

The C. Lorenz A.G., has been experimentating with the heating effects to be obtained from Poulsen high frequency currents, especially with a view to surgical use. These researches are exciting considerable interest here, and we trust to say more about them on a future occasion.

Recording Wireless Messages.

The *Frankfurter Zeitung* reports that three Danish engineers, Dessau, Myrop and Thomsen have succeeded in inventing an arrangement whereby messages received by wireless are typed on a strip of paper, such as is used in a tape machine.

Electrical Daylight Measurer.

E. Ruhmer has invented a solenium-photometer for automatically recording the intensity of daylight. Its principle is the well-known fact that the electric conductivity of crystallised selenium is increased by exposure to light. There is a full description of the instrument in the "Elektrophysikalische Rundschau, 1909," Vol. II, pp. 17–21.

Company Notices.

The Elektrizitats Aktiengesellschaft vorm Kolben & Co., of Prague, is so full up with home orders, especially government orders, no others can at present be accepted. This important company is paying a dividend of 6% as against 5½% for 1909.

Reductions in the price of Tungsram lamps are announced from Vienna. This is another example of the general fall in prices of metallic filament lamps.

Negotiations seem to be in progress for the acquisition of the Grosse Berliner Strassenbath by the municipality. At the general meeting a shareholder expressed the opinion that it would not be to the interest of the shareholders to sell to the town even at 100% premium, seeing how well the company was doing in spite of fresh competition. The chairman admitted that the question had been raised, but said that no offer had been made to the municipality respecting a premium of 100%. The town hinted that 60% would be more than enough, but met with no favourable reply from the directors. Inasmuch as the concession is valid until 1949, there is no reason for selling the concern. At the same time an understanding will no doubt be made with the municipality with a view of solving some of the many traffic problems here prevailing. The meeting, attended by about a hundred shareholders, representing about three million sterling of capital, approved the chairman's suggestions unanimously.

The Strassenbahn, Hanover, reports a very favourable year for 1909, in spite of bad trade, the takings having increased in every department. The number of passengers carried was 49,530,600, as against 46,947,207 in 1908, and the average fare increased from 11·11 pfennigs to 11·59 (say 1¼d.). A 3% dividend on a capital of 23 million marks will be paid with a carry over of 91,851 marks. The gross takings were 6,008,650 marks in 1908, and 6,353,160 in 1909. There are not wanting other illustrations of the magnitude and continual growth of electric street trams in Germany. The Stuttgarter Strassenbahn pays a dividend of 11% for 1909, and received 2,860,000 marks. The Archener Kleinbahn Gessellschaft has increased its system from 149·4 to 153·7 km. in 1909, in which year it carried 18,852,700 passengers. The dividend is 7½%. The same is the case with our power stations. The Elektrizitatswerk Strassburg, increased its net profits from 991,771 marks in 1908 to 1,159,733 in 1909. The dividend will be 11% on 7½ million marks of old shares, and 5½% on 4¼ million marks of new shares. Even the small concerns show the same thing.

It may interest readers to know that the A. E. G. has been experimenting with a 500,000 volt oil transformer built solely for experimental purposes. The value of high initial tensions in economising electrical power transmission is being recognised more fully every day, and it is difficult to forecast what may be consequently required in the way of transformers. The toy under notice weighs five tons, and requires very nearly 1,800 gallons of oil. It is 15 feet high, and will give a spark a yard-and-a-half long.

UNITED STATES.

NEW YORK.

A total investment up to $20,000,000 is contemplated by the Commonwealth Edison Company in the construction of two new light and power stations in Chicago, which are to have a rating of 120,000 kw. each. The existing capacity of the Commonwealth Edison Company in Chicago is 240,000 kw., and the new equipment therefore will give a total capacity of 480,000 kw. Mr. Samuel Insull, President of the company, in referring to the purchase of 109 acres of land for these new stations, said: "We have bought the property for the purpose of building two new generating stations in which six turbines will be installed in each station, or twelve in all. In the first station there will be six turbines, each having a capacity of about 30,000 h.p., or 180,000 h.p. in all. We are building these stations for the natural growth of the business in that part of the city—erecting one station immediately and just as soon as the growth of the business demands it we will erect a second with about the same capacity. It is quite possible that at this place we will erect generating plants having a capacity of 350,000 h.p. We have had in mind the requirements of the future in buying this property, and while we will in all probability have 60,000 h.p. in operation within two years, it will be some years before we will have the entire plant as contemplated completed."

The Equipment.

For the first of these new stations orders have already been placed with the General Electric Company for turbo-generators, which will have a rating of 20,000 kw., for continuous service. The generators will be 2,300-volt, 25-cycle, three-phase, 750 r.p.m. machines. The dynamo potential will be raised in the transformer house to 9,000 volts, 12,000 volts or 20,000 volts, as required. In the turbine room the units will be placed in a row and will be spaced 44 ft. between centres. There will be six of these 20,000 kw. turbo-generators in each of the power houses, and the initial installation for the first station will be two units. These machines will be by far the largest electrical generating units ever built. When the Fisk Street station was designed eight years ago, the company demanded from the manufacturers the largest electrical generating units made up to that time. These, which were also the first large power-house steam turbines, were 5,000 kw. machines. Later on the Fisk Street station was rearranged, and again the company demanded machines of a greater rating than any previously existing, installing 12,000 kw. units. When Quarry Street was designed the company made another step in advance, requiring 14,000 kw. units. Now they have arrived at the 20,000 kw. stage.

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Electrical Prevention of Rust.

Dealing editorially with modern scientific methods of protecting iron and steel from rust, the *Electrical Review*, of Chicago, says: "Magnetic oxide has proved extremely serviceable for protecting iron from rust if the coating can be made without blemish. One of the best methods of producing the desired magnetic-oxide coating on iron is known as Barff's process, which at one time obtained some considerable vogue but which of late years has fallen into disuse. In this process, originated many years ago by E. S. Barff, the articles to be coated are placed in an oven and subjected to the prolonged action of superheated steam at a high temperature. A process has recently been introduced by which the same result is obtained electrolytically without heating to such a high temperature. The iron to be coated is connected as an anode to a source of electric current, the cathode being a piece of carbon or iron, or even the cell wall. The electrolyte is simply hot water at a temperature of about 180° Fahr., and the current used is only strong enough to establish a circuit and produce electro-chemical action. The nascent oxygen released at the iron changes the surface to magnetic oxide of iron, and the same result is said to be attained if the iron is already coated with rust. With the introduction of this electrolytic process it may be that Barff's method of protecting iron may become re-established, and if the articles so treated prove their rust-resisting properties under prolonged trial, a great field will be open for the exploitation of the new process."

Electric Mine Hoists.

Three extremely interesting papers on electric mine hoists were read at last week's meeting in this city, of the American Institute of Electrical Engineers. The first was by Messrs. Rushmore and Pauly, who summed up the advantages of electric hoisting as follows: (1) Greater economy resulting from the centralisation of the development of power in a large central electric station, favourably located for the economical development of power, and from a reduction in the operating force, from the increased life of the rope and the greater life of the brakes; (2) greater safety in operation; (3) especially, adapatation for underground installations; (4) the fact that it permits of the utilisation of water power which is frequently available in mining districts. They pointd out that of four systems described in the paper, the simplest consists of a polyphase induction motor directly connected or geared to the hoist drum. The speed of the motor is controlled by a variable resistance in its rotor circuit, which, because of the magnitude of the currents involved, is usually some form of water rheostat. In a second system the hoist is driven by a direct-current shunt-wound motor receiving energy from the alternating-current supply system through a synchronous or induction-motor-generator set. The speed of the hoist motor is controlled by varying the voltage of the generator, which is separately excited, one generator being used for each motor. In the third system advantage is taken of the low first cost and efficiency of the flywheel as a means for storing and returning large quantities of energy for short intervals, while a fourth system is similar to the first, but there is added a converter equaliser consisting of a rotary converter connected on the alternating-current side to the supply system and on the direct-current side to a motor driving a large flywheel. The field current of the direct-current motor is controlled by a regulator actuated by the line current. When the power taken by the hoist motor drops below the average the field current of the motor is automatically reduced, and the speed of the flywheel is increased, the energy being taken from the supply system. When the hoist-motor load exceeds the average, the operation is reversed, the speed of the flywheel decreasing, thereby returning energy to the system. This has the advantage over the third system in that the operation of the hoist motor is not dependent on the operation of a converter equaliser, and in the event of the failure of the latter, hoisting may be continued, providing, of course, that the equipment of the supply system is sufficient to take the load.

Efficiency and Economy.

The second paper, which was by Mr. Wilfred Sykes, dealt in the main with the advantages of electric hoists from an operating standpoint, the most important of which was declared to be the complete control afforded over the hoist when running, enabling the operator to work much quicker and with great certainty. Mr. Sykes pointed out that the ease with which the braking can be taken care of electrically makes it possible to manipulate the hoist with the greatest precision, the mechanical brakes being used only for holding the load. Under certain circumstances energy may be returned to the system by the hoist, which reduces the power consumption, but the main point is that it obviates the excessive wear on the brakes which would otherwise have to absorb this energy. Electric hoists may be fitted with devices for automatically reducing the speed and preventing over winding, which are absolutely certain in their action, and on this account the authorities in Germany allow men to be hoisted at a speed up to 2,000 ft. per minute, whereas, with steam hoists, the limit is fixed at 1,000 ft. per minute. An electric motor is a very simple machine and requires considerably less attention than a steam engine needs, and the splendid service which it gives under the most severe conditions disposes of any question as to its reliability. Mr. Sykes' paper was followed by one by Mr. R. Seeber, who, in giving an account of some tests made last month on actual operations, showed that the economy of the electric over the steam hoist worked out at 25%. The use of the electric hoist enabled Mr. Seeber's company to dispense with two boiler plants and their attendants. The tests were made upon a hoist in Michigan, where the Winona Copper Company has installed an electric hoist of the flywheel motor-generator type with Ward Leonard control. There are two generators driven by a single induction motor by means of flexible couplings. These generators supply energy to motors operating hoisting drums at separate shafts. The test showed a consumption of 1·79 kw.-hours per ton of rock hoisted 600 ft. up a 70° incline. The coal for this energy was about 4 lb. per kw.-hour, the ratio of rock to coal being 279 : 1. Tests made upon steam hoists under similar conditions showed a ratio varying from 100 : 1 to 200 : 1.

Low Power Tungsten Lamps.

The question has arisen on this side as to whether there is any demand justifiable on the score of economy for tungsten lamps of lower power than 20 candles. It is noted that English manufacturers are supplying low power tungsten lamps, but the general feeling here seems to be that the need is very questionable, as the saving with anything less than 20 c.p. is comparatively insignificant when the higher first cost is taken into account. The *Electrical World*, dealing editorially with this question, expresses the belief that the use of the tungsten lamp in general will at present be confined to places where lamps are operated a considerable number of hours per year, and that in most of such locations lamps of more than 20 c.p. are desirable with our rapidly increasing ideas of what constitutes sufficient illumination. "For general use in residences and offices, there is really no good reason for a lamp less than the 40-watt, 32-c.p. size. The short-bulb, 40-watt tungsten lamp can be used in practically all sockets where 16 c.p. carbon-filament lamps have been used heretofore. They will give double the illumination with less power consumption, and for the general lighting of any ordinary room, nothing less than 32 c.p. is needed." The *Electrical World* thinks that the central station industry missed a great opportunity which attended the coming of the metallic-filament lamp by failing to insist that advantage should be taken of the occasion to raise the unit electric light to the gas-mantle standard. "The tungsten candle-power standard should have been 40 watts; the lower rating of 25 watts is distinctly disadvantageous to the central station industry, which should not only resist any further lowering of tungsten candle-power, but should unite in a movement to make the 40-watt lamp the standard."

Panama Electrical Installation.

The technical papers of the current week give details of the electrical equipment of the Miraflores power house, near the operated line of the Panama Railroad, in the Pacific Division. The generating equipment consists of three 1,500 kw., 2,200 volt, three-phase, 25-cycle turbo-alternators with base condensers; two 35 kw., 125 volt, turbo-exciters and one 30 kw., 125 volt induction motor-driven exciter.

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The turbines are of the Curtis vertical type. Their guaranteed steam consumption is 17·6 lb. per kw. hour when operating at 100% load, with 150 lb. gauge pressure, 140° Fahr., superheat at throttle, 2 in. absolute back pressure and 12 kw. excitation at 125 volts. The condenser equipment for each turbine consists of one 3,500 sq. ft. surface condenser, one engine-driven centrifugal circulating pump and one dry-vacuum pump. All steam-driven auxiliaries are designed for 150° Fahr. superheat. There will also be installed for service during construction of the locks two 500 kw., 600 volt and one 300 kw., 600 volt rotary converters. The two 500 kw. converters are now located in the sub-station at Pedro Miguel, but these will be installed later in the generating station to furnish energy for work at Miraflores. There is also a 300 kw. converter installed at Balboa to furnish energy for the sand-unloading cranes. Overhead three-phase transmission lines deliver energy generated to the concrete-handling plants at Pedro Miguel and Miraflores, various electrically driven pumps, the Ancon quarry crusher plant and the sand-unloading cranes at Balboa. The lines to Ancon quarry are approximately 5½ miles in length, and that to Balboa 4 miles.

Power Developments.

The Guggenheims, associated with Mr. J. C. Edon, president of the Superior Portland Cement Company, are to begin work at Bellingham, Wash., on a concrete dam, 160 ft. high, to be placed across a deep gorge on the Baker River, a mile above the Washington Cement Company's plant. A reinforced concrete flume will be built to the power house, 4,500 ft. away, to develop 25,000 h.p. The Alabama Power Company has camped its corps of men on the bank of the Coosa River, 50 miles from Montgomery, to construct the big dam that will furnish the State with 50,000 h.p. in hydroelectric drive. The first 50,000 h.p. dam is only the beginning, for there are to be five more of the dams, supplying enough water power to furnish all of Alabama with electric driving power. The Pacific Light and Power Corporation has been incorporated with a capital of $40,000,000 to take over the properties of the Pacific Light and Power Company. The proceeds of the first million and a half dollars of preferred stock sold will be used for the construction of a 10,000 kw. plant at Redondo, Cal., and for constructing distributing lines.

New Electric Engines.

Two new electric motors for use in the Baltimore & Ohio tunnel and on the Belt Line at Baltimore have been delivered. The new type has a flexible wheel base consisting of two trucks coupled together and surmounted by a platform carrying a steel cab and running the whole length of the locomotive. The two trucks are permanently linked together with a heavy hinge and carry the draft gear and bumper on the outer end frames. With this construction all hauling and pushing stresses are transmitted through the truck framing on approximately the same horizontal line and are not carried through the centre pin into the platform framing. This relieves the platform of all stresses except such due to its own weight and that of the apparatus on it.

Current Items.

The Electric Storage Battery Company of Philadelphia has acquired all the patents and rights of the Westinghouse Storage Battery Company. The latter owned all the rights of the General Storage Battery Company, and the storage battery interests and patents of the Westinghouse Machine Company. From this time on the Electric Storage Battery Company will have the sole right to manufacture Westinghouse batteries.

The Illinois Traction System has inaugurated a new sleeping-car service between St. Louis and Peoria, a run of 172 miles. Two cars for this service have just been delivered from the St. Charles plant of the American Car & Foundry Company. These equipments include a number of innovations in car building, all designed to make sleeping-car service more comfortable and more safe. An underlying motive in the design of these cars is to offer a passenger means for passing a more comfortable night while *en route* over the electric line than could be had on the regulation sleepers of any competitive steam road. As a step in advance the sleeping car of this new design has upper berths into which daylight and air are readily admitted. An outside view is obtainable through two windows at the side of each upper berth.

An act to incorporate the Niagara Falls, Welland & Dunnville Electric Railway line to run between Niagara Falls and Dunnville has been passed. The capital stock of the company will be $200,000, and the company may issue bonds for $30,000 a mile. The road will cover 73 miles.

RINKING BY THE "OSRAM" LIGHT.

We have in several recent issues given evidence of the manner in which the metal filament lamp is rapidly ousting not only high pressure gas, but also arc lighting for the illumination of streets and other large open spaces; it is therefore with considerable interest we learn that skating rinks are now figuring amongst the converted.

Up to the present the flame arc lamp has held the monopoly for the lighting of large rinks, but apparently the

many obvious advantages of the high candle power "Osrams" have appealed to the proprietors of the Maida Vale Rink—one of the largest and most popular in the Kingdom. As will be seen by the accompanying illustration, this hall is illuminated entirely by the "Osram" lamps, of which sixty 400 c.p., 200 volts, and nearly six hundred 50 c.p. 200 volts are at present installed, the necessary current being taken from the Metropolitan Electric Light Supply.

INDIAN APPOINTMENT OPEN.

The Corporation of Calcutta desires to secure a suitable man as Superintendent of Public Lighting. Calcutta has a street mileage of 270, mostly lighted by gas, but oil is also used, and it is contemplated to light the principal streets by electricity. The pay offered is 500 rupees per month, rising to 750 rupees per month, but the Corporation would give the maximum amount at once to an exceptionally qualified man. A month's leave on full pay is given each year, and long leave (for absence from India) is given periodically. Applications have to be lodged with Mr. P. N. Mookerjee, Secretary to the Corporation, by May 3.

TANTALUM LAMPS ON CARS.

In reference to a note by our Berlin correspondent, referring to the use of Tantalum lamps on German railways, Messrs. Siemens Brothers Dynamo Works, Ltd., write to point out that these lamps are largely used on British railways. This has been so on the Great Northern & City Railway for some time past.

ELECTRICAL ENGINEERS TERRITORIALS (London Division).—Orders for week ending April 16: Monday, April 11, "A" Company, Technical Drill, 7 to 9.30 p.m.; Tuesday 12, "B" Company, Infantry Drill, 7 to 8 p.m., Technical Drill, 8 to 10 p.m.; Wednesday 13, Gymnasium, 6 to 9.30 p.m.; Thursday 14, "C" Company, Recruits' Infantry Drill, 6.30 to 7 p.m., Technical Drill, 7 to 9.30 p.m.; Friday, 15, "D" Company, Recruits' Infantry Drill, 6.30 to 7 p.m., Technical Drill, 7.15 to 9.30 p.m.—(Signed) P. H. CAMPBELL, Capt. R.E., Adjutant.

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ELECTRIC BRAKING ON GLASGOW CORPORATION TRAMCARS.*

By A. GERRARD, A.M.I.E.E.

There are many points in connection with the operation of electric tramway cars which are of interest, not only to the management of the undertaking, but also to the general public. However, there is, in our opinion, no point of so much interest and importance as that of braking the car. This interest is, unfortunately, kept alive by an occasional car getting out of the motorman's control. It is, therefore, hoped that this subject will not be out of place at this time. It is usual in a paper such as this to touch upon the history of the subject, so it is proposed to show the progress of braking since 1898, so far as it pertains to our own experience in connection with the operation of the tramway system belonging to the Corporation of the City of Glasgow. It may be mentioned at this stage that all the statistics which it is intended to put before members have been obtained from the tramway undertaking referred to, under our own personal observation.

Electric street traction was inaugurated in Glasgow in the autumn of 1898, the track from Mitchell-street to Springburn being equipped as an experiment. At that time the electrical equipment on the cars was partly British Thomson Houston and partly Westinghouse. The controllers were arranged for electric braking, as recommended at that time by these firms.

Rheostatic Brake.

The brake, as arranged by the Westinghouse Co., was what is now known as the rheostatic brake, and was simply a circuit which included the armatures, field coils and rheostat. The rheostat was gradually cut out as the car slowed down until the motors, which were working in parallel, were short-circuited on themselves.

Electromagnetic Disc Brake.

The British Thomson Houston brake was composed of two sets of discs per car, one set of discs or the brake for one axle comprised one revolving and one stationary disc. These discs were about 22 in. in diameter, and their adjacent faces were machined for rubbing against each other, and setting up friction which assisted in retarding the car. The revolving disc, known as the brake disc, was keyed to the axle, and the stationary or rather unrevolving disc, known as the brake-shoe, was supported on two lugs projecting from the motor case. The brake-shoe, although prevented from revolving could, when magnetically attracted, travel across the truck and make contact with the brake disc. There were embedded in each brake-shoe two magnet coils, which formed part of the electric brake circuit, so when the brake was applied to a moving car, the shoes became magnetised, and drew themselves into mechanical contact with the revolving brake discs. The car was, therefore, retarded electrically through the work done by the motors acting as generators, magnetically by the revolving brake disc cutting the field, and mechanically by the adhesion of the machined faces of the brake-shoes to the brake discs. The brake-shoes, being necessarily thick to receive the magnetic coils, were heavy and rather difficult to attract to the revolving brake disc. They were not suspended in any way in order to allow them to move freely, but simply lay on the lugs projecting from the motor case. It will be readily seen that they were of little use for braking the car if the current was light, as, for instance, in coasting† or at the beginning of a service stop. They only did their work when a very heavy current was passing through the equipment, and when they did act, the result was so severe that skidding of the wheels usually took place. The equipment was also complicated since in starting up on the power side it was necessary to shunt a portion of the trolley current through the magnetic coils of the brake-shoes in the opposite direction, in order to demagnetise them and allow the car to accelerate. Ten years have passed since this type of brake was used in Glasgow, so we are unable to say more about them, as they were removed from all the cars thus equipped, which were then simply connected up for rheostatic braking.

Electromagnetic Track and Wheel Brake.

About this time, 1899 and 1900, Mr. F. C. Newell, an American railway engineer, invented and patented what is known as the Newell brake. The design of this braking apparatus is very ingenious, and was a great stride in the right direction. The component parts of this brake are :—

1. Two powerful electromagnets, one suspended over each rail. To each magnet is fitted two mild steel track-shoes, one to each pole. The magnetic circuit is completed through the core of the electromagnet, the track-shoes and the rail, while the coils of the electromagnets are energised by current from the motors when acting as generators. The two magnets are connected in parallel, so that all the current which is generated by the motors is equally divided between them.
2. Special wheel-shoes which have no connection with either hand brake-shoes or rigging.
3. Connecting rods and levers between the track magnet and the wheel-shoes, so arranged that any movement of the magnets either forward or backward will apply the wheel-shoes to the wheels.

The track magnets are each suspended from the truck frame by two spiral springs, and their shoes are adjusted to within $\frac{5}{16}$ in. of the rail. The action of the brake is as follows : When it is applied on a moving car, the magnets immediately adhere to the rail and drag, falling behind their normal or central position on the truck. This backward motion or lag is utilised to apply the wheel-shoes through the medium of the connecting rods and levers. The magnets lag behind their normal position until all the slack motion has been taken up, and the wheel-shoes are tightly pressed against the wheels. Thus, with this type of brake there are three powerful agencies at work, all assisting to retard the car :—

(*a*) The electrical work performed by the motors acting as generators.
(*b*) The drag on the rails by the track magnets.
(*c*) The friction set up by the special wheel-shoes.

Leverage.

The leverage exerted on the shoes of the leading wheels is in the ratio of 3·346 to 1, whereas the leverage on the shoes of the trailing wheels is only in the ratio of 2·175 to 1. This unequal division of the leverage is designed to compensate for the unequal distribution of weight between the leading and trailing wheels when a fast stop is being made, or even when stopping slowly on an incline ; for it will readily be seen that when a fast stop is being made, or when coasting down an incline, very much more than half the weight of the car is thrown upon the leading wheels, so a greater leverage can safely be applied to them without fear of skidding than can be applied to the trailing wheels, which are carrying less than half the weight of the car.

In the spring of 1901 the Glasgow Corporation Tramway Department equipped six cars with this type of brake. Some rough tests were then made to find out what it could do. The officials of that time bestowed most of their attention on the capabilities of the brake to make quick stops, and did not pay so much attention to the electrical work thrown upon the motors as has been done of late. However, they were satisfied that the motors were required to do very much less work than in braking through the rheostat only, and the risk of skidding the wheels was thereby reduced. So pleased were they with the performance of the brake that within a very short time every passenger car on the system was equipped with the apparatus.

Damage to Equipment.

The brake question then lay dormant for some time, until we began to discuss the probable cause of the damage to some of our armatures, controllers, etc. The concensus of opinion was that the use or abuse of the electric brake was responsible for the bulk of the damage referred to, and we accordingly endeavoured to prove our contention. A few rough tests were, therefore, made to find out the voltage across the armature terminals when the brake was applied, and it was found that when running at 18 to 20 miles per hour with 10 ohms in the brake circuit, the voltage was as high as 1,000 to 1,200. Those figures were taken roughly, but were in themselves quite sufficient evidence that some alteration would require to be made in order to prolong the life of the equipments. It may be mentioned here that the motors are built to operate at 600 volts maximum, so they could scarcely be expected to generate heavy currents at double that voltage without being damaged and occasionally burned out.

* Abstract of paper read before the Institution of Electrical Engineers.

† *Coasting* by means of the electric brake means that the controller handle is set on the first, second, or third braking-point, according to the gradient, and the brake is then allowed to take care of the car.

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Skidding.

Another interesting point was demonstrated by these rough tests, viz., that 17 to 18 miles per hour was the critical speed at which skidding took place, that is to say, with an equipment such as is installed in Glasgow (namely, cars weighing 10 to 11 tons unloaded, equipped with Westinghouse 49B motors, and a resistance of 10 ohms in circuit with first braking-point), momentary skidding took place when the brake was applied even on a level clean rail. It was, therefore, quite evident, both from a braking-point of view and from a desire to protect the equipment, that the voltage should be reduced. It is well to point out that skidding the wheels by the hand brake differs from skidding by the electric brake. If the wheels are skidded by the hand brake they do not revolve again until the brake-shoes are released; therefore, to skid wheels by the hand brake means to skid continuously. It is, however, impossible to skid wheels continuously by the action of the electric brake, as immediately the wheels cease to revolve the current dies away, and they are free to revolve again until such time as the current generated by the machines is sufficiently heavy again to cause skidding. Skidding by means of the electric brake can only be intermittent, but if the speed of the car be high enough, the movement of the wheels between the skids will be so slight as to be almost imperceptible. We then considered the various ways of reducing the high voltage, and decided to weaken the field by introducing a shunt resistance in parallel with same.

Solenoid Controlled Fields.

In January, 1908, we began experimenting with a permanent shunt resistance in parallel with the fields when braking, but that idea had to be abandoned, because when a low resistance, such as 0·25 ohm, was inserted in the shunt circuit, the motors would not excite, while on the value of the shunt resistance being increased to 0·5 ohm, the braking effect was improved and the voltage kept low, but the machines would not excite quickly enough for an emergency stop. Our next move was to introduce the shunt automatically, as required, by means of a solenoid operated switch. This turned out to be the proper course to follow. A brief description of our initial experiences with the solenoid control apparatus may perhaps be of interest. We started with the solenoid operated by a shunt coil, and connected the coil across the terminals of one of the armatures. At first the solenoid had a lift of 2 in. When its armature rose, it closed a circuit which was in parallel with the fields, and in which there was inserted a low resistance. This operated, but not with entire satisfaction, and we soon found that the time lag between the exciting of the machines and the closing of the shunt circuit was too great. This time lag must be very small, otherwise the shunting arrangement is of no use, as the voltage rise occurs before the solenoid operates. So the coil of the solenoid was gradually weakened, and the lift of its armature reduced, until we finally determined that the lift should not exceed $\frac{7}{16}$ in. The next point to decide was whether the coil operating the solenoid should be in shunt to an armature or in series with the main brake circuit. After very exhaustive tests, it was conclusively proved that the series coil in the main brake circuit was the more reliable and instantaneous in action; and it also had the advantage of keeping the armature of the series operated solenoid switch in contact until the car actually came to rest, and the current flowing through the circuit had almost died away, so that when the plunger dropped and opened the shunted circuit of the fields, there was practically no arc. In the case of the shunt-operated solenoid, whenever the voltage began to fall, the solenoid dropped its plunger while there was still a comparatively heavy current passing across the solenoid switch. The next two points to be decided were at what current the solenoid should operate and the value of the shunt resistance. After very exhaustive experimenting it was found that when the solenoid operated with 30 amperes and brought in a shunt resistance of 0·2 ohm we had complete control of the voltage, at least up to 20 miles per hour, without impairing the effect of the brake. The voltage never rose above 600, and, of course, there was no skidding. The next question to be considered was whether this shunt arrangement with the solenoid operating at a comparatievly low current would save the motors and prevent skidding in an extreme case of high speed, such as might occur if a motorman at the top of a gradient unskilfully applied the hand brake, thereby skidding the wheels and allowing the car to attain a speed of 25 to 30 miles per hour, and then realised that the proper course to adopt was to release the hand brake and apply the electric brake. As it was not convenient or advisable to carry out tests at those high speeds on the public highway, it was deemed wise to make the solenoid double barrelled. The low-speed solenoid operated at 30 amperes, bringing in a shunt resistance of 0·2 ohm, and the high-speed solenoid at 80 amperes, bringing in another shunt resistance of 0·2 ohm in parallel with the first. In the event of a motorman running his car at, say, 18 miles per hour, and, through excitement or carelessness, passing over the first on to the second brake-point of his controller, both solenoids will operate, and thereby bring a shunt resistance of 0·1 ohm in parallel with the fields. This gives the very best results without skidding. It may be mentioned that with this double solenoid control the voltage never rises above 600, no matter what the speed may be.

Track Magnets (New Design).

In order that the very best braking results might be obtained in conjunction with solenoid control, two sets of more powerful track magnets were tested. They are listed by the Westinghouse Co. as 26C and 25B magnets. The following tabulated list gives the vertical pull in lbs. weight at 5, 10, 25, and 50 amperes:—

Vertical Pull of Different Magnets.

Type of Magnet.	Exciting Current in Amperes.			
	5.	10.	25.	50.
	Lbs. Weight.	Lbs. Weight.	Lbs. Weight.	Lbs. Weight.
Standard 21 ..	1,050	1,300	1,600	1,800
,, 26C ..	2,400	3,250	3,900	4,100
,, 25B ...	1,900	3,550	4,600	5,150

These new magnets are quite different in design from the old Newell magnet, on which the poles follow each other in series on the rail. On the new type the poles are placed side by side and parallel to each other. The invention of the new type of magnet marks a most important advance in electric braking, for not only does it give a far greater maximum pull, but its effect with a current of 5 amperes is greater than that of the old magnet with 50 amperes. The difference in the heating of the motor is most important.

The preceding remarks have been of a general nature, and no detailed figures regarding braking have been given, but data will now be given which was obtained from actual tests on the tramway track, showing the action of the various track magnets when controlling a car on a gradient unassisted by any wheel-shoe combination, also their action when combined with wheel-shoes and with auxiliary track-shoes.

Coasting.

For coasting tests two gradients were chosen, one 200 yards long, with an average fall of 1 in 27 being selected as the easy gradient, while the heavy gradient was 100 yards long, with an average fall of 1 in 13.

In the coasting tests, the general plan was to run first with the rheostatic brake only, and to use the values so obtained as standards to which the values obtained from the other tests could be compared. The following tests were made:—

Test A.—Easy gradient.
- Rheostatic brake, car No. 438.
- No. 21 magnet without wheel-shoe attachment, car No. 438
- No. 26C magnet without wheel-shoe attachment, car No. 438
- No. 25B magnet without wheel-shoe attachment, car No. 438

Test B.—Heavy gradient. Same as for Test A.

Test C.—Easy gradient.
- Newell brake with No. 21 magnet, car No. 368.
- Newell brake with No. 26C magnet, car No. 687.
- Newell brake with No. 25B magnet, car No. 438.
- 1908 brake with No. 25B magnet, car No. 782.

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Test D.—Heavy gradient. Same as for Test C.

Test E.—Heavy gradient. With and without solenoid control, car No. 438.

In Tests A and B car No. 438 was used. It is a top-covered car with 17 ft. body, and seating accommodation for sixty-two passengers. During these tests a drag chain was fixed between each magnet and the truck in such a way as to permit the magnet to move towards the rail, but to prevent it from operating the wheel brake.

The average current required to control the car on the easy gradient is as follows :—

COASTING TEST.—EASY GRADIENT, RHEOSTATIC *versus* TRACK BRAKE ONLY.

Type of Brake.	Amperes.	Percentage.	Per cent. Decrease.
Rheostatic only ..	36·72	100·00	—
Standard 21 magnet ..	23·66	64·43	35·57
Standard 26C magnet ..	8·94	24·34	75·66
Standard 25B magnet ..	8·00	21·78	78·22

In the above test the 25B magnet was slightly superior to the 26C. It may be mentioned here that in calculating the average amperes and volts, the readings from the initial surge are always neglected.

The average current required to control the car on the heavy gradient is as follows :—

COASTING TEST.—HEAVY GRADIENT, RHEOSTATIC *versus* TRACK BRAKE ONLY.

Type of Brake.	Amperes.	Percentage.	Per cent. Decrease.
Rheostatic only ..	63·27	100·00	—
Standard 21 magnet ..	49 66	78 48	21·5
Standard 26C magnet ..	34·25	54·00	46·0
Standard 25B magnet ..	25·25	39·90	60·1

During this test the 25B magnet again gives the best results, but later on it will be seen that when the combination wheel-shoes are doing their share of the work, and the current passing through the equipment is thereby reduced, the 25B magnet must share the honour with the 26C, which is the more efficient when the current is low.

COASTING TESTS ON COMBINATION TRACK AND WHEEL BRAKES.

As it was impossible to test all the various combinations on one car, three other cars were used along with car No. 438, namely, Nos. 368, 687, and 782. The bodies and electrical equipment of the four cars are similar. Their rheostats were all set alike, so that the value of R_4 and R_5, the braking-points while coasting, were respectively 6·8 and 3·8 ohms.

BRAKE-GEAR.

The brake-gear fitted to the different cars was the following :—

Car No. 368, mounted on an ordinary Brill single truck with steel-tyred wheels, was equipped with the Newell brake-gear operated by the old standard 21 magnets.

Car No. 687, mounted on an ordinary Brill single truck with steel-tyred wheels, was equipped with the Newell brake-gear, operated by the new standard 26C magnets.

Car No. 438, mounted on a Mountain and Gibson radial axle truck, was equipped with the Newell brake-gear, operated by the new standard 25B magnets, the brake rigging being designed to operate the hand-brake shoes.

Car No. 782, mounted on an ordinary Brill single truck with steel-tyred wheels, was equipped with a different type of brake, which will be referred to throughout this paper as the 1908 brake. It was placed upon the market during the year 1908, so is of the very latest design. The magnets used were identical with those used on car No. 438—namely, Westinghouse 25B—and the brake rigging was very similar, the only radical difference being that the motion obtained from the movement of the magnets was utilised in pressing auxiliary track-shoes down on the rail, instead of applying auxiliary wheel-shoes. The idea of substituting auxiliary track-shoes in place of wheel-shoes was to relieve the wheels of the braking effort of the auxiliary wheel-shoes, and thereby reduce the risk of skidding when making fast stops.

Test C: Coasting Tests—Combination Brakes.—The average current required to control the various cars on this gradient was as follows :—

COASTING TEST.—EASY GRADIENT, RHEOSTATIC *versus* COMBINATION BRAKES.

Car No.	Type of Brake.	Amps.	Per-centage.	Per cent. Decr'se.
Average	Rheostatic only ..	36·00	100·00	—
368	Newell and Standard, 21 magnet	12·66	35·10	64·90
782	"1908" and Standard, 25B magnet	10·50	29·10	70·90
438	Newell and Standard, 25B magnet	7·44	20·66	79·34
687	Newell and Standard, 26C magnet	3·47	9·64	90·36

This test very forcibly illustrates the superiority of the standard 26C magnet when the current is low. When the current falls below 8 amperes per magnet the 26C becomes the most efficient.

Test D.—The average current required to control the various cars on this gradient was as follows :—

COASTING TEST.—HEAVY GRADIENT, RHEOSTATIC *versus* COMBINATION BRAKES.

Car No.	Type of Brake.	Amps.	Per-centage.	Per cent. Decr'se.
Average	Rheostatic only ..	63·00	100·0	—
368	Newell and Standard, 21 magnet	30·10	47·7	52·3
782	"1908" and Standard, 25B magnet	21·00	33·3	66·6
438	Newell and Standard, 25B magnet	13·60	21·6	78·4
687	Newell and Standard, 26C magnet	13·28	21·0	79·0

The initial voltage for any of the cars during this test was very low when the nature of the gradient is considered. The reason for this is that after starting with power the machines require less time to excite than after starting from rest without power, as was the case on the easy gradient tests.

Test E: Coasting under Solenoid Control.—Attention may now be drawn to the beneficial effect of the solenoid control in coasting on the steep gradient where the current occasionally exceeds 30 amperes and so causes the solenoid to operate. Under solenoid control the initial surge is checked, the voltage being reduced from 210 to 175, and the back-kick is less pronounced, being 25 against 15. The whole reading of the curves plotted is more uniform throughout, the number of complete waves being reduced from 8 to 6, the average voltage of the three readings reduced from 82·1 to 65·8, and the amperes from 17·0 to 13·6, while the average time taken to descend the gradient is also reduced from $47\frac{1}{5}$ to 46 sec.

SURGING WHILE COASTING.*

Before leaving the subject of coasting it may be mentioned that great trouble was experienced with surging. The trouble is attributable to various causes—chiefly to the track magnets being too powerful for the weight of the car, to the high leverages between magnets and brake-shoes, and to the track-shoe suspension springs being too strong. Coasting on the rheostat alone is ideal so far as smooth riding is concerned, but it is too costly. A car will coast down an incline on the rheostat as steadily as it will ascend the incline on power, but immediately powerful track

* Surging while coasting means that the car does not run steadily down the incline, but is allowed to accelerate until the brake acts, when it is pulled up almost to a standstill. The brake then releases its hold and allows the car again to accelerate, and so on.

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magnets are introduced surging more or less will assuredly be set up. Regarding car No. 438, the trouble with it was caused by the powerful magnets operating on a weak truck. The radial-axle truck which was carrying this car body had no stability—that is to say, the magnets through the brake rigging could work the truck out and in like a concertina, and thereby aggravate the surging effect. A good coasting combination can only be obtained with a truck, the wheel base of which cannot be extended or contracted by the leverage of the brake rigging. It is, therefore, quite evident that on a truck of this kind we cannot have a powerful brake and a perfect coasting brake in one, so a compromise must be arranged. We must put up with the discomfort of a little surging while coasting on heavy gradients in order to have a powerful brake for making fast stops.

Brake Stop Tests.

Brake stops are of two kinds, service and emergency. A service stop is one made by the motorman when he has plenty of time to do so properly, the controller handle being passed slowly over the braking-points, thereby calling upon the motors to do as little work as possible. An emergency stop is a stop made by the motorman in as little time and in as short a distance as possible irrespective of the work the motors are called upon to perform. It was not considered necessary to carry out the brake stop tests at low speeds, so that attention was confined to moderately high speeds, such as 17, 18, and 19 miles per hour. The tests were all made in the daytime on a service track between a car depôt and the main line, on which we could carry on our work undisturbed. There is an average fall of 1 in 108 on this piece of track. All the tests were carried out in the following manner: For tests at 17 miles per hour the cars were started from point A_1 and run at full speed until point B was reached, where the power was switched off, and then 20 yards further on at point C the brake was applied. For tests at higher speed a fresh starting-point (A_2) was located, from which 18 miles per hour was attained. Then A_3 was located to give 19 miles per hour. Points B and C were never changed. To determine the speed at which the car was travelling when the brake was applied the following method was adopted. Before the brake was applied the time which the car required to travel over the last 30 yards was checked by stop-watch. Over these 30 yards the car thus ran 10 yards with power and 20 yards without power. Many preliminary tests were made with various cars and various arrangements of magnets, leverages, and solenoid settings, but it will be sufficient to indicate only the results of the final test between car No. 782, equipped with the 1908 brake-gear, operated by 25B magnets, and car No. 687, equipped with Newell brake-gear, operated by 26C magnets under solenoid control. The two cars are alike in general construction and equipment, both being top-covered cars with 17 ft. bodies and Brill trucks. Car No. 782 weighs 2½ cwts. more than car No. 687. This is accounted for entirely by the difference in weight of the two brake equipments. The state of the rails when the test began was perfect. In order that the test should be carried out in absolute fairness to both cars so far as the condition of the rail was concerned a special car fitted with emery blocks for grinding out rail corrugations was put on the test track and run up and down for a period of three or four hours immediately before the test was begun, so it may be assumed that the first car on the track had as perfect a rail as the second. Throughout the test no sand was dropped on the rail to assist retardation. At each speed three service stops and three or four emergency stops were made. When making service stops at the various speeds, it was our endeavour to make every stop in the same distance—as, for instance, at 17 miles per hour, 60 ft. was the distance aimed at; 18 miles per hour, 70 ft.; and at 19 miles per hour, 85 ft.—in order that we could compare the electrical energy required by the different braking combinations in making similar stops. When making emergency stops, the motorman, of course, pulled up the car in the shortest possible distance. The same motorman and recording staff were engaged throughout the entire test.

Result of Tests.

On comparing the stops at 17 miles per hour we find the following:—

Service Stops at 17 Miles per Hour.

Car No.	Stop distance.	Maximum volts.	Maximum amps
782	60 ft.	875	110
687	57 „	475	70

Emergency Stops at 17 Miles per Hour.

Car No.	Stop distance.	Maximum volts.	Maximum amps
782	34½ ft.	875	190
687	36·0 „	475	140

The emergency stops of car No. 782 at this speed are rather better than those from car No. 687, but at what cost? The last reading from car No. 782 is 33 ft., which works out at a retardation in ft. per sec. per sec. of 9·44, and when corrected from gradient to level gives 9·69, which is exceptionally high; but, unfortunately, we cannot compare the voltage readings obtained during this test with those obtained from car No. 687 under similar conditions, because the machines flashed over before the voltmeter had time to indicate the true maximum voltage. Turning now to service stops at 18 miles per hour, we find that car No. 782 always skids once, and sometimes twice, during every stop, whereas car No. 687 shows no signs of skidding.

Service Stop at 18 Miles per Hour.

Car No.	Stop distance.	Maximum volts.	Maximum amps
782	70½ ft.	1,025	200
687	70½ „	525	90

On comparing the emergency stops at this speed, we find car No. 687 making, if anything, the better stops, the last reading, 44 ft., indicates a retardation of 8·18 ft. per sec. per sec., when corrected to level. As regards car No. 782, the only test where the true voltage has been recorded is the first, the 52½ ft. stop, so we might compare the readings taken from it, during this stop, against the readings from car No. 687 during a similar stop.

Emergency Stops at 18 Miles per Hour.

Car No.	Stop distance.	Maximum volts.	Maximum amps
782	52½ ft.	1,125	165
687	52½ „	535	150

Retardation.

Regarding the brake on car No. 782, it has been conclusively proved by our tests that it can bring a car to rest in an extremely short distance, but from observation made during the tests, we are of the opinion that the retardation throughout an emergency stop is the reverse of uniform, being very low at the beginning and extremely high towards the end of a stop—in fact, so high that sitting passengers are hustled along the seats. Retardation to this extent would very soon ruin the framework of a car body, and create no end of claims from injured pasesngers. What is wanted is uniform retardation throughout the stops. Retardation from car No. 687, in our opinion, was perfectly uniform throughout the most severe emergency stops, being as high at the beginning as at the end of the stop. It was found that it makes very little difference in the voltage whether the controller is properly handled or not, as on every occasion of making emergency stops two tests were carried out, making use of all the braking-points, and other two when the first braking-point was passed over. From the foregoing particulars it seems quite evident that the double solenoid can protect the equipment, and at the same time improve the braking of the car.

Heating Due to Braking.

A tramway or railway motor is usually selected with reference to the work it has to do in propelling the car, with little regard to the extra work which is thrown upon it when braking. It is, therefore, often urged that, since a motor usually operates at a fairly high temperature under normal conditions, the extra load thrown upon it by electric braking is certain to produce more or less rapid deterioration of the

insulation. This argument is, undoubtedly, a sound one where rheostatic braking is used, and it may apply also with the earlier types of magnetic brakes, especially if the motor is hard wrought under normal service conditions. When the insulation of the motor has been thus weakened, and is subjected to the heavy overloads and excessive voltage which occur in braking at high speeds, there is little wonder that trouble results. But with the latest type of track magnet the current taken from the motors is a very small percentage of that required for rheostatic braking, and when it is remembered that the heating varies as the square of the current, it becomes evident that the increased heating due to braking with this type of magnet is practically nil. If, in addition, the motor fields are provided with solenoid operated shunts, excessive voltage cannot occur, and the objections to the use of the motors for electric braking have been removed.

SUMMARY.

(*a*) Rheostatic braking is destructive in its action on motors, due to the added heating effect from the high braking currents, and to the excessive voltage generated by the motors acting as generators during service and emergency stops at high speeds. This high voltage causes flashing at the brushes and insulation breakdowns. Rheostatic braking permits smooth coasting, but the current is high, and skidding occurs when braking at high speeds. The retardation is much lower than with the magnetic brake.

(*b*) The Newell brake with the old type of magnet is greatly superior to the rheostatic brake, both in retarding power and in the current consumption, but the current is still high; the voltage generated by the motors during high-speed braking is excessive, and skidding occurs unless the controller is handled with great care. While much easier on the motors than the rheostatic brake, it is severe enough under the best conditions, and when not carefully handled is responsible for a large part of the trouble with motors and controllers.

(*c*) The 1908 brake, with auxiliary rail blocks and parallel shoe magnets, is a powerful one, and requires comparatively little current from the motors, but the voltage rise is excessive, and the skidding serious when braking at high speeds, while the surging during coasting is prohibitive. The retardation obtainable is very high but very uneven, probably due to the tendency of the track blocks to grip the rails. The excessive voltage rise might be reduced by means of the solenoid control, but it seems doubtful whether skidding and uneven retardation would be prevented.

(*d*) The Newell brake with parallel shoe-magnets requires little current from the motors, gives good results when coasting, and high retardation under ordinary braking conditions, but the voltage generated by the motors when braking at high speed is excessive, and with emergency stops from high speed, skidding may occur if the controller is not properly handled. This brake is much easier on the motors than the Newell with the old type of magnet, on account of the decreased current required, and for the same reason it is better than the 1908 brake. It would be quite satisfactory were it not for the high voltage and the skidding at high speeds.

(*e*) The Newell brake with parallel shoe-magnets and solenoid controlled shunts to the motor fields possesses all the advantages of the brake described under (*d*), while the possibility of obtaining high voltage on the motors is eliminated and there is no longer any necessity for careful manipulation of the controller to prevent skidding. Exhaustive tests have shown the brake to be skid-proof and the motors to be free from any excessive voltage rise, and it is hoped that actual experience at Glasgow will entirely confirm these tests.

CONCLUDING REMARKS.

From actual experience gained, the author is of the opinion that automatic solenoid control of the field, such as has been described, is a valuable addition to the brake-gear of an electric car. It is an everyday occurrence in the life of a tramcar driver to get into a tight corner and have no time to apply his electric brake in the proper manner, notch by notch. Even if he has time, he is sometimes too excited to do so, and passes over the first point or two, with the result that he skids the wheels. He then operates his sand valve, and trusts that the sanded rail will save him from collision. It may be of interest here to point out that the Glasgow Corporation Tramways Department is at present engaged in fitting to each car an automatic sanding apparatus, the component parts of which are a solenoid and a continuous flow sand valve. The coil of the solenoid is inserted in the main braking circuit, and its armature is connected to the continuous flow sand valve, so that, when the solenoid operates, the sand valve is opened, and a copious supply of sand is projected on the rail without any effort from the motorman. A spiral spring is attached to the valve in such a way as to work against the action of the solenoid, and adjusted so that if the electric brake is applied for an ordinary service stop, or for coasting, the solenoid is prevented from opening the valve and serving out sand when it is not required; but in the event of the motorman making an emergency stop, the current flowing through the circuit is sufficient to operate the solenoid and automatically to supply sand at a most opportune moment.

LARGE UNITS AT HIGH SPEEDS.

Mr. J. T. Irwin has favoured us with an extended note of his remarks on the adjourned discussion on Mr. Walker's two remarkable papers. Mr. Irwin said that the author appeared to have only considered the forces due, the mutual attraction of the coils, and had not taken into account at all the forces due to the stray field. He was not sure of the exact figure, but he believed that at full load the ampere turns on the armature per pole were about 10,000, if the field ampere turns were three times as great, they then got 30,000 field ampere turns. When a short circuit took place, at the first moment the field strength remained the same as before, but since the current in the armature is now twenty times as great and the current lags 90°, the back magneto-motive force is about 200,000, which mean that the forward ampere turns must be 230,000. These turns were supplied by the current in the pole tip. If they had the back M.M.F. twenty times as great as before, and the forward ampere turns were then 230,000 as against 30,000 at normal load, then we had the magnetic potential at the pole tip at least seven times as great as it was before, which meant that the strength of the leakage field was at least seven times as great, so that if under normal running conditions the strength of the stray field is 1,000 lines per sq. cm., under short circuit conditions it would be a least 7,000. The force due to this stray field on three conductors, each carrying 10,000 amperes, is about 1,400 lbs. per ft. run, or about 25% greater than that due to the mutual action of the coils. If the stray field in normal running is anywhere equal to 1,500, as it might be with a 2 in. air gap, the stray field at short circuit will be 10,500, and the forces on the conductors would be about one ton per foot run. This force is additional to and not in substitution for the force mentioned by the author. The force will be alternating in direction as the coil passes from pole to pole, and thus would easily account for pieces of wood being splintered up. The force due to the mutual action of the coils is always in the same direction.

ELECTRIFICATION OF THE MONT CENIS RAILWAY.

Special exertions are being made to get the electrification of the line complete in time for the opening of the Turin International Exhibition of 1911. As in the case of the Simplon, a commencement will be made with engines using a 3,500 volt, 15-phase rotary current, formerly used on the Giovi line. The power will be got very cheaply form the Turin water power works. These give a 50,000 volt, 50-phase current, which will be transformed underground at Bardonneche. This underground station is of special interest, as it is the first large example of its kind in Europe, and also because it is proposed to compensate for the variations in the demand for power due to the fact that the trains are run but unfrequently, by employing phase regulators and very heavy flywheels, instead of using accumulators and transformers of rotary into direct current.

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Business Notes and News.

LIGHTING AND GENERAL—Home.

ARDROSSAN.—A Board of Trade inquiry into an application by Mr. George Balfour, London, for a Provisional Order to supply electricity for lighting and power purposes within a district embracing the burghs of Ardrossan and Saltcoats, and the Special Lighting District of Stevenston, was held in the Town Hall, Ardrossan, recently. Formal objections were lodged by Messrs. Nobel's Explosives Co., Ardrossan Harbour Co., the Caledonian and the Lanarkshire and Ayrshire Railway Cos., the Glasgow and South-Western Railway Co., and the Glengarnock Iron and Steel Co. The Town Council also objected as owners of the local gas undertaking. An agreement was come to between the promoter and Nobel's Co., the railway companies, the Harbour Co., and the Glengarnock Co. With regard to the municipal opposition the Commissioner said he could not recommend the Board of Trade to refuse the application merely because the promoter would enter into competition with the Corporation of Ardrossan.

BUNDORAN, IRELAND.—Messrs. John Miles & Co., of Ballyshannon, who have for some years supplied the electric lighting and power for the public lighting of Ballyshannon, are extending their system to Bundoran. On Easter Monday, the work commenced in connection with the cutting of the ground for the purpose of laying the mains to connect the town of Bundoran with the works of Messrs. Miles. The required cables are already delivered, and it is expected that the houses in Bundoran and the public thoroughfares will be illuminated by the most up-to-date method during the coming summer. Already fittings have been placed in some of the houses in Bundoran in anticipation of the new illuminant, the *Central Hotel*, better known as Sweeney's, which is the property of Mr. Gorman, being completely wired and all in readiness for connection with the main from Ballyshannon when it is laid.

DUBLIN.—The South Dublin Board of Guardians have provisionally accepted the offer of the Dublin Corporation to supply electricity for the lighting of the Workhouse at 3d. per unit, this arrangement to be subject to the approval of the Local Government Board. Mr. Raymond suggested that there should be a contract entered into with the Corporation for three years, as by doing so the Board would get the electric light at 3d. per unit instead of 4½d., which, according to Mr. Allan, Secretary of the Electric Lighting Committee, would be the price charged by the Corporation at the end of the month.

EDINBURGH.—The Electric Lighting Committee have recommended the erection of three cooling towers at the Dewar-place electric power station, and recommended that they be put up. It is calculated that the result will be a saving of £10,000. The towers will be of ornamental pattern. The towers will allow the output to be increased from 7½ to 11 million units.

LEEDS.—A letter has been received from the Postmaster-General stating that provision would be made in the coming Estimates for a beginning to be made with an underground telegraph cable from Leeds to Hull.

LONDON (City).—Electricity has replaced gas at St. Giles, Cripplegate, the church being illuminated by the new method for the first time on Easter Sunday.

LOWESTOFT.—The putting into commission of the new 400 h.p. steam engine at the Corporation Electricity Works was made the occasion of a social function, Mr. G. A. Bruce, M.I.E.E., being anxious to bring the advantages of electricity prominently under the notice of ratepayers.

MAIDSTONE.—The following new tariff has been adopted as from April 1:—(1) For shops, licensed and business premises, in the case of old customers, 10s. per annum for each 32 watt lamp alight at one time or a flat rate of 4d. per unit, and in the case of new customers 10s. per annum for each 32 watt lamp alight at one time, or a flat rate of 8d. per unit. (2) For private houses 8s. per 32 watt lamp per annum alight at one time or (if preferred by the customer) 4d. per unit as at present. N.B.—A 32 watt lamp is equal to a 25 c.p. metal filament lamp or an 8 c.p. carbon lamp (old style).

ST. HELENS.—Application is to be made by the Corporation to the Local Government Board for powers to borrow £3,930 to carry out extensions to the electricity works, boiler house and plant, the supply and fitting of mechanical stokers and elevators, and the erection of water softening plant. A further application is also to be made to borrow £6,300, the estimated cost of the extensions of the high tension plant.

TORQUAY.—The whole scheme of street lighting is to undergo re-organisation.

LIGHTING AND GENERAL—Overseas.

CALCUTTA.—In order to meet the demand for power in the presses and riverside warehouses at a fair rate, the Calcutta Electric Supply Corporation are arranging for the transmission of energy from their Ultadanga station in the north of the town at 6,000 volts. Step-up transformers being used at the power station.

CALCUTTA.—The Director-General of Commercial Intelligence notifies that a scheme is under consideration for deriving electrical energy from the falls of the Bari Doab canal, in the Punjab, for the following purposes:—(1) driving the machinery of the canal workshops at Amritsar; (2) working pumps for raising water from the subsoil for irrigation purposes; (3) working the pumping plant of the Amritsar water works; (4) pumping operations connected with the disposal of sewage. The names of persons interested in the scheme may be obtained by British firms on application to the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, London, E.C.

DACCA, EASTERN BENGAL.—Messrs. Octavius Steel & Co. have applied for a licence to the Government of Eastern Bengal and Assam under the Indian Electricity Act for the supply of energy to the public for the purposes of general supply, and to particular consumers under special agreements within the limits of the new Dacca Civil station and a portion of the adjoining area. The generating station will be within the area of the supply.

MEXICO.—A contract has been entered into between the Mexican Government and Señor Manuel Tamborrel, empowering the latter to utilise the waters of the river Conchos, in the District of Hidalgo del Parral, State of Chihuahua, to an extent not exceeding 4,000 litres per sec., for irrigation and motive power purposes. The concession is for a period of 20 years. The concessionaire engages to commence operations within 24 months, and to complete the work in five years. He is granted the right to import free of duty, once only, all the machinery necessary for executing the work, and is further authorised to construct any bridges, electric power conductors, telegraph and telephone lines that may be required.

PARIS.—Telephonic communication has now been established with Vienna. Very shortly extensive inter-communication will be opened between the French and Spanish telephone systems. The following towns will be in direct connection: Irun, St. Sébastian, Tolosa, Pampeluna, Saragossa, Madrid, Lérida, Iqualada, Martorella, Tarragona, Reus, Barcelona, Gerona.

SIMLA.—Final estimates for the hydro-electric scheme show that the whole cost of the project will come to about 9½ lakhs of rupees.

ST. PETERSBURG.—The Central Telephone Administration have obtained permission from the municipal authorities to use a sum of 2,835,000 roubles (about £300,000) in extending the telephone system and enlarging the central exchange so as eventually to serve 34,000 subscribers. The Administration are, however, now desirous of providing arrangements for an eventual 45,000 subscribers, and have accordingly asked that the amount be increased to 4,846,000 roubles (about £510,000).

TRACTION—Home.

BELFAST.—The Belfast Corporation Bill for the acquisition of the Cavehill and Whitewell Tramways came before the Parliamentary Examiners on the 31st ult. A formal non-compliance with the standing orders was entered on account of late deposit. The Bill will therefore come before the Standing Orders Committee, when it is understood it will not be opposed.

EDINBURGH.—Messrs. Dick, Kerr & Co., Ltd., have begun the work on the electric tramway from Aldmillan-terrace to the new Corporation Cattle Market.

HALIFAX.—Mr. C. F. Spencer, the chairman of the Tramways Committee, in moving the minutes of the committee, announced that the statement showed that the profits for the year amounted to £13,082. The result was that they would be able to clear off the accumulated deficit on the tramways and leave £1,377 to start a reserve fund.

LONDON (Islington).—The Borough Council will oppose the London County Council Bill for the electrification of the northern portion of the tramways section, with a view to secure the widening of Ball's Pond-road as part of the scheme.

LONDON (Paddington).—The Borough Council have withdrawn their opposition to the London County Council Tramways and Improvements Bill.

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TRACTION—Overseas.

ALBERTA, CANADA.—Mr. J. A. McCullough, of Calgary, is negotiating with the council of that city regarding a proposal to build an electric railway from the city to Chestermere Lake, a sheet of water about nine miles out.

COPENHAGEN.—Electricity is making great headway here. The existing generating works are to be enlarged and a new A. C. generating station is to be erected. At first, three turbo-dynamos of 7,500 h.p. each will be installed, but the station will be designed for an ultimate output of 180,000 h.p. The first instalment of the work will involve a cost of £340,000.

LILLOOAH (India).—The Carriage and Wagon Workshops of the East Indian Railway at Lillooah are to be provided with a motor generator set, together with control panels, etc., and the equipment, which will be under the control of the Electrical Department, has been ordered from England.

QUEBEC.—Application is to be made to the Provincial Legislature next session for an Act incorporating a company, under the name of the Montreal Underground and Elevated Railway, with a capital of $20,000,000 (about £4,111,000), empowered to construct and work, by electricity or other motive power, underground and elevated railways through the city and island of Montreal.

REGINA (Saskatchewan).—Council has approved of granting a 20-year street railway franchise to J. W. W. de C. O'Grady, J. A. Anderson, and John Geddes, of Winnipeg. The plans provide for an overhead or trolley electric system and cars of the latest type, with a service regulated by the city from 6 a.m. to 11 p.m. The tracks will be 4 ft. 8½ in. wide and 7 miles are to be completed by December 1 next, and in operation by May 1, 1911. The city is to have the privilege of taking over the system at the date of franchise expiration, the value to be determined by arbitration, and all construction work is to be supervised by the city engineer. City's percentage on earnings to be as follows: On gross earnings amounting to $8,000 per mile, 5%; $9,000 per mile, 7½%; $10,000 per mile, 10%; $12,000 per mile 12½%; $15,000 per mile, 15%.

TOKYO (JAPAN).—The Odawara Electric Railway Co. proposes to extend the Kozu-Yumoto line to Miyanoshita and reach Gotemba *via* Gora, Sengoku and Otome-toge. The cost of construction is estimated at 4,300,000 yen (about £439,000).

COMPANIES' MEETINGS AND REPORTS.

MEXICAN LIGHT AND POWER.

The directors have declared a dividend of 1% on the ordinary shares payable April 15 next. The transfer books of the company for ordinary shares will be closed from April 12 to 15 inclusive.

TELEPHONE COMPANY OF EGYPT.

The directors announce a dividend of 6% on the preferred and deferred shares for the half-year, making 10% for the year, carrying £500 to reserve for a contemplated pensions scheme, and £42,326 forward.

LYMINGTON ELECTRIC.

At the meeting of the Lymington Electric Co., reporting to the Resident Engineer and Manager, Mr. Lotter stated that in 1902 the gross revenue was £1,400 and net £470, while this year the gross had increased to £2,900 and the net £1,500.

ANGLO-AMERICAN TELEGRAPH.

The directors of the Anglo-American Telegraph Co., Ltd., after placing £5,000 to the credit of the renewal fund, have declared an interim dividend for the quarter to March 31, of 15s. per cent. on the Ordinary stock and £1 10s. per cent. on the Preferred stock, less income tax.

DOUNE LIGHTING.

The report of the Doune Lighting Co., Ltd., states that the accounts for the year to December 31, show a net profit of £156, including £23 brought forward. The directors recommend a dividend of 5%, that £27 be written off the capital cost of the gas works and £27 off the meter and plant account, that £25 be carried to reserve, and the balance carried forward.

INDO-EUROPEAN TELEGRAPH.

The directors of the Indo-European Telegraph Co. recommend the payment of a dividend for the six months ended December 31 last of 17s. 6d. per share (making, with the interim dividend already paid, 6% for the year, and a bonus of 20s. per share, both free of income-tax) They also recommend a special distribution of 15s. per share, free of income-tax, out of interest accrued during the year upon certain investments and advance accounts. The dividend, bonus, and special distribution will be payable on and after May 2 next, to shareholders registered on April 27. The transfer books will be closed from April 14 to April 27, inclusive.

NORTH OF SCOTLAND ELECTRIC LIGHT AND POWER CO.

The Directors in their statement of accounts for the year ended December 31, 1909, report that satisfactory progress has been made during the year. The gross profit, including £1 7s. 5d. brought forward from last year, is £4,107 15s. 8d., and after meeting interest paid on debentures and loans, amounting to £1,876 3s. 8d., and writing off £406 6s. 3d. for loss on free wiring and motors dismantled, balance of cost of street lighting alterations and depreciation on meters, etc., there remains a net profit of £1,825 5s. 9d. It is proposed to carry £1,600 to renewal reserve account and the balance of £225 5s. 9d. forward to the next account. £1,004 of debenture stock has been issued during the year. At Montrose, 247,704 units were generated: of these 182,481 were sold, 51,277 used at the works, and 13,946 were unaccounted for. At Brechin the figures were respectively: 174,667, 124,012, and 12,011. At Inverness: 328,844, 267,968, and 17,405.

RHONDDA TRAMWAYS CONSTRUCTION SYNDICATE.

The directors state that the net profit earned during the year was £20,044 9s. 10d., and of this amount £3,500 has been placed to the reserve and renewals account; £16,000 credited to the syndicate, and £543 5s. 6d. carried forward. The amount to the credit of the syndicate's profit and loss account for the year is £15,965 19s. 6d., and with the balance of £1,684 16s. 8d. brought forward the total was £17,650 16s. 2d. An interim dividend of 3% having been paid, a balance of £10,150 16s. 2d. remained, and the directors recommended that a final dividend of 3% be declared, leaving £2,650 16s. 2d. to be carried forward. The expenditure was 50·80% of the gross receipts, which were £40,864 9s. 10d. The number of passengers carried during the year was 8,821,095; the traffic receipts for the year showed a substantial increase, and the first year's working was satisfactory. The Rhondda Council had a Bill before Parliament this session to authorise various extensions to the tramways. The heads of an agreement between the council and the company had been agreed upon, and if the Bill received the Royal assent the working of the extensions should add to the profits of the company.

SIEMENS "ONEWATT" HIGH CANDLE POWER LAMPS.

Full particulars are to hand regarding the new "Onewatt" lamps which Messrs. Siemens Bros. Dynamo Works, Ltd., Tyssen-street, Dalston, London, N.E., are placing upon the market, and we have had the opportunity of putting a sample to the test. This "Onewatt" is a "Tungsten" lamp, fitted with a filament of drawn "Tungsten" wire. The efficiency of the new lamps is the same as the average lamp of that type, namely 1·1 watts per candle-power, and owing to the very low rates at which it is being placed upon the market should find a ready sale. The present "Onewatt" lamps are 100 c.p. for 100–130-volt and 200–250-volt circuits respectively, and are listed at the price of 4s. 6d. each, subject to the usual trade and cash discounts. For street and shop lighting they are most suitable, and we may confidently predict highly satisfactory results from them. These lamps provide municipalities, contractors and consumers with a lamp of very high efficiency at a low initial cost, thus reducing the maintenance and installation costs, which up to now have considerably hampered the adoption of electric lighting in many cases.

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LIENS REGISTERED AND DEBENTURES ISSUED.

BRITISH COLUMBIA ELECTRIC RAILWAY CO., LTD.—Issue on February 22 of £530,000 Debentures, part of a series of which particulars have already been filed.

CONSOLIDATED ELECTRIC WORKS & APPLIANCES, LTD.—Second Mortgage-Debenture to "Bearer" dated February 22, 1910, to secure £1,340, charged on the company's undertaking and property, present and future, including uncalled capital (subject to First Mortgage Debentures securing £2,500).

ELECTRIC LANDAULET CO., LTD.—Satisfaction is full on March 8, 1910, of Debenture, dated June 2, 1909, securing £5,000.

TRADE NOTES.

Messrs. James McMillan & Co., of Clun House, Surrey-street, Strand, London, W.C., have been appointed sole agents for Great Britain for the Swedish Metal Works Co., Ltd., manufacturers of copper and brass, in sheets, tubes, wire rope cables, trolley, telegraph and telephone wire. The Works also supply aluminium, phosphor and silicium bronze, silver, new silver, nickel, lead, zinc, tin, platinum, and delta metal in different sections and profiles for various purposes.

PERSONAL.

The Rochdale Electricity Committee have unanimously decided to recommend the Town Council to advance the salary of Mr. C. C. Atchison, the electrical engineer, from £350 to £400 per annum. Fifteen months ago a similar recommendation was rejected by the Council.

We understand that Messrs. Humphrey-Davies & Co., of 5, Laurence Pountney-lane, E.C., have been retained by practically all the electric power companies of London to watch over their interests in connection with the forthcoming quinquennial re-valuation.

ELECTRICAL TRADES BENEVOLENT INSTITUTION.

The Annual General Meeting of the above Institution will be held on Wednesday, April 6, at 4 p.m., at the Hotel Cecil, Strand, W.C., when the fol owing subjects will come up for consideration: Report of the year's work of the Institution; report of the Second Festival Dinner; report concerning the Institution's investments; election of Committee of Management as per Rule 5; and election of auditor as per Rule 16.

CATALOGUES AND PRICE LISTS.

Leaflet No. 42/1 of the British Westinghouse Electric and Manufacturing Co., Ltd., deals with their large induction motors. It is a clear description, fully illustrated.

Messrs. W. T. Glover & Co., Ltd., have brought out a new edition of their Cables List, Mains Section. It is a book of 285 pages, full of valuable information, and well illustrated, many of the plates being in colour to show methods of cable construction.

A revised price list of ignition cells, small accumulators, and 25 volt sets of accumulators for metallic filament lamp installations, has been issued by the Brockie-Peel Arc Lamp Co., of Wimbledon.

A catalogue of "Sunlite" and "Sunline" reflectors, showing their ready adaptability for indoor and shop lighting, has been prepared by the Sun Electrical Co., Ltd., It is a capital book for contractors, as its numerous illustrations give good ideas, which would prove useful in influencing hesitating customers.

Messrs. W. H. Keys, Ltd., of West Bromwich, send us a small pamphlet explaining the special merits of "Mastico," a damp-proof solution for cable makers, electrical works, and station engineers.

Messrs. Bruce Peebles & Co.'s latest publication deals with open and enclosed type turbo alternators. The pamphlet gives a full specification of each type, together with various illustrations of the complete machines and of the stators and rotors separately. On page 16 will be found tables of outputs of the various frame sizes at speeds of 1,500 and 3,000 r.p.m., for 50 and 25 cycle circuits, while on page 18 is given very complete tables of weights and dimensions.

DIARY.

MONDAY, APRIL 11.

INSTITUTION OF MECHANICAL ENGINEERS, GRADUATES' ASSOCIATION.—At 8 p.m., Mr. A. B. E. Cheeseman on "Mechanical Flight."

TUESDAY, APRIL 12.

JUNIOR INSTITUTION OF ENGINEERS.—At 7.30 p.m., at the Royal United Service Institution, Whitehall, paper on "High Speed Steam Turbine Rotor Design and Construction," by Mr. J. M. Newton, B.Sc.

NATIONAL ELECTRICAL MANUFACTURERS' ASSOCIATION (Incorporated).—Committee meeting, at 2.30 p.m.

WEDNESDAY, APRIL 13.

ASSOCIATION OF ENGINEERS-IN-CHARGE.—At the St. Bride Institute, Fleet-street, E.C., at 8 p.m., Mr. R. J. Wallis-Jones, M.Inst.C.E., M.I.E.E., on "Welding and its Application."

INSTITUTION OF ELECTRICAL ENGINEERS (Students' Section). Meeting at 7.45 p.m., at 72, Victoria-street, S.W., paper by Mr. A. P. Young, "The Theory and Design of Current Transformers."

THURSDAY, APRIL 14.

ILLUMINATING ENGINEERING SOCIETY.—At the Royal Society of Arts, at 8 p.m., discussion on "The Measurement of Lights and Illumination."

TUESDAY, APRIL 19.

INSTITUTION OF ELECTRICAL ENGINEERS, STUDENTS' MEETING (Manchester Section).—At the Municipal School of Technology, at 7.30 p.m., Mr. F. Shaw and Mr. J. Davies on "The Application of the Cradle Dynamometer to the Testing of Electrical Machinery."

INSTITUTION OF MECHANICAL ENGINEERS.

As already announced, a joint meeting of the American Society of Mechanical Engineers with the Institution of Mechanical Engineers will be held in Birmingham and London, and will begin on Monday July 25. A Local Committee, consisting of the Right Hon. the Lord Mayor of Birmingham, Alderman W. H. Bowater, together with members of the Institution and other gentlemen resident in the neighbourhood, has been formed to make the necessary arrangements. A Ladies' Committee will be formed in Birmingham to make arrangements for the entertainment of ladies accompanying the members of both societies.

The following is an outline of the programme as at present proposed, subject to revision:—

Monday, July 25.—Arrival in Birmingham.

Tuesday, July 26.—Morning: The Right Hon. the Lord Mayor of Birmingham and the members of the Local Committee will receive and welcome the President, George Westinghouse, Esq., and the officers and members of the American Society of Mechanical Engineers, and the President, John A. F. Aspinall, Esq., and the Council and Members of the Institution of Mechanical Engineers. Reading and Discussion of Papers. Luncheon in the Town Hall. Afternoon: Visits to Stratford-on-Avon, Worcester, Gloucester, or Bourneville, and local Works. Evening: Garden Fête.

Wednesday, July 27.—Morning: Reading and Discussion of Papers. Luncheon in the Town Hall. Afternoon: Visits to the University, and local Works. Evening: Reception in the Council House, by invitation of the Right Hon. the Lord Mayor of Birmingham.

Thursday, July 28.—Visits to Works in Coventry and Rugby; also to Warwick, Leamington, Kenilworth, or Lichfield.

Following these meetings, the members of the American Society of Mechanical Engineers will be entertained in London, and this is the Provisional London Programme so far arranged:—

Thursday, July 28.—Evening: Conversazione at the Institution (members will be invited).

Friday, July 29.—Morning: Reading and Discussion of Papers. Evening: Institution Dinner in the Connaught Rooms, Freemasons' Hall, Great Queen-street, W.C. (Including ladies.) This will be open to members to the extent of the accommodation available.

As already mentioned, Mr. George Westinghouse will be one of the principal American visitors.

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PATENTS.

Electrical Power Transmission.

1582.—1909. J. G. P. THOMAS, Holywell. Power is taken direct from the engine shaft by means of the generator and transmitted to the dynamo, thereby driving it as a motor in the same direction as the engine. This method diminishes the losses due to circulation of electrical energy.

Regulators for Dynamo Electric Machines.

24634.—1908. DICK, KERR & Co., LTD., London. The speed of the machines is controlled by regulating the position of the brushes by means of an electric relay actuated partly by a current depending on the speed of the machine to be regulated, and partly by a hand controlled current or spring. The relay actuates the brush holder by regulating the flow of liquid kept under pressure by a pump driven by the machine to be controlled to either side of a piston connected to the brush holder.

Electrical Telegraphic Typewriting Machine.

1551.—1909. DR. L. CEREBOTANI, Munich. A contact spring is provided which, in the initial position of the contact arm being held in the position by spring action is drawn off a contact piece. Two further contact springs are provided which come into effective contact with the escapement only if either the current or its interruption is stopped. Another contact is also provided which is in contact with the armature of the printing electro magnet as long as it is not actuated. The circuit of a homogeneous battery shows the three places of interruption whereby it may be attained, firstly, that the printing magnet is actuated only if the indicator is in the working position, secondly, that the actuating of the printing electro-magnet, or the printing of the type set takes place not only when the main circuit is present, but also at a constant interruption. Thirdly, that immediately after the print the current of the home battery is interrupted and the armature turned back again, whereby the initial position of the type wheel and the indicator is established again.

Combined Magneto and Coil Sparking Mechanism.

534.—1909. C. A. VANDERVELL, Acton Vale. The magneto contact device and the coil contact device are arranged coaxially and relatively adjustable to one another about their axis in combination with means for simultaneously giving, on rotation of those devices, a differential motion to the contact device relative to the magneto contact in order to obtain greater angular advance of the coil contacts relative to the magneto contact device.

Electrical Means for Protecting Ships' Bottoms from Barnacles.

279.—1909. J. E. JAMES, Rathmines. One pole of a battery, coil or dynamo or other source of electricity carried on a ship is divided into a number of points and connected to a number of plates attached to, but insulated from, the outside of the ship's bottom. The other pole is similarly subdivided and connected to plates outside the vessel. The plates permit the even distribution of the current around the ship so that the surrounding water is uniformly electrified.

Adjustable Transformers for Polyphase Electric Alternating Currents.

20003.—1909. SIEMENS BROS. DYNAMO WORKS, LTD., London, S.W. This adjustable alternating current electric transformer consists of two electrically and mechanically coupled rotary field stators and rotors arranged in such a manner that the positions of the stators with respect to each other can be altered and the rotors can either be moved together or with respect to each other.

Multiple Electric Switches and Automatic Circuit Breakers.

4093.—1909. P. S. BROOK & J. A. HIRST, Chester. These switches are arranged so that they may be closed in succession by means of cams, levers or pawls mounted on a shaft rotated by a handle, which when free returns to one of its extreme positions. Some or all of the switches are retained in the closed position by means which are released when a "no volt" or "overload" device is operated. If the handle is returned to its extreme position before all the switches are closed, it operates the "no volt" device.

Automatic Selective Switching Apparatus for Telephone Systems.

20842.—1909. WESTERN ELECTRIC CO., Chicago. This is an improvement in the type of apparatus in which the switch carriage or brush carrying travelling member is arranged to be rotated by mechanical power applied under the control of an electromagnet which is itself controlled by a separate sending apparatus. The improvement consists in connecting the controlling magnets of the sender in circuit. A contact device operated in the movement of the selector is also included in the circuit and made to cause changes in the current traversing the sender magnet without interrupting the steady flow of current through the selector magnet or relay.

Telephone Exchanges.

25883.—1909. SIEMENS BROS. DYNAMO WORKS, LTD., London, S.W. In a telephone exchange in which an automatic cabling mechanism is disconnected when the subscriber answers a call, a relay is provided for bringing about the disconnection which by the insertion of the plug in the socket is connected in parallel to the calling relay of the required subscriber, but is prevented from becoming operative by one or more counterwindings also in circuit during the passage of the calling current.

Braking Semaphore Arms of Electric Signals.

26103.—1909. SIEMENS BROS. DYNAMO WORKS, London, S.W. The brake parts are not rigidly connected to the signal arm, but are moved into one extreme position by the moving of the signal arm to the on position and into the other extreme position by a much smaller force, such as a weight or spring. The brake protects the semaphore arm of the signal from shocks when returning to the on position.

Telegraphic Call Signal.

3933.—1909. W. ROUBANOWITSCH, Moscow. The armature of the main working electromagnet is connected in series with a battery, a self induction coil and a relay. The relay serves to close the electric circuit of a signal line, as required, by means of its armature. The self induction coil may be substituted by a transformer with a rheostat.

Armouring Electric Cables.

3917.—1909. E. WITZENMANN, Pforzheim. The armour for the cable consists of a metal tube composed of a helically wound S-shaped metal band. This is fitted directly over the cable and pressed into the insulating cover. The profile of the band slightly penetrates the layer and prevents elongation of the tube.

Electric Winding Devices for Time Switches.

3854.—1909. H. F. REASON, Brighton. In the winding gear of time switches and meters the core of a solenoid actuates a pawl bearing lever. The care is weighted with a counterpoise to balance the time piece main spring tension and friction within prearranged limits so that the counterpoise acts as a switch to make and break the solenoid circuit and allows one or a series of impulses until balance is restored.

Train Lighting Systems.

3906.—1909. SIEMENS BROS. DYNAMO WORKS, London, S.W. This is an improvement in train lighting systems in which the position of the brushes on the commutator of the dynamo electric machine is altered according to the direction of travel of the train for the purpose of fixing the electrical polarity of the brushes. A solenoid actuated multiple switch is employed which has a simple to and fro motion. The solenoid is provided with two windings, both of which are unenergised when the multiple switch is open, both energised when the multiple switch is being closed, and only one energised when the switch is closed.

Telephones.

3717.—1909. C. ADAMS-RANDALL, New York City. The resistance in the transmitter is subdivided into units independent of each other and adapted to be connected up in series with each other, and a source of electrical energy. The resistance is contained in a number of narrow elongated receptacles of shallow depth. One or more units can be used according to the resistance required for the electrical energy or current employed through the transmitter.

Electrical Heating Devices.

3709.—1909. G. KOLEMINE, Madrid. The heating device is composed of a number of contact bodies arranged in series and connected together by conducting pieces of very small cross section. The contact bodies are composed of a coherent piece, whilst the contact surfaces are produced by constriction. Access of air is prevented by surrounding the constricted portions with an insulating envelope.

Locking Devices for Holders for Electric Glow Lamps.

3674.—1909. G. BOURON, London. W. The object is to prevent the removal of the lamp without the aid of a releasing key. The holder comprises a socket to which is attached a spring. A portion of the spring enters a slot and prevents the pin of the lamp and likewise the lamp itself from being removed.

Control Systems for Electric Motors.

3533.—1909. J. S. PECK, Trafford Park. This is an improvement in control systems, in which the various connections and disconnections are effected by individual electromagnetically operated switches. According to the invention the switch employed is of such a nature that after the switch has been closed the mechanism connecting the moving part of the electromagnet with the movable member of the switch will maintain the switch in such position without requiring the continuous excitation of the electromagnet.

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Electric Radiators.

3554.—1909. W. FENNELL & W. P. PERRY, Wednesbury. This invention comprises improvements in electric radiators and other apparatus where banks of massed lamps or other radiating devices are used, and refers more particularly to that class of apparatus in which ordinary incandescent lamps are used and tot hat class of radiator in which the lamps have end contracts designed to engage a bus-bar. According to the invention a pair of bus-bars with spring contacts and a casing element having inclines around the lamp insertion holes are employed in combination. The inclines engage the studs and draw the lamps through the casing to cause their end contacts to engage the spring contacts on the bus-bars. The two bars are made of sheet metal. The edges of two adjacent bus-bars are slightly separated, and the lamps are arranged to bridge the space. Special projecting tongues make spring contact with the lamps.

Starting Electric Induction Alternate Current Motors.

6956.—1909. SIEMENS BROS. DYNAMO WORKS, LTD., London, S.W. In a dynamo machine which consists of two induction asynchronous electric motors having rotors coupled together, both electrically and mechanically, and stators wherein the phases of the magnetic flux are capable of adjustment, the improvement consists in the combination of two motors, the rotors of which give different voltages and equal currents at equal speeds.

Electric Sparking Plugs.

5955.—1909. E. J. TWIGG, Coventry. The terminal screw of the plug passes with a sliding spring fit into a sleeve let into the insulating body of the plug. When desired the terminal may be instantly disconnected from the plug by withdrawing the terminal screw out of its socket.

Maximum Current Indicator.

5459.—1909. T. MCCLELLAND, Cathcart. The pointer is attached to a solenoid core by which it is operated. A pawl in connection with the pointer co-operates with a ratchet in connection with a meter counter. A second pointer is provided and this indicates the maximum current after the current has fallen and the first pointer has returned to its initial position.

Shut Off Appliance for Electric Controllers.

5223.—1909. F. W. LACEY, Bournemouth. In some forms of electrical controllers used on tramcars it is possible to shut them off and leave certain electrical contacts touching. This has sometimes resulted in serious accidents. To prevent this a slotted quadrant is provided, which operates a lever for locking the reverser drum in its off position and preventing the reverser drum handle from being returned to the off position and removed except when the drum itself is in the off position.

Diaphragms for Receiving, Transmitting or Reproducing Acoustic Vibrations.

4329.—1909. DR. W. BURSTYN, Berlin. The diaphragm is divided into a number of small sections which vibrate independently of each other. The diaphragm is secured to a plate provided with openings so that only the parts of the diaphragm lying beneath the openings are free to vibrate. It is claimed that this diaphragm possesses a high period of natural vibration in spite of its small thickness.

Electrolytic Devices.

4258.—1909. W. B. THORPE, Balham. This is an improvement in electrolytic devices used in the construction of meters, time switches, etc. The electrolytic cell is adapted to be connected between current supply mains through a high resistance. A second electrolytic device is connected up between the mains through the high resistance so that the main electrolytic cell and the absorption cell are connected in parallel with each other and in series with the main resistance across the current supply mains, whereby the apparatus works in a practically accurate manner under varying voltage conditions within permissible limits of voltage variation.

Controlling the Voltage of Dynamo Electric Machinery.

4181.—1909. W. STANSFIELD, Manchester. This is an improvement in variable speed generators and consists in exciting the field of the main conductors by means of a field winding connected across the auxiliary conductors, with or without compounding closed circuit windings, and arranging the resistance characteristics of differential windings, or the resistance characteristics of the arms of a Wheatstone net to potential points of which a winding is connected, so that as the voltage to be controlled increases the strength of the auxiliary field controlled by such winding is decreased.

Regulating Devices for Direct Current Dynamos.

27245.—1909. FRIED. KRUPP, Aktiengesellschaft, Essen. This is a regulating device for direct current dynamos in which that portion of the magnetic frame through which, when the dynamo is driven the lines of force of the field of force passing through the armature are closed, is interrupted by a gap that can be bridged over by means of an iron core rotatably mounted and which itself carries the field winding of the dynamo machine.

Generating Alternating Currents.

27033.—1909. J. L. MILTON, Chicago. This improved inductor alternator method of generating currents consists in first increasing the number of magnetic lines through a suitable winding, then decreasing the number of lines through the winding to generate an electromotive force to oppose that first set up, and next suddenly increasing and decreasing in quick succession the number of magnetic lines through the winding.

Electrically Reset Gravity Escapement.

4632.—1909. W. D. WALDEN, Wokingham. The gravity arm is provided with a number of impulse pins which impart impulse to a pendulum at every second swing through the medium of a pallet and crutch.

Electric Fuse Fitting.

25733.—1909. SIEMENS BROS. DYNAMO WORKS, LTD., London, S.W. The gauge pieces and bridging pieces of the fuse fittings described in patent 8263—1909 are made in two separate parts so arranged that the bridging piece clamps the gauge piece tightly and in the proper position in the socket. The gauge piece is made of insulating material, quite smooth on its outer circumference. The bridging piece takes the form of screws with heads of different heights to effect the non-interchangeability.

Electrodes for Arc Lamps.

21374.—1909. GEBRUDER SIEMENS & Co., Charlottenburg. A molybdate or tungstate of a rare metal is added to the carbon electrode in order to increase the illuminating efficiency.

Arc Lamps.

22768.—1909. E. CHRISTOPH, Frankfort a Main. In this lamp the magnet armature which serves to advance the feed spindle, simultaneously effects the ignition. An arc forming pin which is rotatable about its axis causes the movement of a slide embracing one of the electrodes, and simultaneously with the movement of the field spindle is rotated according to the oscillation of the magnet armature so as to render the regulation of the distance of the carbons dependent on their longitudinal as well as on their lateral displacement.

Electric Motor.

15317.—1909. C. H. PROTT, Rheydt. The motor has an idle armature arranged at each side of the working armature. When the motor is started the idle armature first causes a great leakage of the lines of force of the magnetic field, so that at first only a small amount of magnetism is induced in the working armature, and so that the working armature starts with a small velocity and acquires its normal velocity gradually when the lines of force are concentrated on it.

Electrical Torsiometer.

13010.—1909. C. H. JOHNSON, Dumbarton. The torsiometer comprises a pair of sleeves and discs mounted upon a shaft in which torsion is to be measured. On one disc is a rheostat and on the other disc is a contact finger which traverses the rheostat. The finger and rheostat are in circuit with a battery and with a voltmeter in such a way that when torsion is applied to the shaft upon which the apparatus is mounted an indication of the variation in resistances due to the varying position of the contact maker upon the rheostat is given upon the voltmeter.

Suppressing Electric Currents Due to Harmonics in the Wave Forms of Alternating Current. Dynamo Electric Machines.

13041.—1909. SIEMENS BROS. DYNAMO WORKS, LTD., London, S.W. In a star connected three-phase dynamo electric machine arrangements are made for neutralising the third harmonic voltage in each of the armature windings. Three single-phase transformers with a voltage transformation ratio of three to one are employed. Their primary windings are connected in star grouping to the main dynamo terminals or bus-bars. Their secondary windings are in open delta between the earthing bus-bar and the neutral points of both the dynamo and primary transformer windings.

Electric Train Lighting and Heating.

25844.—1908. J. P. CROUCH, Newton Heath. Each of the shunt windings of the two main switches of the switch apparatus are connected to the poles of a dynamo through a circuit controlling device, so constructed that one winding is brought into circuit for one direction of running of the dynamo, and the other for the opposite direction of running. The shunt windings can be disconnected from the dynamo when the latter rises above or falls below a certain predetermined value.

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TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns per week.			Increase or decrease.		Miles of track open.		Accounts for past year.						Cost per car mile.
	Ending	1909-10.	1908-9.	Week.	Current year.	1909.	1908.	Ending	Total receipts.	Passengers carried.	Car miles run.	Receipts per Passenger.	Receipts per Car mile.	Receipts per Mile of track.	
		£	£	£	£				£						
Aberdeen Corporation	Mar. 23	1,170	1,133	+ 37	— 599	27½	27½	May 31	71,930	17,517,304	1,566,119	·98	11·02	4,940.	5·93
Ayr Corporation	Sept. 18	671	562	+ 108	—	8	8	—	—	—	—	—	—	—	—
Baker Street and Waterloo Ry.	Nov.	8,141	6,070	+2,071	—	4·25	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	Mar. 27	1,005	972	+ 33	+ 389	24·003	13·52	—	—	—	—	—	—	—	—
Birmingham Corporation	Mar. 30	6,643	6,486	+ 157	—	56·792	58·52	—	—	—	—	—	—	—	—
Blackburn Corporation	Oct. 6	1,100	1,293	— 173	— 1,036	24·53	28·3	—	—	—	—	—	—	—	—
Blackpool Corporation	Aug. 26	2,152	2,050	+ 102	+ 732	—	—	—	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams	,, 8	2,304	2,309	— 24	—	—	—	—	—	—	—	—	—	—	—
Bolton Corporation	Oct. 10	2,416	2,337	+ 79	— 259	42	42	Mar. 31	117,799	25,492,902	2,492,147	1·1	11·34	2,804	6·50
Bournemouth Corporation	July 21	1,681	1,723	— 42	— 23	29½	29½	,, 31	86,225	13,991,328	1,766,068	1·47	11·71	2,912	7·22
Bradford Corporation	Mar. 26	5,325	4,362	+ 963	+12,597	98	54·81	,, 31	235,258	47,839,569	5,331,007	1·17	10·59	2,378	—
Brighton Corporation	April 3	1,057	752	+ 305	+ 96	9·5	—	—	—	—	—	—	—	—	—
Bristol Tramway Company	April 1	7,327	4,862	+2,465	—	57	51½	Dec. 31	265,362	46,652,389	5,756,842	—	—	—	—
Burnley Corporation	April 2	1,299	1,214	+ 85	—	19½	19½	Mar. 31	64,261	12,355,958	1,202,330	1·23	12·83	5,971	7·92
Burton Corporation	April 3	267	248	+ 19	+ 35	6½	6½	,, 31	14,918	3,221,595	430,913	1·04	8·30	1,460	5·85
Cardiff Corporation	April 3	2,000	1,957	+ 43	—	—	—	,, 31	109,979	25,058,146	2,497,169	—	10·57	—	—
Carlisle Tramways Company	June 19	170	175	— 5	— 89	—	—	—	—	—	—	—	—	—	—
Central London Railway	Mar. 26	4,730	5,622	— 892	— 1,295	6·32	6·32	Dec. 31	350,150	41,898,373	1,456,781	2·01	5·769	56,404	30·27a
Charing X, Euston, & Hamp. Ry.	Nov.	6,822	6,092	+ 730	—	7·75	—	—	—	—	—	—	—	—	—
City and South London Railway	April 3	3,297	3,246	+ 51	— 982	7·26	7·26	—	—	—	—	—	—	—	—
Colchester Corporation	July 14	200	219	— 39	—	8	—	Mar. 31	10,983	2,308,721	349,539	1·09	7·74	1,477	6·56
Cork E. T. and L. Company	Mar. 31	486	442	+ 44	+ 311	9·89	9·89	Dec. 31	24,044	5,737,478	896,945	—	6·43	—	4·43
Croydon Corporation	Mar. 11	1,639	1,139	+ 500	+ 9,590	11½	—	Mar. 31	74,132	16,277,418	1,884,137	1·06	9·56	3,703	7·109
Darwen Corporation	Oct. 1	239	256	— 17	— 201	7·23	7·23	,, 31	13,899	2,557,654	245,584	1·30	13·68	1,922	9·40
Dover Corporation	Sept. 18	230	252	— 22	— 395	7	—	,, 31	11,593	2,697,672	316,754	·98	8·78	—	—
Dublin and Lucan Electric Ry.	April 1	188	107	+ 81	+ 71	7	7	—	—	—	—	—	—	—	—
Dublin U.T.	April 1	5,870	4,793	+1,076	+ 3,501	54½	54½	—	—	—	—	—	—	—	—
Dundee City Tramways	Oct. 6	1,332	1,305	— 27	— 569	—	26½	May 15	60,573	16,367,911	1,281,552	·875	1·9	2,371	7·46
East Ham Corporation	April 2	1,114	915	+ 199	+ 6,088	15	15	Mar. 31	47,430	15,355,703	1,091,586	·73	10·26	—	6·96
Glasgow Corporation	Mar. 26	17,466	16,610	+ 856	— 259	191	185	May 31	907,494	226,948,290	20,766,722	·96	10·49	5,080	5·89
Gloucester Corporation	Oct. 6	395	425	— 30	+ 535	15	—	—	—	—	—	—	—	—	—
G.N., Piccadilly and Brompton	Nov.	13,429	9,354	+4,075	—	9·25	—	—	—	—	—	—	—	—	—
Halifax Corporation	—	—	—	—	—	52·574	37	Mar. 31	81,872	20,378,672	1,786,390	11·40	11·18	1,528	8·40
Huddersfield Corporation	Dec. 4	1,613	1,357	+ 256	+ 2,663	28	28½	,, 31	84,704	16,200,020	1,960,329	1·29	10·37	2,421	5·10
Hull Corporation	April 2	2,666	2,480	+ 186	+ 8,280	26	26	,, 31	128,722	30,964,254	3,022,844	1·	10·22	—	6·04
Ilford Corporation	Feb. 12	451	391	+ 60	+ 1,969	10	10½	,, 31	25,328	6,385,466	634,446	·87	9·58	2,066	6·42
Ilkeston Corporation	Mar. 16	114	119	— 5	— 237	4	4	,, 31	7,214	1,968,850	198,415	9·1	7·9	1,803	7·04
Kirkcaldy Corporation	Sept. 5	269	266	— 7	—	7½	7½	May 15	14,993	4,874,199	459,066	·711	7·838	1,856	5·26
Lancashire United Tramways	Mar. 20	2,115	1,162	+ 953	+ 1,153	39	39	Dec. 31	68,904	12,554,593	2,244,344	—	—	—	—
Leeds Corporation	Sept. 18	6,896	6,624	+ 272	+ 3,662	108	96½	Mar. 31	340,368	75,734,083	7,694,989	1·06	10·62	3,527	5·51
Leicester Corporation	Sept. 11	2,162	2,130	+ 32	—	—	—	—	—	—	—	—	—	—	—
Liverpool Corporation	Nov. 19	10,803	10,687	+ 116	— 1,977	109	104	Dec. 31	572,822	124,043,239	12,231,799	1·108	11·24	5,508	7·94
Liverpool Overhead Railway	Mar. 27	1,245	1,276	— 31	— 60	6·65	2·40	June 30	79,004	11,171,515	1,106,386	—	—	—	—
London County Council	Mar. 19	39,571	32,161	+ 7,410	+154059	131½	121½	Mar. 31	1,274,660	279 166,461	25,591,028	1·08	11·74	—	6·79
Lowestoft Corporation	Dec. 11	155	150	+ 5	+ 30	3½	—	Sept. 30	11,399	2,645,206	370,320	1·03	7·36	2,279	6·12
Maidstone Corporation	Mar. 6	157	100	+ 57	—	7·4	—	—	—	—	—	—	—	—	—
Manchester Corporation	Sept. 11	15,631	15,297	+ 334	— 2,871	183	181	—	—	—	—	—	—	—	—
Metropolitan District Railway	April 2	10,554	9,903	+ 651	+12,792	24	24	—	—	—	—	—	—	—	—
Metropolitan Railway	April 3	16,483	16,040	+ 443	+ 7,070	24½	21½	June 30	680,357	99,846,735	—	1·46	—	—	—
Nelson Corporation	Oct. 16	151	131	+ 20	+ 7	2½	2½	Mar. 31	7,362	2,060,712	204,710	·85	8·63	1,907	—
Newcastle-on-Tyne Corporation	Mar. 26	3,820	3,752	+ 68	— 1,163	60½	59½	,, 31	211,085	46,203,164	4,411,745	1·10	11·48	3,504	6·36
Newport (Mon.) Corporation	Oct. 9	663	638	+ 25	— 311	14½	14½	,, 31	35,531	8,174,003	798,029	1·04	9·89	2,450	7·21
Oldham Corporation	Jan. 24	1,778	1,516	+ 262	— 386	—	—	—	—	—	—	—	—	—	—
Portsmouth Corporation	Oct. 10	2,046	1,809	+ 237	—	28½	28½	Mar. 31	97,741	21,247,048	2,309,439	1·10	10·15	—	—
Reading Corporation	Mar. 31	677	556	+ 121	+ 351	13½	13½	,, 31	32,769	7,933,572	915,481	—	8·93	—	4·65
Rochdale Corporation	Dec. 26	1,240	1,126	+ 114	+ 746	20·9	20·93	,, 31	56,558	10,196,148	1,252,925	1·32	10·83	2,693	6·47
Rotherham Corporation	Feb. 4	565	587	— 32	—	—	—	—	—	—	—	—	—	—	—
Salford Corporation	Sept. 27	4,096	4,662	— 66	— 3,326	78	74½	Mar. 31	244,065	45,771,611	5,486,150	1·25	10·67	3,185	—
Scarborough Tramways Co.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Sheffield Corporation	Mar. 27	5,921	5,354	+ 567	+ 397	39½	37	Mar. 25	289,745	17,568,686	7,065,380	·896	9·842	4,225	5·04
Southampton Corporation	Mar. 23	935	920	+ 15	+ 760	18	18	,, 25	52,647	10,121,887	1,157,451	1·25	11·33	—	7·30
Southend-on-Sea Corporation	Aug 21	995	557	+ 438	+ 1,483	—	—	—	—	—	—	—	—	—	—
Stockport Corporation	—	—	—	—	—	25	25	Mar. 31	52,004	9,155,172	1,335,911	1·34	9·342	1,830	4·75
Sunderland Corporation	Jan. 27	1,310	1,336	— 26	— 7,984	—	—	—	—	—	—	—	—	—	—
Swindon Corporation	Mar 30	122	122	—	—	—	—	—	—	—	—	—	—	—	—
Torquay Tramways	Aug. 26	630	647	— 30	—	8·41	—	Dec. 31	15,065	2,880,420	353,297	1·40	1·023	—	—
Wallasey U.D.C.	Mar 26	853	855	— 2	+ 1,018	12·68	12·45	Mar. 31	43,823	8,331,038	891,540	1·2	11·79	3,453	7·72
Warrington Corporation	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
West Ham Corporation	Mar. 24	2,250	2,111	+ 139	+ 9,072	27	14·7	Mar. 31	122,881	35,502,836	2,556,854	·789	10·95	4,417	6·79
Wolverhampton Corporation	Nov. 3	841	823	+ 18	— 206	21¾	—	,, 31	44,432	9,440,369	975,714	—	10·929	2,190	6·509

a Train Miles. h Half-year's figures.

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NOTES.

BRAKING OF TRAMCARS.

Mr. Gerrard's paper before the Institution of Electrical Engineers, although professedly dealing with Glasgow experience really embraced the whole field of braking tramcars. It was an instructive paper and gave rise to an unusually animated discussion, some aspects of which are to be deprecated, but which on the whole proved a useful addendum to the paper. It is one of the most important and troublesome problems in tramway management. A point which we may legitimately deduct from the facts brought forward by Mr. Gerrard is that the device of brakes must largely depend upon the type of car and the character of the prevailing gradients.

IRON IN GOLD PULP.

We mentioned in our Notes (Vol. XLV., page 359), that the members of the South African Institute of Electrical Engineers had been invited to solve the difficulty of removing iron found in gold pulp, when removed from the stamps. Mr. C. McCann, of the Premier Mine, has replied that the main magnetic separator at his mine is used for the extraction of magnetic substances from the concentrates before going to the sorting tables. It appears that although some 32,000 tons of ground are crushed and treated per day, the concentration methods are so good that only about one ton of concentrates, which contains the whole output, needs treatment by this machine. The machine runs a few hours per day, and the method of treatment is as follows:—The concentrates are fed by hand into a hopper which distributes them over a slowly-moving canvas belt some four feet wide; on this belt they first pass under a narrow magnet placed across the width of the belt, and along the face of this magnet runs a small canvas belt. All metallic iron particles are attracted and lifted up by this magnet and carried and thrown on one side by the small belt. They amount to about 10% by weight of concentrates. The remainder is then carried on by the main belt, and allowed to fall between the poles of a pair of powerful magnets, where they are divided by a knife edge; the non-magnetic particles dropping straight down and the others being deflected. A peculiar fact in connection with the operation is that practically the whole of the above-mentioned second stream of matter consists of what are generally believed to be non-magnetic substances, and are so, in an ordinary field, such as that produced by a powerful horseshoe magnet. Mr. McCann took samples on several occasions, and after fine pulverisation, even with the assistance of a powerful horseshoe magnet and a microscope, he was unable to detect any particle showing any signs of magnetism. Chemical analysis also failed to show any general trace of iron, but in a few samples traces of oxides and sulphides were found. He also found a few traces of nickel, in the form of nickeliferous pyrrhotite, which is a magnetic compound. The field which produces this unusual degree of separation is an exceedingly powerful one (B 20,000 per sq. cm. estimated). The pole pieces are about 4 to 5 ft. wide, and are wedge-shaped, tapering from some 6 to 8 in. to a curve of about ¼ in. radius, at which part, of course, the flux is concentrated. The main energising coils are four in number, each resembling one of the field coils of a large two-pole dynamo. The current taken by these is some 40 amps. at 500 volts. Mr. McCann has been requested to read a paper on the subject.

CROP ELECTRIFICATION.

Some particulars are just to hand from Germany which confirm the results obtained by Sir Oliver Lodge in promoting the growth of crops by means of electricity, some particulars of which we gave in our last issue. Professor Breslauer, of the University of Hall, has been experimenting on a farm of about 160 acres. He finds that the effects extend quite 30 ft. beyond the actual electrified zone. Within the electrified area he estimates that crops are benefited at least 30%. For an area of about 55 acres the capital expenditure is a little under £250. About 500 watts are required. The annual expense, all items being considered, is put down at £52, and it is calculated that the increased value of crops resulting from this expenditure is £150. Dr. Hostermann, of Dahlem, seems to be going back to Benjamin Franklin's methods. He is experimenting with balloons to attract electricity from the air for field electrification.

A TEXTILE INSTITUTE.

A hearty welcome will be extended to the newly formed Textile Institute (with temporary headquarters at 12, Exchange-street, Manchester, Mr. George Morres, Secretary). Its main object is, of course, to promote the general interests of the textile industry. Certainly, one of the indispensable requirements is economy of management of factories, and electricity is one of the best means to obtain that result. The Institute may do much good if it will study practice abroad, with a view to adopt, or adapt, whatever new departures are best. It is clear that abroad textile manufacturers—both spinners and weavers—are showing more enterprise than ours in taking advantage of the benefits accruing from the use of the electric drive. We note that among persons who are eligible for membership are engineers interested in the application of their science to the textile industries.

WHAT IS SUPPLY OR DISTRIBUTION?

In our last issue dealing with the new Electric Lighting Act, we asked what would be the position "of, say, the owner of a building estate or the managers of a Garden City, within a supply area, desiring to generate electricity and supply it to their tenants?" According to a legal contributor to *The Engineer*, this is likely to prove a difficult question. He asks: "What constitutes the supply or distribution of electricity? So long as the Electric Lighting Acts conferred no monopoly, the answer to this question was unimportant, but it now wears a different aspect. Does it, for instance, include the charging of accumulators for a motor or motor boat? The older Electric Lighting Acts throw no light on the question. It can only be answered in the law courts on some future occasion. With regard to the enforcement of the provisions of the section, the Act imposes no penalty on anyone who infringes it. We may presume, however, that the remedy will be in the hands of the local authority or company whose rights are being affected. An action may be brought for an injunction, and if it prove successful, the defendant may be landed with the payment of costs." Section 23 is, he thinks, also likely to prove a thorny one. Under Section 15, he holds, companies or municipal authorities will be entitled to charge special rates to consumers who generate their own electricity and only require supplies from the mains as "stand-bys," whether at regular or irregular periods.

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SOUTH AFRICAN LEGISLATION.

In a recent number, we gave particulars of the new Electric Lighting and Power Act which comes into force on May 1 in Cape Colony. Fresh regulations are to be imposed in other parts of South Africa. For instance, in the Transvaal a Government draft Bill for regulating electric power companies has been issued. It places very large discretionary powers in the hands of the Minister of Public Works and Mines, who will have an advisory board of officials to assist him. All companies will be compelled to obtain a licence from the Minister, and such licence may stipulate how rates are to be controlled; provide for all consumers being treated on the same footing; lay down the rate of percentage to be paid on capital, and the disposal of surplus profits, and so on. The Bill enables the Government to acquire an undertaking after ten years as a going concern. After 35 years, it may give notice to purchase at the end of two years, without payment for goodwill or possible profits to accrue. The Victoria Falls Co. and its subsidiary are brought under the provisions of the proposed law, but inasmuch as it is founded on concessions of the old Republican Government, recognised by the Crown Government, special terms are extended as regards delay before expropriation could be put in force, and the recognition of existing trading contracts. Like the Cape Act, sections lay down regulations for the safety of the public and traders. Drastic as is the Bill, it is not likely to meet with opposition, as it has been thoroughly discussed with all interested, before the final draft was issued.

RURAL LIGHTING.

In another column we give some particulars of the Rural Electricity Supply Co., Ltd., whose prospectus has just been issued privately. The idea at the back of the promotion is to establish undertakings for the supply of electric light and power in the smaller towns and large villages, proceeding not by way of obtaining Acts of Parliament or Provisional Orders, but by arrangement with the local authorities. There is, we are convinced, much to be done in promoting the use of electricity in comparatively rural districts, and we have always been glad to report such undertakings, as at Grassington and in one or two instances in Wales. There should be a big future before this pioneer company, which is, we hope, soon to take up very useful work.

COAL DUST IGNITION.

Speaking before the North of England Institute of Mining and Mechanical Engineers on the ignition of coal dust by single electric flashes, Dr. W. M. Thornton and Mr. E. Bowden, B.Sc., pointed out that coal dust, although an insulator when dry, became a conductor if wet enough for carbonisation to take place. The necessity for keeping commutators clean, especially the small gap between live copper and the frame, was obvious. There appeared to be no danger of flashing over on 480 volts between live parts 1¼ in. apart, unless the deposit of dust was entirely conducting, as from carbon brushes. Distributing boxes should be dust and flame-tight, and should be in compartments, so arranged that the main terminals could not be short-circuited by a flash. Cartridge fuses should be used where possible, and once used should not be replaced by bare wire or by running wire through an empty tube. Momentary arcs produced by break of cables or conductors could ignite dust; but the current required to do so was very much greater when the voltage was low, and at moderate voltages was greater for alternating than for direct current. The authors were careful to point out that although it had been shown that a cloud of coal-dust could be ignited by small single flashes, it did not follow that the use of electricity in collieries was dangerous. Electricity was no more dangerous than the supply for domestic use of highly poisonous and explosive coal-gas. An efficient leakage-indicator was equally necessary for both, but while no indicator would prevent risk from sudden breakage of either pipes or cables, in the electrical case the main supply could, if desired, be cut off by a small leakage current.

ELECTRIC BRAKING ON GLASGOW CORPORATION TRAMCARS.

By A. GERRARD, A.M.I.E.E.

DISCUSSED BY THE INSTITUTION OF ELECTRICAL ENGINEERS, LONDON.

The paper by Mr. A. Gerrard, A.M.Inst.E.E., on "The Progress of Electric Braking on the Glasgow Corporation Tramway System," came before the Institution of Electrical Engineers, London, for discussion on the 7th inst. An abstract of the paper appeared in the ELECTRICAL ENGINEER of the 8th.

Mr. J. S. Peck (of the Westinghouse Co.): When a tramcar accident occurs, an investigation usually shows that it is due to some fault in the brakes. An enormous amount of inventive genius is expended in designing new forms of braking apparatus, but as long as there are defective brakes in service we shall get accidents. For twelve or eighteen months there has not been a severe accident and the question of brakes has been slumbering peacefully. But accidents will come if the brake apparatus is defective and if it is necessary to depend upon the human element for operating the brakes. Mr. Fell, in his paper presented before the Tramways and Light Railways Association, showed, I think, conclusively that it is possible to obtain a brake which, when properly handled, will give as great a retarding effort as can be reasonably expected. There is always the possibility of improper handling and I think the device described by the author in his excellent paper is a thing which as far as possible eliminates the human element. It is as skid-proof and as nearly fool-proof attachment to the braking apparatus as I consider we can ever hope to get. Having eliminated the human element, there is, however, another element which enters and which has received scant attention heretofore, namely, the effect of the braking apparatus upon the rest of the equipment. The author has shown very clearly that with rheostatic brake and also with the old type of braking very heavy currents are taken during the braking period and those currents must add materially to the heating of the motor, and consequently to the rate of deterioration of the installation. The Glasgow Corporation has been noted for a long time for the extremely low maintenance costs of their tramway equipment, and this I think is due in a large measure to the excellent supervision which they give to it. Yet they found that, although the maintenance costs were so low, they were higher than they should be. The first thing they ascertained was this heavy current at breaking. They then found when breaking very high speeds, making emergency and other stops, they got a voltage which was at least twice the normal voltage across the armature terminals. Now, any such voltage as this must tend to cause break-down and many of the break-downs in armatures are undoubtedly attributable to this cause. The skidproof or shunt field device appears to eliminate this entirely.

Mr. E. H. Cockshott (Leeds): The paper has been especially interesting to me, because of the fact that I was personally associated with the development of the brake referred to by the author as the 1908 type, and also because we in the Leeds Tramway Department have devoted a large amount of time to the brake problem, and have conducted an extensive series of experiments on various brakes during the last two or three years. The real name of this 1908 brake is the Maley electro-magnetic rail brake, of which 30 have been supplied to the Leeds Corporation. We have now had three years' experience of them under actual running conditions, and on the steepest gradients had numerous opportunities of investigating their general behaviour. We have also had many Newell brakes, having No. 21 magnets, in use on our cars, and have had experience of the latest type of this brake fitted with No. 25 magnets. Our experience teaches us that owing to the excessive voltage and currents generated, the sphere of usefulness of the old type of Newell brake is limited to coasting on steep gradients, and to making purely emergency stops. The latest type of this brake is undoubtedly a very powerful one under favourable conditions. The trouble we experienced with it was that at high speeds it became a most difficult matter to prevent the wheels skidding when the brake was applied, and also,

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contrary to the author's remarks, we did not find it satisfactory at moderate speeds. In fact, so many reports were received regarding passengers who complained of being severely shaken due to the alleged irregular and jerky action of the brake, that it was decided to remove it. It must not be thought that under all conditions the coupling of wheel shoes to the magnets reduces the liability to skid, or limits the current and voltage generated, as compared with a magnetic track brake having no wheel shoes. For a given braking force it certainly reduces the currents and voltage generated, if the controller be operated with great care; but should all the resistance be cut off, as generally happens in cases of emergency, it is evident that, while the wheels continue to revolve there will be at equal speeds the same maximum voltage and current generated with the two types of brake. The trouble with the Newell brake is, however, that in such cases the wheels, having an excessive torque on them, commence skidding, and continue to do so for some few seconds, during which time the sudden reduction in the braking force often causes a considerable increase in speed. In a test made at Leeds with one of these brakes on a gradient averaging 1 in 11, the speed attained previous to applying the brake was 26 miles per hour. On the application of the brake the wheels ceased to revolve, and did not again reach their normal speed until the bottom of the hill was reached, a distance of about 130 yards from the point where skidding commenced. I quite agree that the solenoid device to some extent reduces skidding, but it nevertheless seems to me that the addition of such complications into the braking circuit may cause trouble under the rough usage it is likely to get in actual service. I think it would have been more useful if the author had given us the results of trials of the Newell brake and solenoid device at speeds exceeding 20 miles per hour, because at such high speeds it is of the greatest importance that a good brake should be available. With regard to the comparative brake tests made by the author, I feel bound to question some of the figures quoted for the 1908 brake, in view of the great number of similar experiments we have made on numerous brakes of this kind, from which very different results were obtained. Taking the test table showing the electrical energy required to control test cars while coasting on combination brakes, the author's figures for the 1908 brake on the 1 in 13 gradient are as follow: Average amps. after initial surge, 21·3, and volts, 99·16. The figures we have obtained for coasting a much steeper grade, viz., 1 in 9, with a car weighing 11 tons 2 cwt., at 6 to 7 miles per hour, averaged 12 amps. and 55 to 70 volts. Taking, now, the test table for service and emergency stops, the maximum figures quoted for current and voltage are 200 amps. and 1,125 volts respectively. These are, indeed, somewhat high, but during the whole of the large number of similar tests we have made on this brake, even at speeds up to 28 miles per hour, we have not recorded a voltage exceeding 890 volts. Further, only at speeds exceeding 20 miles per hour have we reached the current value quoted, and even then such a value was only shown by an instantaneous kick of the ammeter. In these references to our experiments, I am including tests made both on the level and on a 1 in 8·4 gradient, with comparative retardations in agreement with those quoted by the author. As to the tendency to skid of this brake, it has for some time—for some considerable time—been one of the chief claims that the wheels never really skid unless the brake is outrageously misused, and even then it is of such momentary duration, that the retardation is unaffected. Throughout our extensive series of trials on this brake, in the presence of independent experts, it has invariably been observed that skidding was entirely absent. If the wheels did really skid at Glasgow, I feel that it can only have been due to the imperfect setting of the brake and the fact that the generated voltage and current is unusually high, and that the flashing over has occurred, which we have never experienced in our tests, seems to add colour to this view. I cannot agree with the author's remarks regarding the uneven retardation of the 1908 brake, because, provided the rheostat is regulated correctly, our experience goes to show that its working in this respect is all that could be desired. The Tramway and Light Railway Association's report, in fact, remarks on the delicate graduation of the stops made by this brake. In the summary of his paper the author makes the peculiar statement that on a 1908 brake it is doubtful whether a solenoid would reduce the tendency to skid or ensure more even retardation. I fail to see why such a device should operate differently with a 1908 brake to the way it does with the Newell brake. There has, however, up to the present, been no need to consider the advisability or otherwise of adding any such device.

Mr. A. W. Maley: The paper is largely a comparison of the Westinghouse brake and the 1908 brake of which I am the inventor. It is very difficult for me to reply very fully, because I only chanced by accident to hear of this paper being read. I can hardly understand why this paper was written, because there are two Brake Committees who have been at work—one appointed by the Municipal Tramways Association, and the other by the Tramways and Light Railways Association. Several members of those Committees are members of your Institution. They have been at work three years and will meet again next month, and all the matters referred to in the paper are dealt with in reports which have been issued. The chief object appears to be to make a comparison between the so-called 1908 brake and the Westinghouse brake with the solenoid control. The conclusions arrived at are most unfavourable to the 1908 brake, and this is very strange having regard to the results obtained at Leeds and Birmingham, where a large number of the 1908 brakes are in daily service. At Leeds, in particular, they operate over one of the worst gradients in the country, in fact the Board of Trade would not consent to top-covered cars being used on this route until these brakes were utilised. With regard to the author's tests, speaking generally, I think they will be considered to be of a very rough character and consequently somewhat misleading. In view of the very exhaustive tests with accurate recording instruments which were put on a brake at Leeds, on behalf of the Tramways and Light Railways Association, by Mr. Fell, Chief Officer of the London County Council Tramways and tests carried out extending for a fortnight by other gentlemen. I do not think there was any call for this paper to be published. At any rate, I maintain that we are entitled to say that the conclusions of the author are so contradictory to those in the Brake Committees' Reports that they should be most closely investigated. The first part of the paper dealing with the Westinghouse old type brake is of chief interest as it emphasises, what has often been said, that the power of this brake is very small. The author illustrates my brake, but he does not give the name of the patentee and maker. In any case, I think it would have been fairer had he given us an opportunity of being present at the comparative tests. On December 16 and 17 I was in Glasgow and, what I consider, very successful tests were made with my brake. Not those tests, but tests taken a week later are mentioned in this report. The author experimented with the solenoid control for practically a whole year in order to get it exactly to his liking.

The President (Dr. Gisbert Kapp) interposed when Mr. Maley began to indulge in personalities, reminding him that they were there to discuss scientific matters only.

Mr. W. H. Booth: I believe it is generally admitted that electric brakes cause a good deal of injury to equipment, and I think it is also recognised by a great many engineers that it is desirable to put some mechanical stand-by to an electrical brake. Is a magnetic brake of very much service when the car comes off the line? I think we may answer that question ourselves with a negative. Is there any serious reason why cast iron brake shoes, which are so much more efficient in a mechanical brake, should not be used with the electrical brake and resistances and coils designed accordingly?

Mr. H. M. Sayers: Neither the author nor any of the speakers has yet mentioned the outstanding difference between an electro-magnetic brake of the Westinghouse type and mechanical brakes acting either on the wheel or upon the rails. The difference is that with the magnetic brake one can get the retarding effect entirely independent of the available weight of the car or of the wheels. It is quite impossible by a mechanical brake, whether applied to the wheels or to the rails, to get anything approaching the eight, nine or ten feet per second retardation obtained with the magnetic brake. I consider that the magnetic

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brake is a great advance upon any other system of braking. The author deserves the thanks of the Institution for giving us the results of a long series of tests. With all respect to the opinions of one or two other speakers, I think this is a very proper electrical subject. Brake tests made by different people in different places do not give consistent results. The results of the tests made at Leeds by Mr. Fell for the Tramways and Light Railways Association and those obtained by Mr. Gerrard at Glasgow show that there must have been some essential difference in the conditions, which is not revealed by the particulars given. I saw the whole of the Leeds tests. They showed a very uniform retardation. I do not think that Mr. Maley's invention should be judged by Mr. Gerrard's comparisons, though I am not in the least of the opinion that the author was at all unfair to Mr. Maley. All the results available seem to show that the magnetic type of brake is the best type of brake for conditions requiring frequent stops at high speeds under more or less emergency conditions, and for heavy traffic. With the addition of the solenoid control it becomes very nearly perfect as regards efficiency and operation. For controlling cars down steep gradients I do not think it is the best brake; there is no need for such expensive and complicated apparatus.

Mr. Gerrard (replying to the discussion): Mr. Cockshott admits straight away that the solenoid would reduce the voltage. The paper was practically written to show up the advantage of solenoid control. The solenoid would undoubtedly reduce the voltage in conjunction with the 1908 brake, but it would not prevent skidding, the design of the brake being against that. I did not make tests at 28 miles per hour, because I have no hills at Glasgow to get up that speed. Replying to Mr. Maley, I may say that the Glasgow Local Section invited me to write a paper, and this subject being uppermost in my mind, I said I would deal with electric braking. As far as I know, it is a long time since you had a paper on the subject, in fact, I don't remember one at all. Had I anticipated that my rough tests would be placed before this Institution, I should have endeavoured to get the most up-to-date recording instruments possible. But I think the instruments used and the methods adopted are quite conclusive. Neither the Westinghouse Co. nor I knew of the Maley patent when we started on the subject: we began on original lines.

The President, answering a gentleman who protested that the paper should not be included in the official proceedings, said it had been duly accepted and would appear in the journal.

Mr. Gerrard (concluding his reply): It is the easiest thing in the world to have a mechanical attachment, as referred to by Mr. Booth. As a matter of fact, cars are working like that in the country. Concerning Mr. Sayers' remarks about surging, there is quite a different equipment at Glasgow and Leeds. I can only deal with Glasgow. We have no steeper gradients than 1 in 13.

The President, on behalf of the Institution, thanked the author for his interesting paper.

ELECTRIC FIRE ALARM.

We hear from a New Zealand correspondent that a successful trial has been made at Wellington of a novel automatic fire alarm, the invention of Mr. L. T. Reichel, late Chief Electrician of the Public Works Department. Among those who witnessed the test were government officials and representatives of the shipping companies and fire insurance offices. The apparatus is simple; the principle used being that of the thermopile.

TRADE IN SOUTH AFRICA.

We are officially informed of the establishment, at the office in Cape Town of His Majesty's Trade Commissioner for South Africa (Mr. R. Sothern Holland), of a Bureau of Commercial Information, where buyers in South Africa may be able to obtain information concerning goods manufactured in the United Kingdom. In this connection, Mr. Holland states that a reading room for commercial travellers, etc., is to form part of the Bureau, where a number of Technical and Trade journals will be found, among these being THE ELECTRICAL ENGINEER.

ELECTRIFICATION OF STEAM RAILWAYS.

SOME CONCLUSIONS FROM AMERICA.

(FROM OUR NEW YORK CORRESPONDENT.)

In view of the interest manifested in railway electrification schemes in Great Britain, the conclusions which have been arrived at by a committee of experts and summarised in the form of a report to the New York Railroad Club, will doubtless be found to possess a value by no means limited to the United States. The committee was appointed to take under review the whole subject of electrification and to indicate the directions in which further investigation was required. Subjoined is a summary of the general conclusions at which the committee have arrived:—

ADVANTAGES.

1. Increasing the capacity of a given terminal by the elimination of switch movements, where multiple units are used, and increasing the scheduled speed of trains without increasing maximum speed by the higher acceleration possible with electric power; also increasing the capacity of the line and permitting shorter block signal spacing.

2. Avoidance of smoke and steam nuisance, making unobjectionable tunnels, subways, and underground stations, and reclaiming the aerial space above tracks for offices, stores, warehouses, hotels, or other buildings; also a saving in deterioration of metallic structures because of the corrosive products of combustion in steam locomotives.

3. Uniform power over grades and greater tractive power of electric locomotives of equal weight with steam locomotives including tender, making heavier trains possible over mountain divisions. Locomotives may be used in multiple without increasing the cost for enginemen.

4. Economy of operation under conditions favourable to electric traction, such as frequent multiple-unit train service or cheap electric power as compared with the higher cost of locomotive coal.

5. Electrical operation has proved itself reliable.

6. Electric power is not a source of danger to the travelling or general public.

DISADVANTAGES.

1. A large investment for re-equipping the railroads with the new power which can only be justified by definite financial or economic results.

2. Increased danger to employees of the railroad due to the presence of the third rail of the overhead conductor, especially in yards or terminals.

FUTURE ELECTRIFICATION.

The following features with reference to present conditions should be considered, having in view future electrification:

1. The signal systems should be designed with a view of meeting the restrictions involved in electrification work.

2. Bridges, yards, and terminal platforms, should be designed to conform to the clearances necessary for the installation of working conductors.

3. Locomotives and cars should be designed to conform to electrification clearances.

4. The lighting system of cars should be designed for economical use on electrified railroads. This applies also to the heating systems.

5. Steam, water, air, and gas pipe, in yards, and at stations, should be laid out to avoid current collectors on future electric equipment and working conductors, also bonded to avoid electrolysis.

CONCLUSIONS.

1. No general information is available on the basis of which steam railroads, as a whole, would be justified in electrifying terminals or main lines, solely on the grounds of economy.

2. Careful investigation is necessary to decide if electrification of terminals and suburban districts would be warranted in order to increase earnings.

3. More attention should be given to the possibilities of electrification in connection with heavy grades, and at other places where an increase in facilities is needed.

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4. It is not likely that conclusive data on the economy of electrification will be available until electrification is extended over a complete steam locomotive stage.

5. The electrification for passenger terminal and suburban service is now more or less settled as to method, but for freight and general trunk line service it is in the experimental stage.

(a) The types of locomotives for various service have not been determined, though progress is being made.

(b) The method of secondary distribution (working conductors), needs much development. The third rail is thoroughly reliable and efficient, but unsuitable for complicated switch work. In its present form it has only been used for voltages up to 1200.

(c) The overhead system for high voltage working conductors also needs much development. Few, if any, are satisfied with present designs, and many changes are proposed.

6. The steam railroad men and electrical engineers should work together in as close harmony as is possible, so as to produce results that will be as free from mistakes and experiments as is possible in any developing art.

7. Each problem must be studied on its merits and a decision can only be made after careful study of the conditions pertaining to each situation.

8. The electrification of large freight terminals has not yet been attempted, nor satisfactorily worked out, therefore it is necessary to proceed with caution in this matter and the problem must be exhaustively studied and new developments made before it would be justifiable to make such an installation. The electrification of any large freight terminal would involve a number of roads, and cannot be undertaken by one road independently, without the co-operation of all the roads affected, on account of the relations existing among the various roads in the interchange of freight traffic.

General Conditions.

In an earlier stage of their report the committee set forth some general considerations which are worthy of special notice.

They point out that a great variety of service is permitted by reason of the flexibility of the electric system. Locomotives may be used independently, or motors may be applied directly to the cars. Locomotives or motor cars may be coupled in a variety of ways, and operated by means of the multiple-unit system, from one point in the train, which applies in any system of electrification. Public streets and highways may be occupied, if necessary, and operation in tunnels cease to be objectionable. Trains may be shorter and more frequent, or they may be of any size that business conditions dictate, consistent with mechanical considerations. A distribution of driving wheels throughout the whole train permits high acceleration, which, in turn, permits increased schedule speed without excessive increase in maximum speed. All of these features have a varying weight according to the circumstances of the particular problem at hand.

Electric service has been found to be but slightly affected by snow or other weather conditions. It is well known, however, that a steam locomotive loses a serious part of its steaming capacity in cold weather, not to speak of the care, and consequent expense, necessary in such weather to keep the locomotive, while idle, in condition to operate. With steam, the problem is to keep the locomotive hot, whereas, with electricity, the problem is to keep it cool.

It is a fact that the electric locomotive will have much less idle time, under the same conditions, than the steam locomotive. If desirable, the electric locomotive can be designed for practically continuous operation over any length of run. Many of the repairs, and almost all of its inspections can be made without the necessity of having to run the electric locomotive into the round-house, thus rendering unnecessary a large part of the round-house handling, and the possibility of having the continuous and immediate use of a locomotive, barring accidents, is very great. It should be noted, however, that while the electric locomotive is capable of almost continuous use, conditions frequently make such use impracticable. In the first place, much of the lost time of locomotives (particularly freight locomotives) is due to traffic and schedule conditions; and, second, while frequent visits to the round-houses may not be necessary, it may be desirable in order to increase reliability.

The maximum evaporating power of a locomotive boiler is constant, and, therefore, the maximum tractive effort cannot be maintained as the speed increases; and upon a long grade the element of human physical capacity enters in the person of the fireman. The electric locomotive, on the contrary, granting that the power house is large enough and that the distribution system is arranged for it, can draw all the current that it needs to produce its maximum tractive effort. This feature, however, is somewhat counterbalanced by the fact that the amount of power that can be delivered at a given point depends upon the carrying capacity of the distribution system, which, in turn, is fixed at the time of installation. In case of a serious congestion, or accident to the power supply, the electric system is not as flexible as a steam system, composed of independent steam units. It is only necessary to mention this feature to call attention to the increased attractivenesss of the electric train, whether running in the open or in a tunnel. In addition, the absence of destructive gases prolongs the life of station buildings and other structures, and preserves their attractiveness.

The absence of smoke and gas allows the utilisation of property usually occupied solely by station buildings for additional purposes, such as office buildings, and many other purposes which will in itself produce additional net revenue. The current can also be used for the purpose of furnishing electric lighting and power for any purpose. Schedule conditions will usually allow switching, and perhaps some other portion of the traffic, to be done at times of light load.

BLUE MOUNTAINS ELECTRIC SCHEME.

SOME FURTHER DETAILS.

In a recent issue we announced that an instructive scheme for combined lighting was being considered in the Blue Mountain District of New South Wales. Further details of the project are now to hand from the *Australian Mining Standard*. It appears that great interest is being manifested locally in what is felt to be an attractive scheme of supplying electric light and power to these Blue Mountains' townships. There are about 15 of them, between Glenbrook and Mount Victoria, and all, with the exception of Katoomba, will participate. The contract has been placed by the Blue Mountains shire council in the hands of Messrs. Blakey & Sinclair, electrical and mechanical engineers, of 338, Kent-street, Sydney. It provides for lighting streets and roads and for providing power for pumping and quarry working. The area to be covered, it is considered, will demand an exceptionally good load to supply private consumers, their requirements being about 5,000 units a week, and 1,000 units per week will be needed for power. Installations will be set up along the Great Western Railway and road. The places to be served will include Wentworth Falls, Springwood, Lawson, Blackheath, etc. There are 17,000 buildings in the area, most of the residents are well-to-do, and it is considered the scheme will be a great success commercially. Only one gas company is at present in opposition. The lighting of about 300 street lamps of 200 c.p. will be involved, and private consumers will be supplied at 6d. per unit, which rate will be reduced to 4½d. when the consumption amounts to a certain figure.

The supply is to be of the three-phase alternating current, and the voltage on the long distance transmission lines will be 2,200 volts. The area will be divided into three parts, each having its own generating station, and distributing east and west to the extremities. All the settlements will be served with the higher voltage, and a transformer station, supplying 240 volt alternating current for lighting and power purposes. The plants being installed at the three-power stations will include suction gas equipments as a prime mover driving 2,200 volt three-phase 50-cycle alternators by belt drive.

It is estimated that about 70 miles of mains will be erected straight off, and more is to follow at an early date. There will be installed in the first instance three 75 kw. sets, which will be duplicated as required.

We are told that the same firm are handling other similar schemes elsewhere, of which particulars will soon be available.

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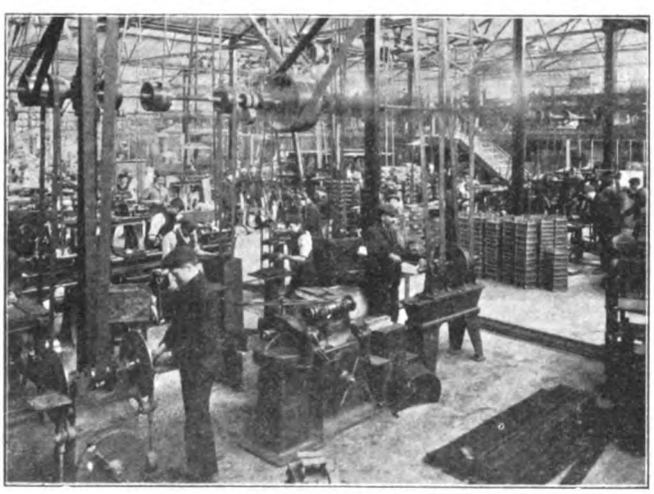
"IGRANIC" ELECTRICAL WORKS.

ADAMS MANUFACTURING CO.'S LATEST DEVELOPMENTS.

At the invitation of the Adams Manufacturing Co., Ltd., a representative gathering of members of the Technical Press paid a visit of inspection at the "Igranic" Electrical Works, Bedford, on the 8th inst. Since the firm launched out as pioneers in this country in specialising in the line of electrical control, the "Igranic" productions have become generally recognised as the hall-mark of excellence, and the opportunity of seeing the manufacture of the latest developments naturally aroused considerable interest.

The party travelled in special reserved compartments from St. Pancras to Bedford, being accompanied by Mr. A. H. Adams, Managing Director of the Adams Manufacturing Co., Ltd. On arrival at Bedford, conveyances were in waiting, and an enjoyable drive brought the visitors to the *Swan Hotel*, where they were hospitably entertained under the genial chairmanship of Mr. Adams.

It would be, of course, out of the question to expect to find control gear operating under working conditions at the works, but, by a happy thought, Mr. J. T. Mould (the enterprising sales manager) showed on a screen, lantern views of examples of apparatus, also applications illustrating control gear in connection with installations, with different controls, for all sorts of industrial purposes. Some of the pictures represented machinery installed in America; but it was all "Igranic" apparatus built at Messrs. Adams' allied factory in the United States. The apparatus shown in use in America is larger than anything of a similar type installed in this country, but Mr. Mould had the gratification to announce that the Adams Manufacturing Co. were



A CORNER IN THE WORKSHOPS.

engaged on preliminary work in connection with a very important firm of consulting engineers for apparatus on a similar scale for installation in this country. "We do believe," he said, "that our experience and actual achievements in work of this kind places us in a position of some advantage as compared with our competitors."

After another pleasant drive the party reached the "Igranic" Electrical Works, comprising part of an estate of between six and seven acres, lying in an angle formed by the intersection of the Midland and London and North-Western Railways. Surrounding the ground is a track on which the celebrated Adams' motor cars are tested. About half the land is occupied by the factory buildings, which are of entirely fire-proof construction (brick and steel with concrete floors), the roof being of saw-tooth pattern, with good north light for every portion of the works. The electrical works have a floor space of about 22,050 sup. ft., of which 4,050 sup. ft. are provided by a gallery which runs along the western side. Adjoining are the automobile works, with a floor area of about 21,500 sup. ft. Between the electrical and car shops is a main machine department, occupied with the manufacture of small parts common to both industries. The lay-out of the electrical shop is such as to reduce to a minimum the amount of handling necessary from the time when the goods enter this hive of industry as raw material and leave as finished articles.

Under expert guidance the visitors toured the various departments, where the large staff were busily engaged coping with shoals of orders from all parts of the world. "When we first began to specialise in electrical control," observed the principal of the firm, "the controller or starter or the speed regulator was a comparatively small proportion of any electrical installation. Now it is more and more regarded as the valve gear of the electric motor, and it has undergone, is undergoing, and, I believe, will continue to undergo the same process of development, only to a greater degree, that the valve gear has passed through. There are over 2,000 different types, sizes and voltages of apparatus in our list, and it would be manifestly impossible to do anything approaching the quantity required unless we had some system of standardisation. The principle on which we try to work is to have certain standard units which are common to a great many different types of apparatus. The control is being constantly modified, improved and extended."

Among the "Igranic" newest productions, the clapper and contactor type remote control switches merit special attention. Electrically operated, these switches have been primarily arranged for circuits carrying large currents, which may easily be controlled from a distance without the use of heavy conductors. The use of leads only sufficiently heavy to carry the magnet energising current is necessary, considerable saving results in cables and labour. It may be noted that the main circuit is carried by laminated copper brushes, and all circuit making and breaking is taken on copper and carbon sparking tips, easily renewable, and protected by powerful magnetic blow-outs. These switches are standardised from 5 to 10,000 amps. on voltages up to 600 volts. The "Igranic" step-by-step slow-speed gear also marks an advance in this particular line. This patent device gives a quick, positive movement between the steps, and a pause on each contact, although a continuous rotary motion is imparted to the spindle.

The firm are now placing on the market series relay automatic starters, designed for use with motors, the starting duty of which is heavy, such as pumps, air compressors, machine tools and lifts. The main feature is that the starting current controls the rate of acceleration of the motor.

The company have patented a distant-stop push button, which can be used with any starting switch having no voltage release features, without alteration to the starter.

Another interesting feature is a patented push button, fitted with magnetic locking device and indicator, for use on fully automatic push-button lifts. The arrangement can only be used in conjunction with the "Igranic" special lift controllers.

The smaller electrically operated main switches, already described, will be found especially adaptable for use with the firm's self-acting starters for the automatic operation of pumps, lifts, etc. The combination of the two on one base has the advantage of neatness and compactness, besides reducing expense.

The company have now designed and standardised a motor starting panel for use with small electrical applications, and which, although offered at a very attractive figure, still possess all the standard qualities of the larger "Igranic" universal motor starting panels.

"Simplicity" regulators, which the company are now introducing, will be found to be of sound construction, specially designed for use as machine, fans and field regulators, and also suitable for dimmers, vibrators, or ceiling fans. In these regulators, all the parts are readily renewable. The maximum watts capacity is 125, and the net weight of the apparatus only comes to 2½ lbs.

In multiple lever starters, the latest improvement is the toggle joint multiple lever starter, which should be in big demand when its advantages become generally known. The new pattern is a departure from the "Igranic" previous standard type using rigid levers, it being necessary to hold in each lever while the next in succession is being closed. The power required to apply to the handles in closing each switch is greatly reduced owing to the toggle action. The main current carrying brushes are of the laminated copper type, and each lever is fitted with an auxiliary copper sparking tip, readily renewable, and contacting with a heavy carbon brush. By this means destructive arching at the contacts is avoided.

Nor does this survey exhaust the list of new productions, for, in addition to treadle controllers for use with sewing machines and other small treadle-operated machines,

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the Adams Manufacturing Co. are also introducing a straight line multiple switch starter, specially designed for enclosing in dust and watertight covers, oil immersing, etc. By means of an up and down motion of a handle at the top, each switch is closed in succession. The first or bottom switch is held in by a no-volt release magnet, and is provided with carbon break and magnetic blow-out. The switch can also be fitted with an overload circuit breaker, interlocked with the first switch, which protects the motor against heavy overloads during starting.

The visit proved both interesting and enjoyable, and could not fail to impress one with the enterprise and progress of the manufacturers of the "Igranic" productions.

NEW ELECTRICITY ACT FOR INDIA.

SUMMARY OF CHANGES INTRODUCED.

DEVELOPMENT OF THE INDUSTRY.

(From our own Correspondent.)

"I believe that electrical enterprise is in its infancy in India, and I hope it is, because I look forward to developments far beyond anything accomplished up to the present."

Mr. Miller, *speaking in the Viceroy's Council, March* 18, 1910.

In July of last year Mr. Miller brought before the Viceroy's Council an Indian Electricity Bill to supersede that passed in 1903. In his opening speech he pointed out the chief reasons that made a new Act necessary. The fact that no adequate arrangements had been made by the 1903 Bill for the supply of electricity in bulk, has, as electricians know, interfered very seriously with the development of schemes for this purpose. Under the administration of the Act, again, it was necessary for anyone wishing to supply electricity in or to carry electricity through military or naval territory to obtain Government sanction, whereas in most other questions application was made to the Local Government. The result was delay and over-lapping, and as other alterations were necessary, it was thought better to repeal the old Bill. The July draft was therefore submitted to various local authorities for criticism, and after being very considerably amended by a select committee was passed by the Governor-General in Council on March 18. It is to come into force as soon as the rules made under it have been thrown into their final form.

The new Act is unquestionably a great improvement on the old. Slovenly drafting has been amended, and, what is particularly important, amended in these directions that experience has shown to be necessary. With details of this sort there is no occasion to deal. The following, however, are the more important improvements that have been introduced :—

Principal Alterations.

1. In the old Act the administration was placed under the control of the Local Governments and Municipalities, but in the hands of the Governor-General in Council for cantonments and "places in the occupation of Government for naval or military purposes"; the result was overlapping, on the part of the central and the Local Governments, occasional differences in the licenses granted by the two bodies, and delay and irritation. The new Act gives the granting of all licenses to the Local Governments, and only makes it incumbent on these bodies to obtain the consent of the General Officer commanding the division in the case of such places as cantonments.
2. Licenses cease to be compulsory, as it is thought "by no means certain that licenses are either necessary or desirable in the cases of industrial companies of certain classes." On the other hand, the non-licensee has to forego the many privileges in respect of the use of roads and so forth, enjoyed by the licensee, and is *de facto* restricted from supplying electrical energy to the public on any considerable scale. In this connection licensees are adequately protected.
3. Provision is made for the grant of licenses of bulk supply. Any distributing licensees in the bulk licensee's area may requisition a supply of energy, specifying all required details in connection with such supply; the bulk licensee may insist on a seven years' agreement giving a reasonable amount of profit, and is not bound to supply a greater rate per unit of time than is required for the licensee's purposes. The bulk-licensee must bind himself to supply energy even if the distributing licensee only comes to him for a portion of the power he requires, but in this instance special terms can be demanded. A year's notice must be given by the distributing licensee who wishes to terminate his agreement. Differences are to be settled by arbitration.
4. Somewhat elaborate changes—all to the interest of the companies concerned—have been introduced into the clauses dealing with compulsory purchase. These may be modified in the case of particular licenses. The maximum period after which an undertaking may be compulsorily expropriated has been altered from 42 to 50 years, and the subsequent recurring period from 10 to 20. After enumerating the terms of purchase (which hardly call for comment), the Act provides for an addition not exceeding 20% being paid over and above the market value of the lands, building and plant, as determined by the arbitrator. The object of the change from 10 to 20 years is, as stated in a preamble, to give sufficient inducement to a licensee to extend his works and add to his capital liabilities.
5. Arrangements have been made whereby a license may be amended instead of its having as hitherto to be cancelled and re-issued.
6. The existing hardship which prevented those on the fringe of a given area from enjoying the supply of that area, has been removed, the Local Government, under restrictions, being authorised to allow any licensee to supply energy to any person outside the area of supply. The privilege is adequately guarded to prevent abuse.
7. Special sub-clauses have been added to prevent excessive delay. After the posting of a licensee's notice, any objection must be sent in within three months, or it is not to be considered.
8. As the compulsory revocation of a part only of a given area for which a license has been given might cause hardship, the Act lays down that in such cases the area shall be regarded as a whole.
9. Greater freedom is allowed in the modifying of licenses, and in the dispensing with the obligation to furnish accounts to the Government.
10. The Governor-General is empowered to appoint a Chief Electric Inspector and Local Governments to appoint Provincial Inspectors.
11. Special provision has been made for the application of the Land Acquisition Act to electrical undertakings.
12. The penalties for interfering with the rights of electrical undertakings have in several instances been increased, and the liability of electrical undertakings for non-fulfilment of their agreements has in several instances been lessened.
13. The liberty of granting rebates has been made to correspond with English law and is left entirely to the licensee, subject to the proviso that no undue preference is shown.
14. The existence of mechanical contrivances whereby electricity could be obtained from companies' lines without passing through the meter, or of evidence that the meter has been tampered with, is laid down as constituting *prima facie* evidence of dishonest abstraction.

Distrust of Local Authorities.

There was a general feeling of optimism in the Council on the introduction of the Bill in its final form, as purged of many of the crudities that aroused criticism when Mr. Miller first brought it forward in Simla, and for such success as the Bill obtains, electricians will have to be grateful in no small measure to the re-drafting committee. There is still about it the rather offensive suggestion that any person other than a Government servant, who wishes to exploit and develop India, must necessarily be either a criminal or feeble-minded, and the usual uneasiness of the central body about granting any discretionary power to local authorities. In this connection it is well to remember that the Central Government (like every government, in fact), lives with the haunting fear ever upon it of certain terrible blunders it has perpetrated in the past; blunders, for instance, such as the permanent land settlement in Bengal, whereby it alienated for ever a most valuable source of revenue from the country. It is not unnaturally afraid that similar and worse blunders may be made by the local powers and prefers to keep everything it can in its own hands. This feeling, and the grandmotherly tendency of the British people—which in practice have worked well enough in the country—are chiefly responsible for the restrictions by which the development of the electrical industry is hampered. Still, the present Act removes the most onerous of the older disabilities. The rules under which the Act will be worked are to be drawn up by the committee, presided over by the Hon. Mr. Justice Carnduff, which has been responsible for amending Mr. Miller's Bill as originally drafted.

Comments in the Councils.

The following extracts from the debates in the council on March 18 are interesting as showing the state of electrical industry, broadly considered, throughout India.

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In moving that the Bill should be passed, Mr. Miller said: "I would venture to express a hope that it will be found satisfactory in promoting the development of electrical enterprise in this country. In deciding on the final form of its provisions, we have had the benefit of many suggestions and criticisms affecting the terms of the original Draft Bill. All of these have been carefully considered and to many of them effect has been given. We have had the experience of the working of the existing Act and have attempted to remove any difficulties that have been found to exist, whether difficulties of a technical or a legal description. The Bill is more favourable to the industrial and commercial interests involved than the Act which it will supersede, and we have had the great advantage of having the Hon. Mr. Rawson, on the Select Committee, to watch over the interests. The Bill is also more elastic in its provisions and Local Governments will have a freer hand in working than before. In asking permission to introduce the Bill at Simla last year, I referred to electrical enterprise as being in its infancy in this country. That remark was somewhat severely criticised as arising from ignorance of what had been accomplished already. I adhere to it. I believe that electrical enterprise is in its infancy in India, and I hope it is, because I look forward to developments far beyond anything accomplished up to the present. If we look to the future the possibilities are greater here than in England. We have done hardly anything to utilise power in our canals and rivers, and, though a few licenses have been issued, only in twelve has action been taken finally. I think there is a great field before electricity, and that we are only on the threshold of its usefulness."

Electricity in America, England and India.

The Hon. Mr. Frank Rawson expressed his thanks to the Viceroy for having appointed a company representative to sit on the Select Committee. He considered the Bill far in advance of any Electricity Bill yet produced. It was naturally technical and complicated as it was necessary to consider the great interests of the Government of the companies on licenses, the consumers and the local authorities, who may want to purchase an undertaking after the period fixed in the license. When the Bill was first introduced there were many criticisms. All the reasonable ones had been embodied in the Bill and he congratulated Mr. Miller on having so successfully reconciled the various interests. He said that only 6¾ crores (4½ million pounds) were in electricity in India, as against 150 (100 million pounds) crores in England and 300 crores (200 million pounds) in America, and it must be remembered that the conditions in India differed very greatly from those in Europe, as regards the number of potential consumers. Even in the Presidency towns, where there were, of course, large numbers of Europeans and Indians, who were certain consumers, and more so in other towns, the percentage of non-potential consumers must be taken at quite 90%, and so the licensee had to depend on not more than 10%, the outside of the population, to obtain a remunerative return on his capital. Towns, too, in India were generally spread over a large area and this entailed heavy expenditure on mains. The mains of the Calcutta Electric Supply Corporation alone, if laid down on a map of London, would extend from Whitechapel to Hammersmith (east and west) and from St. John's Wood to Clapham (north and south), an area which in London is supplied by seven or eight companies. It was thus evident that the cost of cables in comparison with the houses connected on the route must be extraordinarily high in Indian towns as compared to English or European towns. This was one of the reasons why generous terms were necessary to attract capitalists, and Local Governments had now the opportunity under the new Act of availing themselves of its provisions to grant them. He alluded to the increasing cases where some people obtained supplies at their neighbours' expense, and finally said he thought the new Act would encourage the starting of fresh companies and enable the non-paying companies to obtain new licenses on more favourable terms from Government.

The text of the new Act is pubished in the *Gazette of India*, of March 5, 1910. The original text, with a long preamble, setting out the alterations and the reasons for which they were made, was published in the *Gazette* of July 31, 1909. The text of the old Bill of 1903 can be found either in the *Gazette* or in *The Times of India Directory*, for 1904.

BALLISTIC ELECTRODYNAMOMETER FOR MEASURING HYSTERESIS LOSS IN IRON.*

By MARTIN E. RICE and BURTON McCOLLUM.

In all electrical machinery containing large quantities of iron in which the magnetic flux is continually varied considerable power is expended due to magnetic hysteresis. This not only gives rise to a continual loss of energy, but this dissipated energy heats the apparatus. The latter effect is generally much more serious than the former, for the power output of an electrical machine is largely determined by the allowable heating; so it is evident that an excessive hysteresis loss very materially lowers the practical output and rating of a machine. It becomes, then, of great importance to the designer and to the manufacturer to be able to predetermine these hysteresis losses accurately. This requires that a sample of every lot of iron be tested before that iron is accepted and used, in order that only such iron shall be used as will make the hysteresis losses satisfactorily small. It is the purpose of this paper to present a new and accurate method for making such tests of iron.

A fairly complete test of the magnetic qualities of a sample of iron should include three things: The "B-H" curve, the hysteresis loop, and the hysteresis loss per cycle for any specified value of the maximum magnetic flux density. For nearly all commercial purposes it is sufficient to know the hysteresis loss per cycle for any specified value of the maximum magnetic flux density. The method here presented is an especially direct and rapid one for this purpose. The procedure is as follows:—

The sample of iron to be tested should be laminated, the thinner the better. Laminations of ordinary commercial thickness, 15 to 40 mm., are satisfactory. The laminæ should be separated by sheets of paper. This ensures that eddy current losses will not be unduly increased by conduction from one sheet of iron to the next. The laminæ may be cut into the form of closed rings and wound by hand, the magnetic circuit then being a closed one; or they may be cut into the form of half rings and inserted into ready wound magnetising and test coils, the magnetic circuit in this case having short air gaps. The latter arrangement, while perhaps not satisfactory for obtaining the true B–H curve, is practically as good for obtaining values of the maximum magnetic flux density and corresponding values of the hysteresis loss per cycle. It is also exceedingly convenient in that, when the apparatus has once been set up, many different samples of iron can be tested in a short time.

The chief instrument needed is a rather sensitive electrodynamometer that can be used ballistically. The fixed or field coils of the dynamometer should be capable of carrying the current used in magnetising the iron under test; and the movable coil of the dynamometer should have a rather long period of oscillation, say, 35 to 40 sec. The other instruments required include a standard mutual inductance, or a standard condenser and a standard cell; two reliable ammeters, resistance boxes, reversing switches, load rheostats, and choke coils.

To Determine the Value of the Maximum Magnetic Flux Density, B.

This may be determined, if desired, by using a ballistic galvanometer in the ordinary way. If no good ballistic galvanometer is available, or if it is desired to make the complete test with a single ballistic instrument, as often might be the case in practical work, the value of B, and even the complete B–H curve, can be obtained by using the ballistic dynamometer as follows:—

Maintain a steady current in the field coils of the dynamometer. The instrument can then be calibrated and used precisely as a D'Arsonval ballistic galvanometer. The necessary value of the magnetising current, I, to produce a desired value of maximum magnetic flux density, B, in the iron under test can then be determined. Using a mutual

* Report from the Laboratory of Physics and Electrical Engineering of the University of Kansas Engineering Experiment Station.

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inductance for calibrating purposes, the arrangement of circuits for obtaining values of magnetic flux density is shown in Fig. 1.

In the diagram, Fc represents the field or fixed coils of the electrodynamometer and Mc represents the movable coil of the instrument. M_1 represents the mutual inductance used in calibrating, n_2' being the secondary coil. The movable coil Mc of the dynamometer can be connected at will to either the test coil on the iron C_2 or the secondary coil of the mutual inductance n_2' by the double-throw switch, as indicated by the dotted lines. The iron ring is marked Fe, and the rest of the diagram is self-explanatory.

With the movable coil of the dynamometer connected to the test coil on the iron, reverse the magnetising current, I, and note the dynamometer throw, d, a measured current, I″, being maintained in the field coils of the dynamometer; next, with the movable coil of the dynamometer connected to the secondary coil of the mutual inductance, reverse the current in the primary coil of the mutual inductance, and note the dynamometer throw, d′, a measured current, I′, being maintained in the field coils of the dynamometer. The value of B in lines per cm² can then be calculated from the equation—

$$B = \frac{\rho\, n'_2\, R_2\, d\, I'}{A\, n_2\, R'_2\, d'\, I''} \qquad (1)$$

where R_2 and R'_2 are the total resistances in the circuit of the movable dynamometer coil, respectively; n_2 and n'_2 are the number of turns in the test coil and in the secondary coil, respectively; A is the cross-sectional area of the iron under test; and ρ is the total effective flux linking with the secondary coil of the mutual inductance, and which is

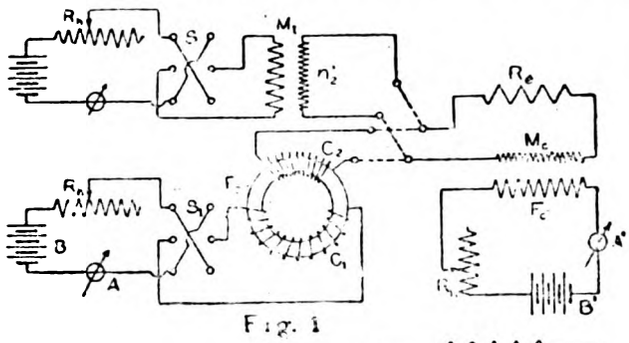

Fig. 1

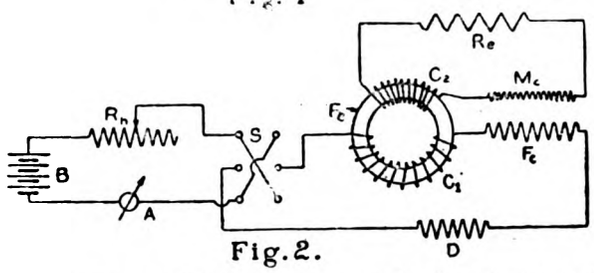

Fig. 2.

obtained by multiplying the current in the primary coil of the mutual inductance by the coefficient of mutual induction. If a suitable mutual inductance is available, I′ can be made equal to I″, thus simplifying the equation. The complete B–H curve can be obtained if desired. In this case, the value of H in lines per cm² is calculated from the equation—

$$H = \frac{4\,\pi\, n_1\, I}{10\, L}, \qquad (2)$$

where I is the magnetising current in amperes, n_1 is the total number of turns in the magnetising coil, and L is the total length of the magnetising coil in cm. This equation is true, of course, only for closed magnetic circuits.

To Determine the Value of the Hysteresis Loss Per Cycle, W_h.

The arrangement of circuits is shown in Fig. 2. In this diagram, the coils of the electrodynamometer are indicated as in Fig. 1. The movable coil, Mc, is connected in series with the test coil, C_2, on the iron and an adjustable resistance, Re. The field coils, Fc, are connected in series with the magnetising coil, C_1, on the iron and a choke coil, D. The reversing switch, S, should be so constructed as to close the circuit in the new position before the circuit in the old position is opened. The rest of the diagram is self-explanatory. Reverse the magnetising current, I, and note the dynamometer throw, θ. Use the value of I corresponding to the value of B maximum desired, as determined by the arrangement in the preceding paragraph. The total loss, W, in joules per cycle in the iron under test can then be calculated from the equation—

$$W = 2\,\theta\, n_1 \frac{2\,\Phi\, I'\, n'_2\, R_2}{10^8\, d'\, n_2\, R'_2}, \qquad (3)$$

where the letters have the meanings already given above. This value of energy loss per cycle includes a small and usually negligible eddy current loss. If it is desired, the eddy current loss can be calculated approximately, and its value deducted from the above value of the total iron loss, thus giving the true hysteresis loss per cycle, W_h. To do this, observe the pointer of the ammeter in the magnetising circuit of the iron under test, while the current is being reversed, and note the time required for the pointer to fall and rise again to its former position. This is, roughly, the time of a half period of the hysteresis cycle. The eddy current loss, W_e, in joules per cycle in the iron under test is computed from the equation—

$$W = 1{\cdot}645\ t^2\ f\ B^2\ V\ 10^{-11}, \qquad (4)$$

where t is the thickness of a lamina in cm., f is the reciprocal of the period of the cycle, B is the maximum magnetic flux density in lines per cm², and V is the volume of the iron in cm³. By inserting a choke coil in the magnetising circuit of the iron under test, the period of the hysteresis cycle can be made so long, one to three seconds, that the eddy current loss will be less than 1% of the total iron loss. In such cases a very rough estimate of the time of the period of the hysteresis cycle will enable the eddy current loss to be computed with ample accuracy.

Thus, when the apparatus has been set up and calibrated, one reading suffices to determine the value of the maximum magnetic flux density, B, and another reading to determine the hysteresis loss per cycle, W_h. Each reading has only to be multiplied by a single numerical factor to give the final result desired. Hence it is possible to test a large number of samples of iron and to compute the final results in a comparatively short time. A complete numerical illustration follows, the data being taken from one of the tests made by the writers on a sample of rather heavy sheet iron. The iron was in sheets of 25 mm. thickness, and was cut into the form of closed rings. Thirty of these rings were assembled and wound with a magnetising coil and a test coil. The mean dimensions were: Length of magnetic circuit, L = 60·66 cm.; cross-section of iron, A = 4·195 cm²; volume of iron, V = 254·5 cm³; the thickness of a lamina, t = ·0635 cm. With steady currents maintained in the field coils of the dynamometer, throws were observed with the movable coil connected to the test coil of the iron and to the secondary coil of the mutual inductance, respectively. A value of current in the primary of the mutual inductance was used which gave a total magnetic flux in the secondary coil of ρ = 58,735 lines. Substitution in equations (1) and (2) gives—

$$B = \frac{58{,}735\cdot \times 10\cdot \times 1242{\cdot}4 \times d \times 1{\cdot}486}{4{\cdot}195 \times 20\cdot \times 1242\cdot \times 10{\cdot}34 \times 1{\cdot}446} = 677{\cdot}0 \times d.$$

$$H = \frac{4 \times 3{\cdot}1416 \times 272 \times I}{10 \times 60{\cdot}66} = 5{\cdot}636 \times I$$

The values of d and I used were d = 17·34 cm and I = 1·446 amperes, giving B = 11740, and H = 8·15, each in lines per cm². Data for a complete B–H curve can be obtained by taking a number of corresponding readings of d and I. Substitution in equations (3) and (4) gives—

$$W = 2 \times \theta \times 272 \times \frac{2 \times 58{,}735\cdot \times 1{\cdot}486 \times 10\cdot \times 1245{\cdot}6}{10^8 \times 10{\cdot}34 \times 60\cdot \times 1242\cdot} = {\cdot}01533 \times \theta$$

$$W_e = 1{\cdot}645 \times ({\cdot}0635)^2 \times {\cdot}5 \times B^2 \times 254{\cdot}5 \times 10^{-11} = {\cdot}833 \times 10^{-11} \times B^2.$$

The value of B was the same as above, and the value of θ was 11·48 cm., giving the total iron loss per cycle, W = ·1760, and the eddy current loss per cycle, W_e = ·001146, each expressed in joules.

The difference, $W - W_e$, gives the true hysteresis loss, W_h = ·1748 joules per cycle. Dividing this result by the volume, V, of the iron under test gives the hysteresis loss in joules per cycle per cubic centimeter, namely, ·000687 joules. The value of W_e is usually so small, as in the above illustration, that for nearly all commercial work it can be

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entirely neglected. The hysteresis loss, W_h, is then given immediately by the expression for the total iron loss, W, thereby shortening the calculations materially.

The writers have shown * by mathematical proof that the ballistic dynamometer measures both the iron loss and the loss in the test-coil circuit. By making the period of reversal of the magnetising current long, say, 1 to 1½ sec., the eddy current loss in the iron can be kept below 1% of the total iron loss. This can be accomplished by adding one or more choke coils in series with the magnetising circuit, sufficient to make the period of reversal of the desired length. The I^2R loss in the test-coil circuit can easily be made entirely negligible by using a moderately high value of R^2. The first of the above conditions requires that the period of swing of the movable coil of the dynamometer shall be relatively long, say, 35 to 40 sec., in order that the discharge through the movable coil of the dynamometer shall have taken place before the coil has moved appreciably. The writers have shown experimentally that when the period of swing of the dynamometer coil is 30 or 40 sec., no appreciable error is introduced by making the time of reversal of the magnetising current as great as 1½ sec.

Referring to equation (3) for calculating the total iron loss per cycle, W, it is seen that the quantities to be measured are θ, ϕ, I', d', R_2, R'_2. The value of R_2/R'_2 can easily be determined with an error of 0·2% or less, if ordinary precautions are taken against wide variations in temperature. The value of I'/d' can usually be determined with an error of 0·3% or less. The value of ϕ can be relied upon as closely as the ammeter reading in the primary coil of the mutual inductance, which, if a good instrument is used, should be accurate to within 0·2%. The value of θ can be read easily within 0·2% with such slow moving instruments. If all these errors should combine to affect the value of W in the same way, the total error in W would be 0·7% or less. Since the eddy current loss, W_e, is usually considerably less than 1% of the total iron loss, W, even a very rough estimate of its value would enable the true hysteresis loss, W_h, to be determined with a maximum error of 1% or less. This degree of accuracy is readily attainable with good instruments.

As a further comparison, the writers made a test of a sample of good transformer iron in sheets of 15 mm. thickness, by both methods. In this case the electrodynamometer was calibrated by means of a condenser and standard cell. The results were: By the dynamometer method, hysteresis loss in sample ring = ·05747 joules per cycle for B maximum = 7548 lines per square centimetre; by the ballistic galvanometer method, hysteresis loss = ·05732 and B = 7552. This agreement is well within the limits of experimental error.

A similar examination of the equations employed in the ballistic galvanometer method shows about the same degree of accuracy attainable, theoretically. In practice, this accuracy may be realised if the new single step procedure suggested by A. Hoyt Taylor in the *Physical Review* (vol. XXIII., p. 95) is followed. If the old and ordinary, successive step by step, procedure is followed, far less accuracy can be hoped for, if, indeed, any accuracy at all is attainable. By either procedure, data for at least 15 or 20 points must be taken, a curve plotted and its area in B–H units determined, so that the test of a sample of iron by the ballistic galvanometer method is a considerable task.

In regard to the comparative time required to test a sample of iron by the dynamometer method and by the galvanometer method, it is only necessary to note that the single reading required by the former method can be taken as quickly as any one of the many readings required by the latter method. Further, when using the dynamometer method it requires but a few moments to calculate the final results from the data obtained; while with the ballistic galvanometer method it is necessary to go through the tedious operation of plotting a curve, measuring its area with a planimeter, and then calculating the final results.

It is thus seen that by the ballistic dynamometer method of testing the hysteresis loss in iron, results of the same accuracy are obtained as by the very tedious ballistic galvanometer method in its best form. And these results are obtained with equal or greater rapidity than by the other admittedly far less accurate methods commonly employed.

Before concluding this paper, it may be helpful to others using the ballistic dynamometer method for the first time to mention some of the precautions that should be taken in any such work, and to describe a suitable electrodynamometer. In all work of this character four readings should be taken for each point: two with fixed test-coil connections, the primary or magnetising current being reversed once in each direction; two with reversed and fixed test-coil connections, the primary current being again reversed one in each direction as before. This procedure eliminates all effects of stray magnetic fields on the iron under test and on the movable coil of the dynamometer. It should be followed in both the ballistic dynamometer method and the ballistic galvanometer method, and for the same reasons. It is preferable to set the dynamometer in such a position that a current in its movable coil will not cause a deflection due to the magnetic field of the earth. All ballistic deflections, taken by either method, should be corrected for damping in the usual way. If a series of readings is to be taken requiring a very wide variation of current in the magnetising circuit, it is best to vary this current partly by changes in the voltage supplied rather than to depend entirely upon changes in resistances, in order that the time constant of the magnetising circuit be kept large for all values of current used. This keeps the period of the hysteresis cycle sufficiently long to insure a small value of eddy current loss.

If a suitable electrodynamometer is not at hand, one may be made as follows: Suspend the moving coil of a D'Arsonval galvanometer in the usual manner, using a rather long fine strip above. If its period of swing is not long enough, it may be increased by fixing two small weights at opposite ends of a light wooden strip attached horizontally to the movable coil. The moving coil and its suspensions should be enclosed to protect it from air currents and sudden changes in temperature. The field coils may consist of two large coils of heavy wire set close to the case containing the movable coil and large enough to give a field throughout the region occupied by the movable coil. All masses of metal, such as brass tubes or cases, should be rigidly avoided in the construction of such an instrument, in order to avoid entirely any disturbing effects from eddy currents.

* Physical Review, vol. xxviii., No. 2, August, 1909.

CANADIAN ELECTRICAL ASSOCIATION.

ANNUAL CONVENTION.

As a result of a postal vote, the Managing Committee of the Canadian Electrical Association have decided to hold their annual conference at Royal Muskoka, the Committee holding that it is advisable to defer going to Ottawa until 1911, when the Chateau Laurier will be completed. The annual convention will therefore be held this year at the Royal Muskoka, Lake Rosseau, from July 6 to 8 inclusive. Mr. W. L. Adams, of the Ontario Power Co., Niagara Falls, has consented to act as Chairman of the Committee of Arrangements, and M. A. L. Mudge, of Smith, Kerry & Chace, Toronto, as Chairman of the Papers Committee. Mr. T. S. Young, Confederation Life Building, Toronto, is Secretary-Treasurer of the Association, from whom all particulars regarding the convention may be obtained.

WIRELESS TELEGRAPHY DETECTOR.—According to the *Australian Mining and Engineering Review*, a wireless telegraph detector has been invented by Mr. J. H. A. Pike, of Arncliffe, New South Wales. By its use, and with wires at a height of 50 ft., Mr. Pike has been enabled to intercept messages flashed by H.M.S. *Powerful* from near Auckland, New Zealand, to the warships lying in Sydney Harbour, a distance of 1,350 miles, after the latter were unable to keep up communication. At various times the inventor has been in communication with shipping at all ports of the Australian capitals, excepting Perth, and confidentially anticipates being able to receive messages over a range of 1,500 miles. Messages are recorded telephonically, and can be distinctly heard 3 ft. away from the apparatus. It is claimed for the invention that it is more sensitive and delicate than any detector known.

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ENCOURAGING FIGURES.

Two publications have made their almost simultaneous appearance which are somewhat in the nature of reports on the census of our electrical enterprises. The Orange Book issued by the Statistical Branch of the London County Council merely deals with the undertakings within the administrative county for the year 1908–9, and is only concerned with the generation and supply of current. "Garke's Manual of Electrical Undertakings," on the other hand, is far more comprehensive, taking in the whole of the United Kingdom, and touches upon not only supply, but telegraphs, telephones, traction, manufacturing and miscellaneous. Moreover, the Manual is, for the most part, brought down to 1909–10. It is convenient for the present, however, to consider these two valuable returns together for certain particulars. Taking the administrative county area returns, we find included 16 metropolitan boroughs, and extra London 8 municipal corporations (Croydon, Ealing, East Ham, Gravesend, Hornsey, Kingston, West Ham and Wimbledon), 19 urban district councils; 13 companies within London and 19 companies extra London. The total area covered by these various bodies is 616 square miles, with a population of 6,604,974, and 996,327 houses. It is curious to note that within one-fifth of a square mile of London, having a population of 3,579 and 621 houses, there is no authorisation to supply electricity! In extra London several of the municipal bodies and companies have powers (and exercise them) to supply areas outside that taken into account by this Orange Book. One metropolitan borough supplies another with electricity in bulk (Poplar and Stepney respectively), while there are nine companies possessing the privilege of supplying in bulk. The total capacity within London was 215,334 kw. (respectively 68,170 kw. for borough councils and 147,155 for companies), the maximum load on the feeders during the year, however, was respectively 41,301 and 95,140. Among the boroughs, the largest outputs must be credited to St. Marylebone with over nine million units, 13% of which was disposed of for power and heating. Shoreditch came next

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with over 7,535,000 units, 21% being utilised for power and heating. Next came Stepney with over 6,833,000 units, 38% going for power and heating. The largest output for power and heating purposes was at Poplar, which, with an output of 5,845,000, sold 68% for power and heating. Then came Hammersmith with a total output of over 6,762,000, and a percentage for power and heating of 64; Battersea with a percentage of 59, and Shoreditch with a percentage of 49. The lowest power and heat percentage was 9 at Hampstead, with a total output of nearly four-and-a-half million units. As regards the companies, the largest total output was by the City of London, with 24,560,406 units and a power and heating percentage of 29. The Charing Cross Co., with a total of over 21,700,000 units, disposed of 43% for power and heating in the city and only 18% in the West-end. Then came the Central with 18,859,180 units (supplied in bulk to the St. James and Pall Mall and the Westminster Co.'s); Westminster with 18,315,792 units and a power and heating percentage of 23; the County of London with an output of 13,610,760 units and a percentage of 49. Coming to extra London, we find the largest output by a public body credited to West Ham, with units disposed of 15,522,065, of which 53% was for power and heating and 30% for traction. The next was Croydon with an output of over six millions, 7% being used for power and heating and 52% for traction. As regards the companies, the largest total output was made by the North Metropolitan Supply, with 14,069,611, of which 64% was for power and heating and 35% for bulk supplies and for supplies to large consumers. The capital account records are instructive. At the date of the returns the Metropolitan Boroughs had borrowed over £6,110,000 in respect of electrical undertakings, at an average percentage of 3·59, and had paid off 10·61% of the debt. The largest capital investment was made by St. Marylebone, with over two millions. The total capital of the companies was £19,307,440, upon which an average interest or dividend of 4·63% was paid (highest 9·28% by Brompton and Kensington). Extra London, the largest capital outlay by a municipal body was at West Ham, the amount being £449,898, of which £368,299 was raised by loan (and of which £93,599 has been paid off). The largest capital of an extra London company is that of the North Metropolitan Supply, at £476,520, plus a debt of over £72,000 owing to Willesden Urban District Council on the purchase of a generating station. As regards working expenses, we find that the total expenditure (but not including rates and taxes) in respect of working per unit sold averaged in London for the municipal bodies 1·08d. (highest 2·12d. at Stepney, lowest ·77d. at Hackney, where, by the way, the refuse destructors raise steam for the electricity works). The average for the companies is higher at 1·16d., but the highest figure is only 1·79d. at Notting-hill, while the lowest is ·72d. for the city branch of the Charing Cross Co. The average combined prices obtained per unit (including meter rentals) is 2·50d. for private supply and 2·36d. for all purposes by the Metropolitan Boroughs, and 3·10d. for private supply and 2·94 for all purposes by the companies, the highest and lowest figures being respectively: Boroughs—Stoke Newington, 3·88d. and 3·79d.; Poplar, 1·55d. and 1·54d. Companies: Notting-hill, 4·66d. and 4·49d.; City of London, 2·66d. and 2·59d. (this is excluding the Central, who receive 1·02d. for bulk supply). Extra London, the averages are for municipal bodies: 2·50d. for private supply and 2·11d. for all purposes, and for companies 4·38d. and 2·19d.; the highest and lowest figures are respectively: Bexley, 5·26d. and 5.76d.; and Erith, 2·16d. and 2·09d.; Chislehurst, 7·04d. and 7·03d.; and North Metropolitan Supply, 3·14d. and 1·29d. It should be noted that this last named company is in business primarily for bulk supply; the high price of 3·14d. per unit is for private supply within the authorised distributing area of Edmonton and Tottenham. So far for London and its immediate neighbourhood.

Now as regards the United Kingdom as a whole, in Mr. Garcke's Annual we find returns of 32 telegraph companies in 1910, being two less than in the previous year, while the capital invested in this branch of company work has decreased by about £600,000 to £35,477,300. We find 15 telephone companies, the same number as in 1909, but with an increase of capital of about £600,000. The supply companies now stand at 239, seven more than last year, with a capital of £47,047,800, an increase of capital of a little over one-million-and-a-half. Traction companies stand at 205, one more than last year, with a capital of £149,206,200, an increase of over six millions. Manufacturing companies now number 265, as against 335, but there has only been a drop of about half a million of capital, thus the the diminution points to certain amalgamations. There is also a drop in miscellaneous electrical companies from 204 to 140, but with a drop in capital of over five millions. There are four municipal telephone undertakings, the same as last year, but with an increase of nearly one million seven hundred thousand pounds to £9,958,700. Supply undertakings, we are told, have dwindled from 353 to 316, but, in spite of substantial payments in reduction of loans, the capital invested has risen by nearly one million to £42,618,000. Traction undertakings are less by seven at 171, and the capital has increased by over £700,000 to £42,800,500. Coming to the trading side, we find that the supply undertakings have sold more current—the company output standing at 388,783,000 (an increase of nearly fifty million units), and the municipal output at 638,637,000 (an increase of over twenty-three million units). The disquieting thing is that the average cost of production, in spite of the increased output, has risen from 1·45d. to 1·54d. per unit, the selling price rising from 2·71d. to 2·81d. per unit. On the other hand, the municipal authorities have succeeded in reducing their average cost of production from 1·0d. to ·92d. per unit, while they have reduced the price from 2·02d. to 1·89d. per unit. This is certainly a result of which local bodies as a whole may well be proud. If we take the whole of the private capital invested in electrical enterprises we find a slight falling off of dividends earned, the average being 3·89%, a decrease of ·06%; but while the earnings of the traction and manufacturing firms remain practically stationary at 2·95% and 5·22% respectively, the supply undertakings have bettered their

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positions, their earnings now being on an average 4·32%, or ·9% per cent improvement. It appears that while gross earnings have risen considerably, most of the increase has been wiped out by a rise in working expenses. Still, these two very different forms of overhauling the material positions of electrical engineering undoubtedly point to a steadily progressing and improving state of trade.

ELECTRICAL THEORY OF DYEING.*

By Professor W. W. HALDANE GEE, B.Sc., M.Sc.Tech., and WILLIAM HARRISON.

The literature relating to the causes of dyeing reveals great differences of opinion as to the physical and chemical phenomena involved. The main theories are summarised** in Dreaper's "Chemistry and Physics of Dyeing," where we read: "Even to-day (September, 1906), with our extended knowledge, we are ignorant of the exact and complete causes which bring about many of the complicated effects, which are classified under the comprehensive term dyeing." To the theories discussed by Dreaper must now be added an electrical one. Its basis is that any two bodies placed in contact are oppositely electrified. In the case of tinctorial chemistry one of the bodies is a non-conducting solid and the other a liquid. There does not seem to be any direct method of obtaining the value of the potential difference between such bodies. We can only avail ourselves of the classic theory of von Helmholtz, which enables the potential difference between a liquid and a porous diaphragm to be deduced.

The first question which requires an answer in considering the electrical theory is, "What is the nature of the dyeing solutions?" Pelet-Jolivet and Wild† conclude that they behave as electrolytes, and in the case of benzo-purpurine, chrysophenine, soluble blue, erika, and naphthol yellow, Knecht and Batey‡ have shown undoubtedly that their solutions are electrolytes. Now, since the dyeing solutions are usually employed hot and dilute, the ionisation must be fairly complete. Thus a suitable bath for dyeing wool with crystal scarlet (a sodium salt of the molecular weight of 502) would be: Water 100 times the weight of the wool, and crystal scarlet 5% on the weight of the wool. This gives a solution about $\frac{1}{1000}$ normal, and it would be used at 90° C. to 100° C.

The experiments carried out by us have shown that wool and silk are negatively electrified in contact with water, and the electrification apparently increases up to 40° C. and then decreases. Hence in dyeing wool or silk which are "wet out," before entering the dye vat they must have a negative charge. Suppose the dye be basic and represented by $n - P$, where n is a small *negative* ion, and P a large *positive* organic basic ion. These ions will be free, and when the wool or silk is placed in the solution the basic ions will be attracted by the negatively electrified fibres, and be fixed by some process which cannot yet be considered as properly understood.

The small ions will combine with the H-ions which are present in the so-called double layer. If inorganic electrolytes are also present in the solution and are of an alkaline nature, they will tend to make the fibre still more negative, and will assist the process of dyeing.

In the case of acid dyes we deal with substances of the nature $p - N$, where p is now a small *positive* ion and N a larger *negative* ion. In this case acid is either added to the bath or the fabric has been previously boiled with acid. In each case the fibre takes a positive charge, as shown by our experiments. The result will be that N will be attracted to the positively electrified material, whilst p will form a salt in the vat.

This alone is a simple statement of the electrical theory, and there are many facts which it seems to explain. Thus Knecht has shown that wool and silk when dyed with basic colours until the dye bath is exhausted, the whole of the HCl is left quantitatively in the bath. We have found that in dyeing tanned cotton with a colloidal solution of night-blue picrate the picric acid was likewise left quantitatively in the bath. In these cases the negatively charged fabric appears to take up the whole of the positively charged complex ion. Knecht has also shown that in dyeing wool with the magnesium salt of crystal scarlet (an acid dye) in presence of free acid the magnesium was left quantitatively in the bath. Here the + charged fabric attracts the —ve acid and repels the +ve base.

We have not dealt with "Direct Dyeing" because salts are added to the bath. These additions alter the conductivity, viscosity, and dielectric constant, and Perrin states that the "contact-charge" is reduced. We are investigating these points.

The ionising liquids are those which produce strong electrification by contact, and it is in such liquids that dyeing is possible. The so-called "dry" dyeing processes are carried on with alcohol, which is an ionising liquid, or more frequently with aqueous alcohol, in which the ionising power is greater. The use of benzole for dyeing is only possible when water is present either in the solution or the fabric, for benzole is a poor ionising liquid. On the other hand, the bleeding or even complete removal of the dye from a dyed fabric is only possible by ionising liquids. A good example is wool dyed with picric acid. This acid can be extracted from the fibre by alcohol but not by benzene. It is also interesting to note that dry wool will not dye from a benzene solution of picric acid.

It has been shown by Burton§ that alcohol favours the production of positive ions only, and therefore when added to wool the negative charge is likely to be destroyed, and so prevent the assimilation of a positive base.

When acid (such as H_2SO_4) is used in dyeing it is required to set free the colour acid, but in practice it is known that an excess of acid is very desirable. The reason of this has not been satisfactorily explained.‖ If we accept the electrical theory, then the extra acid will be required to make the fibre take a positive charge. It is possible that in the case of a very strong acid colour the colour acid may itself be sufficient to produce a positive charge on the fabric.

Another interesting application of the electrical theory applies to the filtration of dyes through various media. Neutral bodies such as sand are able to retain certain dyes. Since these bodies take a negative charge in pure water they ought to be able to absorb—and not simply filter off—basic colours in neutral solutions. The case of animal charcoal, which absorbs acid colours in acid solution, is likewise explained, since this takes a strong positive charge, probably owing to nitrogenous substances ** present. It will appear from the experiments of Lewis†† that *adsorption* does not explain the large amount of dye that is taken up. No doubt surface action will be sufficient to explain the relatively small amount of dye absorbed in the case of sand and graphite when acid colours are used.

A strong confirmation of the electrical theory is afforded by the amount of absorption of dye stuffs at different temperatures. Brown‡‡ has shown that with basic colours the maximum amount of dye stuff absorbed is at about 40° C., and is a minimum at about 80° C. Our results show that the maximum negative charge is apparently attained at about 40° C., and the minimum at about 80° C., the nature of the fibre having but little effect.

It is known that the dyeing of acid colours on wool is best performed at a boiling temperature. In one of our experiments on wool boiled with acid, we found that the wool had a positive charge at 85°, which decreased and changed to negative on cooling. This may help to explain why wool boiled "with acid and subsequently washed has a considerably decreased affinity for basic dyes, but its affinity for acid dyes is increased."‖‖

The effect of the addition of Na_2SO_4 to acid dye baths is to cause a restraining action and diminish the rate of the absorption of colour, and this continues after the amount

* Abstract of paper read before the Faraday Society.
** "Phys. Zeit." 6, p. 201, 1905.
† "Rev. Gen. des. Mat. Col.," p. 9, 1909.
‡ "J.S.D.C." 25, p. 194, 1909.
§ "Phil. Mag.," 11, p. 445, 1906.
‖ See Dreaper, pp. 89-91.
** Knecht, "J.S.D.C." 25, p. 266, 1909.
†† "Phil. Mag.," 1908.
‡‡ "J.S.D.C.," 17, p. 92, 1901.
§§ Dreaper, p. 99.
‖‖ Dreaper, p. 91.

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of sulphate added has been sufficient to form bi-sulphate. This is evidence that the salt diminishes the positive character of the charge, as Perrin proves

The electrical theory as so far developed explains how one type of colouring matter is selected in preference to another by the fabric, but how the colour is actually fixed to the fabric still remains in doubt. Provisionally, we may adopt the view that the primary action depends upon electrical attraction, which is followed by mechanical actions and the colloidal precipitation with the formation of aggregates of a complex character. Absorption is an insufficient explanation, as Lewis¶ has shown, and a solid solution theory $ is also not applicable.

Perrin ‖ has shown that there are important parallel relations between the phenomena of contact electricity and colloidal precipitation, and Pelet-Jolivet*** has extended this to the amount of dyestuff taken up by the fabric and also to the capillary ascension of the dyes in the fibres. In the latter case the experiments of Pelet-Jolivet consisted of measuring the final height of the colouring matter reached when a band of the absorbent material was suspended vertically in the dye-bath. Here we have a mixed phenomenon depending on surface tension and absorption.

ELECTRICAL DRIVING OF A LEAD MILL.

Messrs. Foster, Blackett & Wilson, who have for the past fifty years been established at Hebburn-on-Tyne as important lead manufacturers, decided to equip electrically the whole of its works. The work was entrusted to Charles Martin & Co., Newcastle-on-Tyne, the wiring to Warren Beattie & Co., of Middlesbrough ; and the manufacture of the complete equipment of motors, auto-starters, and the controllers to the British Westinghouse Electric and Manufacturing Co., Ltd. The result of last year's running has, we, understand, fully justified the decision arrived at.

The raw materials are hauled in trucks by a single drum haulage running from the Company's private jetty on the Tyne.

On conversion, the crankshaft of the vertical double-acting steam engine, formerly used, was taken out, and a gear wheel and countershaft put in, by means of which it is now driven by a 60 h.p. motor operated by a drum controller. In carrying out the conversion, care was taken to avoid delays, by using as much as possible of the existing gear. The capital outlay, therefore, was kept down, and is, we are informed, very low for this class of work. The work of conversion was carried out without a shut-down and without any serious hitch in the operation.

In the separating house, the lead pigs are refined, and the pure lead is run into a mould about 8 ft. square, in which a mass of metal, weighing about 8 tons, is formed. This metal slab, lifted by a jib crane, was formerly operated by a two-cylinder double-acting steam engine. The crankshaft and cylinders of the engine were taken out, a countershaft and gear wheel put in, and the drive effected by a drum controller.

The lead mill has rolls about 20 in. in diameter and 8 ft. 3 in. long. Six live rolls, standing in series, facilitate the passing of the billets through the mill. The flywheel, which weighs 7 tons, and has a diameter of 19 ft., was retained for equalising the load on the motor. In contrast to this, the motor is almost lost sight of.

The mill was originally driven by a two-cylinder horizontal engine, 200 indicated h.p. and 4 ft. 5 in. stroke, and working at 60 lb. steam pressure. On conversion, the crank was replaced by a gear wheel, and the countershaft carrying the pinion engaging this wheel is now belt-driven by a 90 h.p. slip-ring motor. A pair of rolling cutters at each side of the bed trims the edges of the sheets when necessary, and also acts as a guillotine for cutting the sheets into lengths, both of these being operated from the gearing of the mill.

We gather that the electric drive now installed has largely increased the output of the mill, in consequence of the steadier drive afforded by it. A 3-ton jib crane, used for loading the finished lead from the mill bed, has been equipped with a 10 h.p. motor, the motor and controller being mounted on a bracket, which swings with the crane. Two pipe presses lie adjacent to the lead mill, each consisting of an hydraulic press forcing the solid lead out of a steel container through a die. A steel core bedded in the container settles the inside diameter of the pipes, which can be made from ⅛ in. to 9 in. inside diameter, a maximum hydraulic pressure of 3½ tons per square inch being exerted on an 18 in. diameter ram. The flywheel of the three-throw plunger pump, formerly steam-driven, has been replaced by a 6 ft. diameter pulley, belt-driven by a 30 h.p. slip-ring motor.

In addition to the quiet drive now obtained, there has been considerable improvement in the class of pipes turned out owing to the even turning moment of the motor.

A group of machinery, consisting of a lathe, flue paddles, circular saw and cupola blast fan, formerly driven by an old type horizontal single-acting steam engine, is now driven by a 20 h.p. motor. Five overhead electrically-driven jib cranes, provided with switches for throwing the motors on and off the mains, are used for loading and unloading the sacks. This is a great improvement on the nine cranes formerly used, driving through the endless rope drive by a 50 h.p. gas engine. The simplicity, convenience, and economy of the electric drive is strikingly demonstrated.

The two white lead grinding equipments, driven by two steam engines (one of 120 b.h.p. and the other an old beam engine with a 5 ft. stroke and 20 ft. flywheel running at 26 r.p.m.) have been replaced by 50 h.p. motors, driving the existing shaft through a belt and a 10 to 1 gear reduction. The two large Torrance mixing machines for converting the white lead into white paint, are driven by a 60 h.p. motor geared to the old shafting. This motor also works a 1-ton hoist, an oil pump, and a dust extractor. The grinding plant is driven by a 50 h.p. motor geared to the original shafting. On account of the danger which might occur from heavy overloads, a large-faced ammeter is placed in front of the operator, with a danger line indicating the overload point.

A dust extractor fan and a mixing and sifting machine are driven by a 10 h.p. motor, and a Sturtevant fan, about 3 ft. in diameter, running at 900 r.p.m., which is used to avoid dust in the packing rooms, is driven by a 5 h.p. motor. Loose sheet iron covers, fixed over the motors and suspended by pulleys from the cross beams, protect the motors from dust.

DUTCH EXHIBITION OF APPLIED ELECTRICITY.

H.M. Consul at Amsterdam reports that an Exhibition of Applied Electricity is to be held at Nymegen, under the auspices of the "Maatschappy van Nyverheid" (Society of Industries) from July 2 to August 15 next. Exhibits from foreign manufacturers will be received. Applications for space should be addressed to the Exhibition Offices, Kelfkensbosch 18, Nymegen.

ENGINEERS' EFFICIENCY CERTIFICATES.

Mr. James Haslam has introduced into Parliament a short Bill, making it illegal for any person to take charge or have control of a boiler or engine of 5 h.p. or upwards, unless holding a certificate to be granted by a Government Department that he is competent to be in charge. The Bill is backed by a number of Labour members.

ELECTRICITY IN MYSORE MINES. — In their annual report, the Directors of A. Goerz & Co., Ltd., who propose paying a 10% dividend, state a substantial portion of the increase in working expenses was due to the higher rate of £24 per horse-power paid, in accordance with the contract with the Mysore Government, for the Cauvery electrical power used under the second installation in the fifth year. In the sixth year of the installation, however, commencing in January last the rate drops permanently to £10 per horse-power, consequently the costs in that respect will be reduced in future. But that this is not considered a drawback is seen by the next paragraph, in which the Directors state that further electrical machinery is to be installed, and will also assist in effecting savings in the costs.

¶ "Phil. Mag.," vol. 15 (6), p. 499, 1908.
$ Walker and Appleyard, "Jour. Chem. Soc.," vol. 69, part ii., p. 1,334, 1896.
‖ "Jour. Chem. Phys.," vol. iii., p. 85, 1905.
*** "Rev. Gen. Mat. Color.," vol. 13, p. 257, 1909.

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PUBLICITY.

In this Section of "The Electrical Engineer" we give Publicity to New Inventions and Specialities.

BUCKLE CLIP.

Some time ago the Sun Electrical Co., Ltd., introduced a useful form of clip for fixing their "Kalkos" wiring tubes. But they were so highly appreciated for fixing conduits and wires of all kinds that the company decided to develop the idea. Our four illustrations give a good

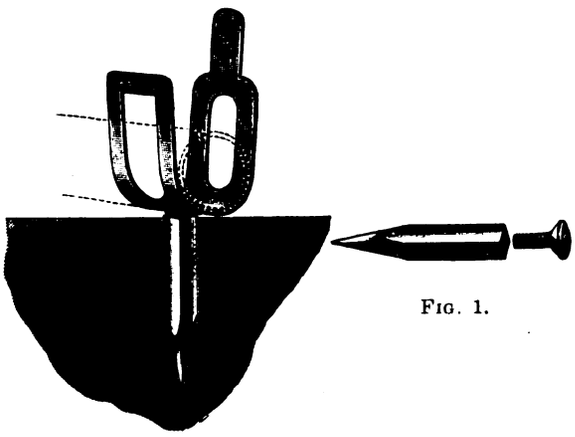


FIG. 1.

notion of the clip and its wide application. Figure 1 shows the clip with nail, these clips being punched out of tough brass, with a screw hole in the centre, by which means it can be fastened to any surface. It will be seen from Fig. 2 that it is made in several sizes. Fig. 3 shows the application of the clips to a circular conduit, while in Fig. 4 we

FIG. 2.

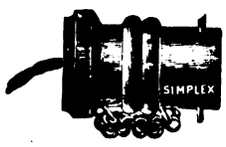
FIG 3.

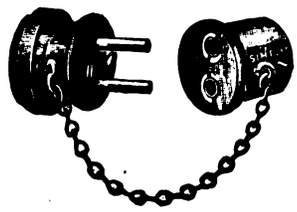
FIG. 4.

see the clips applied to lead-covered wires, which demonstrates how tightly they fit and how inconspicuous they are when once in position. They save an immense amount of time and trouble in wiring, as the clips adjust themselves to any diameter or form of conduit, and while giving a firm grip do the least possible damage to walls, etc.

COMBINED WALL-PLUG AND ADAPTER.

The Simplex Conduits, Ltd., have recently introduced a novel form of combined wall-plug and adapter, suitable for use in connection with electric table standards, floor standards, kettles, irons, and other such appliances. Very often contractors have been confronted with a considerable difficulty when selling these various appliances, owing to his not knowing whether his client requires two pin wall-plug or a lamp-holder adapter for connecting them to the main circuit. But by means of the simple wall-plug herewith illustrated, connection to either can be arranged. The type so far put on the market is suitable either for the





3 amp. wall socket or for a lamp-holder as desired. A further type suitable for 5 amp. wall sockets is at present in course of development. This pattern can be used either with a lamp-holder or a wall socket as desired, and is made in two halves, the two parts being attached together by means of a stout brass chain, so that there is no possibility of that portion which is not in use being lost. The price at which this accessory is sold is low, comparing favourably with the accepted market price for an ordinary wood lamp-holder adapter.

CONCEALED LIGHTING.

Concealed lighting is now so well known that any lengthy explanation of its uses is hardly necessary. The Sun Electrical Co., of 118 and 120, Charing Cross-road, London, W.C., have been to the fore among the pioneers of this system with their "Sunlite" and "Sunline" reflectors, the outstanding feature of which is great adaptability for every conceivable position where reflected light is required. "Sunlite" reflectors are lined with a special heat-resisting mirror plate, which avoids the constant cleaning necessary with other metal reflectors. These mirrors are kept in position by nickelled beading and not by cement. Ease of wiring is assured by the small recess which is fixed on the outer sides of each reflector, and by the front section of each division being detachable. These reflectors have, we understand, been used with marked success for picture lighting, concealed inside shop window lighting, cornice and ceiling work, outside bracket reflectors, facia lighting, etc.

CINEMATOGRAPH RESISTANCES.

The "Electric Theatres" which are springing up all over the country should afford plenty of work for local contractors, and we are glad to notice that manufacturers are not neglecting to introduce suitable accessories for this class of work. Messrs. E. F. Noy, Ltd., of Greenland-place, Camden Town, London, N.W., have introduced a paralleling system of regulating resistances for cinematograph work, which enables the resistance to be placed right away from the operator's box and yet to be completely under his control.

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CATALOGUES AND PRICE LISTS.

Circulars "R. W." and "P. B.," of Messrs. Vaughan & Son, Ltd., West Gorton, describe and illustrate respectively their "switch-trolley" runaways and "triple-auto" pulley blocks, designed for the rapid and economical handling of small loads, in factories and warehouses, not exceeding 2 tons in weight.

Mr. A. Campbell Adams, A.M.I.E.E., of Glasgow has a new system for automatically governing electrically driven air compressors. His price list gives particulars and prices for standard panels complete ready for operation from 20 h.p. to 150 h.p.

Messrs. Tetley & Co., Manchester, are issuing a series of tinted post-cards (with space for brief notes and address on front), illustrating their various electrical specialities, from protected hand lamps to ironclad power distribution boards.

An illustrated price list of indicating and recording pyrometers for all temperatures up to 1,600° C., and for very low temperatures, is sent by Mr. H. J. Lewenz, of Trinity-square, E.C.

A folder on "Tantalum" metal filament electric lamps (with blank space for dealer's name and address) is being issued by Siemens Bros. Dynamo Works, Ltd.

The March and April 1910 Supplements to Messrs. Siemens Bros. & Co.'s catalogue of vulcanised indiarubber wires and cables deal respectively with "Bell wires" and "Motor car leads." "Bell wires" includes single and twin cotton covered bell wires, and silk covered twin flexible bell cord, additional to the bell wires listed in our main catalogue. The "Motor car leads" supplement supersedes the November 1908 issue, the prices having been raised on account of the high price of rubber.

From Messrs. Edison & Swan United Electric Light Co., Ltd., we have received a batch of illustrated descriptive price lists. A. 2181 deals with the "Ediswan" combined switch sockets and plugs, the plugs becoming dead as soon as the plug is removed and remaining so until the plug is replaced and pushed home. E. 2176 is concerned with the enclosed arc lamps and their accessories, giving much practical data. I. 2187 gives sketches and details of ammeters and voltmeters for continuous and alternating currents.

Messrs. A. P. Lundberg & Sons' list S. 23 is mainly concerned with a most useful and economical standardised "Adaptable Combination" for grouping switches and kindred accessories. There are also illustrations and particulars of turn-type switches, wall connections, "Pixy" bell pushes ("Pivots," "Twinnobs," "Duplex," "Marvel," etc.), and various types of plugs.

Messrs. Siemens Bros. & Co.'s April 1910 issue of Catalogue No. 37 deals with "Dry Cells and Dry Cell Batteries," which supersedes the August, 1909, issue. It differs from the latter in certain minor respects, and ignition coils, specially suitable for use with Siemens' Obach dry batteries, have been added.

REVIEWS.

"Electricity and Magnetism," by G. Carey Foster and A. W. Porter. (London: Longmans, Green & Co. 10s. 6d.) Founded on Joubert's "Traité Elementaire d'Electricité."

Electrical engineers must have at least one book which deals with electricity purely as a branch of physics, and they cannot do better than keep this book on their shelves for reference. Questions may crop up at any time which bring to mind the Peltier effect, the thermo-electric pile, ionisation, electro capillary phenomena, Rontgen and Becquerel rays, the Zeeman effect, etc., and as the electrical engineer occupied with the material side of the profession cannot keep in touch with all the developments in physics, a book such as this is most useful. From the reputation of the authors he knows it must be absolutely reliable. The reviewer would suggest that in future editions the authors keep the above remarks in mind, and that they let others who are actually engaged in design deal with transformers, dynamos, etc.

"The Marine Oil Engine Handbook." (London: The Temple Press. Price, 1s. net).

This comprehensive book on "The Marine Oil Engine Handbook," is specially written for "all who have to do with marine motors for commercial purposes, particularly with reference to paraffin and heavy oil motors for fishing craft, canal barges, and coasting vessels," by the staff of the *Motor Boat*. Motors are now extensively used for commercial vessels, but the motor employed is generally of a very different type to the fast-running, light engine to be found under the bonnet of a car. It is a heavy, slow-running machine, with nothing of the finesse and delicacy associated with the automobile. It runs, as a rule, on paraffin or heavy, unrefined petroleum, and electric ignition is by no means universal. Often a lamp or hot bulb is used. The commercial engine has little in common with the ordinary car motor, and for those making their first acquaintance with the former type, a special book of instructions is necessary. That is the function the volume now before us is intended to fulfil, and a glance through its pages shows the object to have been most successfully attained. First of all, the elementary principles of a motor are dealt with, the "Otto Cycle," the leading points of carburation and ignition. There follows a useful chapter entitled "Engine Room Hints," the purpose of which is self-explanatory. Finally, we find descriptions of many of the leading commercial engines of the day, and an interesting article on the power and speed of fishing craft. Though, as already stated, "The Marine Oil Engine Handbook" deals principally with the commercial side of marine motoring, there is much in it that will appeal to the owner of pleasure craft, and the very moderate price of 1s. at which it is published, places it within the reach of yachtsmen and barge-skippers alike. It is essentially a book for the amateur and the non-technical "engineer," and is written in a way that can be followed by any intelligent person. The section on electric ignition is excellently done, both as regards text and illustrations.

PUBLICATIONS.

"Annuaire de la Société des Ingénieurs Civils de France, 1910." (Paris: Office of the Society. Price 3 francs 50 centimes.)

An alphabetical list of the members of the French Society of Civil Engineers, together with list of officials and certain information relating to prizes distributed by the Society.

"The Small Coal Question." Being Coal Trade Pamphlet No. 3. (London: "*The Colliery Guardian*." Price 1d.)

This third of the series of pamphlets deals with a question that just at present is of vital importance to the industry of the nation, and is not without its special interest to electrical engineers.

"Abnormal Places: How the Trouble Arose in South Wales.' ("Coal Trade Pamphlets, No. 4." Price 1d.)

Discusses the question of wages for working in abnormal places.

The Physical Review, No. 3, Vol. XXX.

Among the chief contributions we note, "Relation between Temperature of Electrodes and Voltage of the Electric Arc," by C. D. Childs; "Studies in Luminescence: The Distribution of Energy in Fluorescence Spectra," by E. L. Nicholas and Ernest Merritt; "On the Probability of an Inherent Relation between the Electrical Resistance and the Hardness of Steel," by Carl Barns; "The Absolute Values of the Elementary Magnets of Iron, Nickel and Magneite," by Jacob Kunz; "On Contact Difference of Potential in a Magnetic Field," by E. P. Adams; "The Effect of Temperature on Fluorescence and Absorption: Fluorescence and Absorption of Canary Glass at Low Temperatures," by N. C. Gibbs; and two papers on some photo-electric properties of alkali metals.

"The Journal of the Municipal School of Technology," Manchester. Vol. II.

A well printed collection of technical papers read before British and American Scientific Societies.

"The Post Office Electrical Engineering Journal," April, 1910. Price 1s. net.

This is an excellent number. Its chief contents are: "The Experimental Room at the G.P.O." by F. Addey, B.Sc.; "Electrostatic Charging of Telegraph Wires by Locomotives in South Africa," by R. W. Weightman; "The Hot Wire Telephone," by J. E. Taylor, M.I.E.E.; "Automatic Exchange at Muuich," and a note on wireless telephony.

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Electrical Contractors' Section.

A Survey of New Things and Business Prospects.

NOTICE.

Contract and Miscellaneous Advertisements should reach this Office by Mid-day on Wednesday. For rates apply to the Manager, 149, Fleet Street, London, E.C.

CONTRACTS.

CITY OF MANCHESTER.

The Electricity Committee of the Manchester Corporation are prepared to receive TENDERS for the supply, delivery, and erection of 5-600 k.w. MOTOR CONVERTERS or ROTARY CONVERTERS and STATIC TRANSFORMERS.

Specifications and forms of tender may be obtained on application to Mr. F. E. Hughes, Secretary, Electricity Department, Town Hall, Manchester, on payment of a fee of two guineas, which amount will be refunded on receipt of a bona-fide tender.

Further particulars and information can be obtained from Mr. S. L. Pearce, Chief Electrical Engineer, Dickinson-street, Manchester.

Tenders, duly endorsed, and addressed to the Chairman of the Electricity Committee, must be delivered at the Town Hall not later than 10 a.m. on Friday, the 22nd instant.

The Corporation do not bind themselves to accept the lowest or any tender.

T. HUDSON, Town Clerk.

Town Hall, Manchester, 5th April, 1910.

URBAN DISTRICT COUNCIL OF DARTFORD.

ELECTRICITY DEPARTMENT.

FEEDER PILLAR AND CABLE.

The Council invite tenders for the supply of:—

(*a*) 1 Feeder Pillar.

(*b*) 900 Yards of .15 Paper Insulated and Lead Covered Cable.
450 .07 ,, ,, ,, ,, ,,

Copies of the specification, with form of tender, may be obtained on and after April 11, on application to the Electrical Engineer, Electricity Works, Dartford.

Tenders, endorsed "Tender for Cable," must be delivered to the undersigned not later than noon on Wednesday, April 20.

The Council do not bind themselves to accept the lowest or any tender.

W. KAY,

Council Offices, Dartford, April 6, 1910. Clerk to the Council.

APPOINTMENTS.

SHIFT ENGINEER required for Electricity Works in Scotland. Experience with high tension alternating current and three wire direct current plant essential. Salary 30/- increasing to 40/- per week. Apply, giving briefly, particulars of training, experience, age, testimonials and certain date on which duties could be commenced to Box No. 24, c/o. THE ELECTRICAL ENGINEER, 149, Fleet Street, London, E.C.

PREMIUM PUPIL. Vacancy for Pupil to obtain experience in all branches of Central Station Work.—Apply, Electricity Works, Canterbury.

WANTED, for the Corporation of Durban, Natal, South Africa, Switchboard Attendant accustomed to single phase, high tension working and to continuous current tramway systems. Applicants must be able to undertake repairs to dynamos and switchboards. Rate of Wages will be £240 per annum. Passage money will be allowed and salary on the voyage out. Applications should be sent to the undersigned at once,—WEBSTER, STEEL & Co., Agents to the Corporation of Durban, 5, East India Avenue, Leadenhall Street, London. Dated 7th April, 1910.

CONTRACTS OPEN.

LONDON (FOR AUSTRALIA).—The High Commissioner in London for the Commonwealth of Australia notifies that tenders will be received as follows, viz.: (1) At the office of the Deputy Postmaster-General, Melbourne, up to 3 p.m. on May 17, for the supply of 1,010 reinforced concrete telegraph poles; preference will be given to poles made in Australia from Australian cement. (2) At the office of the Deputy Postmaster-General, Brisbane, up to noon on May 18, for the supply of 1,760 yards of paper-insulated lead-covered cable. Local representation is necessary.

HOME.

CASTLEFORD.—Whitwood Urban District Council.—Copper cables, steel, and poles, support arms, insulators, street fittings, connectors, meters, switchboard instruments, etc. (Specification, £2 2s., H. Marsden, Electricity Works, Honley, near Huddersfield). April 28.

DARTFORD.—Council invite tenders for (a) the feeder pillar, (b) 900 yards of ·15 paper insulated lead-covered cable, and 450 yards ·07 paper insulated, lead-covered cable. April 20.

DOVER.—Harbour Board ask for tenders for an electric-worked jib-crane. Particulars (5s.) from Mr. M. Mowll, Register, Castle-street, Dover. April 16.

EGREMONT.—Wallasey Urban District Council.—Annual supplies for electricity supply works at Liscard. Particulars from Engineer, Seaview-road, Liscard, Cheshire. April 18.

GRIMSBY.—Corporation Electricity Department.—No. 82, three-wire balancer for continuous current; No. 83, continuous-current motor meters. (Specifications, £1 1s., Borough Electrical Engineer). April 17.

HALIFAX.—Corporation Tramways and Electricity Committee.—One 300 kw. rotary converter, transformers and switchboards. (Specification, £10, General Manager, Foundry-street). April 18.

LITTLEBOROUGH.—Urban Council invite tenders for the supply and laying of electric cables and the supply and erection of plant as follows: (1) High tension feeder cables, low tension distributors, road work, etc., for private lighting; (2) transformer kiosk, with transformers and equipment and switchgear in sub-station. Specifications (£5) from Mr. G. H. Wild, Clerk to the Council. May 2.

LONDON.—London County Council invites tenders for the wiring and fitting for electric lighting of the two under-mentioned schools, namely, Shelburne-road Elementary, Torriano-avenue Elementary. Persons desiring to submit tenders may, on and after April 4 in the case of Shelburne-road, and on and after April 11 in the case of Torriano-avenue school, inspect the drawings and obtain the specifications, bills of quantities, form of tender, and other particulars on application to the Chief Engineer of the Council, Mr. Maurice Fitzmaurice, C.M.G., at the County Hall, Spring-gardens, S.W., upon payment to the Cashier of the Council of the sum of one pound (£1) in respect of each school. This amount will in each case, after the Council or its Committee shall have come to a decision upon the tenders received, but not before, be returned to the tenderer, provided he shall have sent in a *bona-fide* tender and not have withdrawn the same, but in no case will the fee be returned unless a *bona-fide* tender is submitted. Full particulars of the work may be obtained on application at the County Hall before the payment of the fee for the specification, etc. Each tender is to be delivered at the County Hall, in a sealed cover, addressed to the Clerk of the London County Council, Spring-gardens, S.W., and marked as the case may be "Tender for Electrical Installation at the Shelburne-road Elementary School," "Tender for Electrical Installation at the Torriano-avenue Elementary School." No tender received after 11 a.m. on Wednesday, April 20, 1910, will be considered.

MANCHESTER.—Corporation invite tenders for the supply and erection of a 500 and 600 kw. motor converters or rotary converters and static transformers. Specifications from the Secretary, Electricity Department, Town Hall. April 22.

NUNEATON.—Borough Electricity Committee.—(*a*) Water-tube boiler, pipework, valves and fittings; (*b*) boiler feed pump, suction and delivery pipes, valves, etc. (Specification, £1 1s., Borough Electrical Engineer). April 25.

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PERTH.—Town Council invite tenders for the supply of 3,500 tons of small coal during the period ending May 15, 1911, delivered free at their electric lighting station. Forms of tenders from Mr. J. Lambert, Borough Electrical Engineer, Perth. May 11.

OVERSEAS.

ANTWERP.—Lower Scheldt Works.—Electric lift for vehicles on floating pier. Dep., £320. Specification No. 19, 2d., plans 1s. 5d., Direction du Service Spécial de l'Escaut Maritime. June 16.

BRISBANE.—The Imperial Trade Correspondent at Brisbane reports that tenders will be received, up to noon on June 8, at the office of the Deputy Postmaster-General, Brisbane, for the supply of common battery telephones and small switchboards and protectors. A deposit will be required with each tender. Local representation is necessary.

BUDAPEST.—H.M. Consul-General at Budapest (Mr. Esme Howard, C.V.O., C.M.G.) reports that tenders are invited by the Municipality of Pécs for the building and working of an electric railway in that town. Tenders will be received up to noon on June 6, by the "Pécs varos gazdasagi tanacsnokanak, Varosi Székhaz," Pécs, Hungary, from whom also detailed conditions and forms of tender may be obtained at a cost of 2 kronen (1s. 8d.). The plans and other documents can be examined on personal application at the Engineering Office of the town of Pécs.

CONSTANTINOPLE.—Public Works Department.—Distribution of electric current in the European part of Constantinople and suburbs except that required for telegraph, telephone and public traction purposes. Prov., £E10,000. May 28.

HERTOGENBOSCH, HOLLAND.—Tenders are invited for the installation of an electric lighting and power plant, including the laying of underground cables, etc. Tenders should be sent to "Heer Administrateur der Godshuizen, Gasthuisstraat, 9," Hertogenbosch, at which address they will be opened at 11 a.m. on April 19. Plans and specifications may be purchased from the same official on payment of 12 gulden (20s.).

TOULON.—Arsenal.—Copper and bronze wire and cables, submarine cable, etc. (Particulars, Ministere de la Marine, Paris). April 27.

TENDERS ACCEPTED.

LONDON, SHOREDITCH.—The Borough Council have accepted the tender of Messrs. Evered & Co. (the lowest of six) at £207 9s., for the supply of a feeder panel.

HEREFORD.—The Electric Light Committee have accepted the following tenders, viz. :—Messrs. W. T. Williams & Co., to supply 400 tons of Welsh Rubble small coal at 13s. 2d. per ton ; Mr. T. Jarrett to supply 750 tons of rough small coal at 9s. 8d. per ton.

NOTES.

DRAWN TUNGSTEN FILAMENTS FOR LAMPS.

Since the introduction of the tungsten lamp, many improvements have been made in the processes of manufacture of the pressed or built-up tungsten filament, with the object of increasing its strength, and, although a large measure of success has been attained so that the best filaments now on the market have the appearance of sound wires, they still have low tensile strength and small resistance to flexture. Siemens Bros. Dynamo Works, Ltd., and the British Thomson-Houston Co., Ltd., have each introduced tungsten lamps with filaments of drawn wire. The Siemens lamp is known as the "Onewatt," and the efficiency is 1·1 watts per candle. These lamps are at present supplied for 100 c.p., for use in circuits at 100-130 and 200-250 volts, respectively, and should prove highly suitable for shop and street lighting, whilst they can also be arranged for lighting living rooms by posting or enclosing in opal globes, which, by reducing the intrinsic brilliancy, produce an exceedingly soft and pleasant effect. These "Onewatt" lamps are already on the market, but the "Mazda" lamp of the British Thomson-Houston Co., having also a drawn wire filament of tungsten are not yet on the market commercially. In the latter type of lamp, the tungsten is held together by a ductile alloy, whilst it is shaped by drawing or pressing into the form of a filament. The filament is then treated to remove the metal binder. It is claimed that by this process, tungsten of surprising ductility and strength is produced, so that it becomes possible to draw it into the finest filaments for incandescent lamps.

Telegrams: "Cuivre, London."
Telephone: 186 Eastern.

66//
COPPER EXPANSION PIECE.

EXHAUSTING TURBINE ENGINES.

HIGH-CONDUCTIVITY CASTINGS & COPPER FORGINGS

JOHN DORE & CO.
Coppersmiths and Brass Founders,
BROMLEY, LONDON, E.

Ammeters
Voltmeters

The Latest and Most Novel Patterns.

The Best and Cheapest in the End.

For Lists and Particulars apply to

The Leysner Electrical Instrument Coy.,
12, Lime St., LONDON, E.C.

PATENTS.

S. SOKAL, Chartered Patent Agent,
AND
Certified Austrian Patent Attorney (Patentanwalt), Specialist for German Patents and Patent Litigation.
55, CHANCERY LANE, LONDON, W.C.

SITUATION WANTED.—Knowledge of Wiring, Arc Lamp Work, X-Ray Apparatus, etc.—Box A. D., c/o THE ELECTRICAL ENGINEER, 149, Fleet-street, E.C.

FOREMAN WANTS SITUATION with Arc Lamp firm ; well up in Theory and Practice of Mechanics and Electricity ; 32 years of age, and 17 years' practical experience.—Box W. E., c/o THE ELECTRICAL ENGINEER, 149, Fleet-street, E.C.

WIREMAN, Experienced in all branches, requires situation —Box A., c/o THE ELECTRICAL ENGINEER, 149, Fleet-street, London, E.C.

ELECTRICAL ENGINEER desires berth in Central Station, or charge of private installation.—Box C., c/o THE ELECTRICAL ENGINEER, 149, Fleet-street, London, E.C.

ELECTRICIAN, young, requires situation ; could take charge of small plant.—Box H., c/o THE ELECTRICAL ENGINEER, 149, Fleet-street, London, E.C.

MEN OUT OF EMPLOYMENT in all branches of the Electrical Trade should write to Box No. 20, c/o THE ELECTRICAL ENGINEER, 149, Fleet-street, London, E.C.

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Retains its High Efficiency under the most severe working conditions.

SAMPLES, PARTICULARS of APPLICATION, and PRICES from

MAJOR & Co., Ltd., Sculcoates, HULL.

AN "ADAPTABLE COMBINATION."

Owing to the want of uniformity in the methods adopted, and the absence of articles standardised for the purpose, the satisfactory grouping of switches and kindred accessories together, often becomes an awkward and expensive problem for the wiring contractor, and haphazard methods have often to be employed to meet special cases. Messrs. A. P. Lundberg & Sons, 477 to 487, Liverpool-road, London, N., have introduced an "Adaptable Combination," which should assist in meeting the requirements of modern practice in a simpler and cheaper manner than has hitherto been possible. This device consists of a block of glazed porcelain (7½ in. long by 3½ in. wide by 1⅝ in. deep), arranged with three suitable recesses to take Lundberg's Standard types of switches, wall connections, Bell pushes, etc. It can be used for either surface or flush work, the only difference being that in the latter type the covering plate is of slightly larger dimensions. It is also suitable for fixing horizontally or vertically, necessary fixing holes for the various accessories being provided for the purpose. Metal straps of suitable shapes have been standardised, and these support the various accessories in a substantial manner, the fronts being screwed on in the usual way by threaded rings. Additional contacts in connection with an electric bell system, or combined bell and telephone system can be simply arranged at small extra cost. Should circumstances require such, two single-way switches may be coupled by a bar in the usual way, and connected in parallel, and so control a wall connection of 10 amperes capacity fitted at the third hole, supplying current, *e.g.*, to a radiator. The "Adaptable Combination" is all the more interesting because the need for standardisation has become more acute, since special tariffs and cheaper and more reliable apparatus have made electric heating and cooking more popular, we think it will be a boon on modern installations inasmuch as it will permit the convenient grouping of lighting, heating, ventilating and call-bell arrangements.

ELECTRIC BELLS.

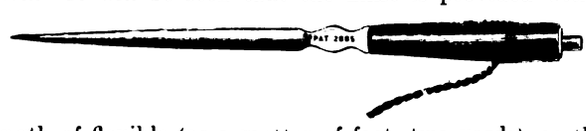
Messrs. A. Emanuel & Sons, Ltd., 9, George-street, Manchester-square, London, W., have perfected a system for using electric bells on high voltage circuits. The bell is of a special character, and the whole arrangement has been devised specially to meet the requirements of workshops, factories, railway stations, and public institutions, although we see no reason why, if the circumstances are favourable or if the conditions warrant it, the system should not be installed in private houses. Under all conditions, however, it is a prime necessity that the work should be done in first class style, and properly insulated, while switches similar to lighting switches must be employed for controlling the service. For hard and continuous wear it is claimed to be advantageous to dispense with ordinary batteries that require re-charging and renovation at intervals, which, of course, is not the case with the circuit service. The construction of the bell itself represents a notable departure from anything that we have seen on the market, inasmuch as it does not necessitate a special contact maker and breaker as is the case with existing bells. It is a bell with low resistance and requires external resistance, but an ordinary incandescent lamp suited for the particular voltage can be inserted to regulate the amount of current required for each bell, at a very small cost. A novel feature of this bell is that, owing to one of the coils of the magnet always remaining in circuit while the push is closed, it is impossible to get a full voltage across the contact breaker, and this avoids corrosion from arcing, for as soon as the resistance of the air gap exceeds the resistance of the first coil, which is always in circuit, the current passes through the first coil only. Consequently, the sparking is less than that of the ordinary electric bell rung by the use of primary batteries. It is claimed that it is impossible to do any damage to the bell, even if the armature gets jammed in any one particular position through accident, or from any other cause.

INCANDESCENT LAMP ATTACHMENT.

A good contrivance for preventing the breaking or damaging of the flexible cords of electric lights, has been brought out by the Clarence Engineering Co., of 67, Aldersgate-street, London, E.C. A steel clip, which grips the shoulder of the lamp just below the cord, has a swinging brass hook attached. This can be linked to a nail or hook anywhere, and so take the weight of the lamp holder or shade. Where changing positions are required for lights the invention should prove a convenience and tend to decrease the number of fused cut-outs. In shop window dressing especially, the need for twisting the flexible wire round a nail or hook to keep the lamp in position is obviated.

PAPER KNIFE AND BELL-PUSH.

Busy people are aware how paper knives are apt to elude their search when most needed, going astray or getting buried under papers on the desk. Well, the General Electric Co. have hit upon a splendid idea, combining a neat paper knife and electric bell push. Our illustration speaks for itself. It will be seen that the knife is provided with a



length of flexible (as a matter of fact, two yards), so that it cannot go astray, and the busy person has always the bell push, *plus* the paper knife at hand. It is an exceedingly pretty as well as handy appliance, made with non-inflammable handles enamelled red, white, green or blue, and also with sterling silver handles. These articles only need to be shown by dealers to be sold.

BRITISH LIFTS FOR MANCHURIA.

The contracts for the electric lifts for the South Manchurian Railway, and also for the Shanghai Municipal Council Buildings, have been obtained by Messrs. A. W. Penrose & Co., Ltd., of 109, Farringdon-road, E.C., in competition with German and American makers.

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PLANT FOR SALE.

Advertisements under this heading: Twenty-four words, 1s. per insertion; three insertions for 2s. 6d.; or each additional line of eight words, 4d.

ELECTRIC GENERATING SETS, Willans & Robinson's engines, Holme's dynamos, 110 volts, 350 amperes. Box No. 30, c/o. THE ELECTRICAL ENGINEER, 149, Fleet Street, E.C.

ELECTRIC MOTOR, by Parker, 15 b.h.p., No. 20, open type, for 460 volts, 40 amperes, 600 revs. continuous circuit; £75. Box 31, c/o. THE ELECTRICAL ENGINEER, 149, Fleet Street, E.C

FOR SALE, 20 h.p. Suction Gas Plant and 14 b.h.p. Engine; also 10 h.p. Vertical Boiler and 6 h.p. Vertical Steam Engine.—Box C.E., c/o THE ELECTRICAL ENGINEER, 149, Fleet-street, London, E.C.

ELECTRIC MOTORS.—Two 15 h.p., 500 volts; one 20 h.p., 100 volts; one 10 h.p., 460 volts; tramway controllers.—Box W.G., c/o THE ELECTRICAL ENGINEER, 149, Fleet-street, London, E.C.

PLANT WANTED.

PLATINUM UTENSILS, SCRAP, LAMP TOPS.—Best prices given by DERBY AND CO., LTD., 44, Clerkenwell Road, London, E.C. N.B.—Platinum Sold.

CABLE PRICES ADVANCED.

The General Electric Co., Ltd., announce that owing to the continued high prices of rubber, the list prices of all rubber-covered wires, cables, flexibles and materials containing rubber will be advanced as from April 1, 20%. In effect this is an advance of only 10%, as prices had already been raised by 10% prior to April 1.

STORAGE BATTERIES AND PUBLIC SUPPLIES.

The Leek District Council and the Letchworth Garden City, having found it necessary to enlarge their plant to cope with the increasing demands for current, decided, as an economical measure, upon adopting larger storage batteries, and have again placed their orders with the D.P. Battery Co., Ltd. Another order, that for the large storage battery required by the Guildford Electricity Supply Co., Ltd., has been placed with the same Company, who have also undertaken its maintenance for a period of ten years.

INSTITUTION OF ELECTRICAL ENGINEERS. STUDENTS' SECTION.

The annual general meeting of the Students' Section of the Institution of Electrical Engineers will be held at 92, Victoria-street, S.W., on May 4, at 7.45 p.m. Nominations of extra-collegiate students to fill these vacancies on the Students' Committee should be sent to the Hon. Assistant Secretary of the Students' Section on or before April 24.

CONTRACTS WORTH WATCHING:—

Balby and Hexthorpe.—Mullins & Richardson, Doncaster. Church extensions.

Barry Dock.—Lloyd & Tape, Barry Dock. Wesleyan Church.

Bath.—Secretary, Education Committee, Bath. Manual Training and Domestic Centre.

Belfast.—Graeme-Watt & Tulloch, architects, Victoria-road, Belfast. Warehouse.

Beverley.—Teacher's house and alterations to schools.

Bilston.—Rev. W. Spencer, Coseley Parish Church, Bilston. Electric lighting and power installation.

Birmingham.—Francis H. Smith, Birmingham. School.

Blackpool.—Dryland & Preston, Blackpool. Library.

Boston.—Castle & Sons, London. Wesleyan Church.

Bourne End.—Flint, Nash & Co., Ltd., High Wycombe. Wesleyan Church.

Dudley.—Collins & Godfrey, Dudley. Church extensions.

Earswick (near York).—Mr. A. D. Creer, architect, 5, Coney-street, York. Warehouse and workshops.

Edinburgh.—City Architect, City Chambers, Edinburgh. New Town Hall.

Falmouth.—Mr. R. J. Loney, Clerk to the Governors. Alterations and additions to the Grammar School.

Fareham (Hants.).—Mr. Wilberforce Cobbett, architect, Fareham. Block at the Isolation Hospital.

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TURNED & MOULDED GOODS TO PATTERN. RODS, SHEETS, AND TUBES.
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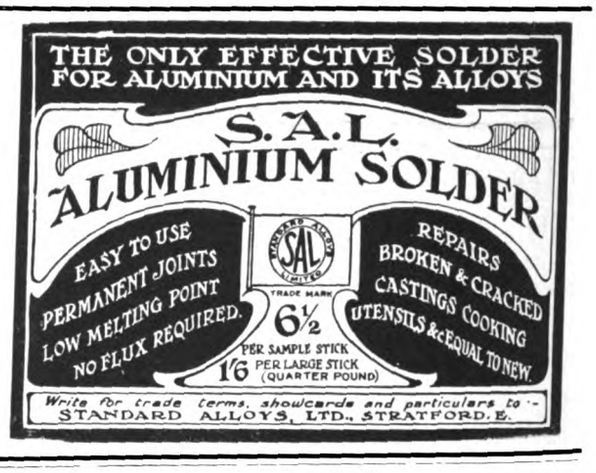
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Write for trade terms, showcards and particulars to:—
STANDARD ALLOYS, LTD., STRATFORD, E.

Felixstowe.—For the Urban District Council. Isolation Hospital. £3,000.

Halifax.—C. Williams & Sons, architects, Commercial-street, Halifax. Additions to Bradshaw Mills.

Herne Bay.—Messrs. Moscrop-Young & Glanfield, architects, 12, Buckingham-street, Charing Cross, W.C. Pier pavilion.

Heywood.—Mr. H. Littler, county architect, 16, Ribblesdale-place, Preston. Technical School; also Picture Gallery and Museum.

Leicester.—James Chapman, Rutland-avenue, Chelmsford. Museum and Art Gallery extensions.

Lytham.—John Whiteside, St. Anne's-on-Sea. Church extensions.

Newport.—Hospital extensions. £16,000.

Radyr.—E. Turner & Sons, Cardiff. School.

Sandwich Bay.—G. H. Denne & Sons, Queen-street, Deal. Residence.

Salisbury.—Mr. F. Hodding, Clerk to the Committee. Erection of an Isolation Hospital for Salisbury and district.

Seaforth.—H. Littler, 16, Ribblesdale-place, Preston. Secondary and Technical School.

Slough.—Messrs. Moscrop-Young & Glanfield, architects, Slough. Converting premises into a cinematograph theatre.

Southend-on-Sea.—Jarvis & Co., Hackney-road, London, N.E. Church extensions.

St. Helens.—For the Town Council. Electric light, plant and buildings.

Stockport.—For the Town Council. Hospital extensions. £16,000.

Stretford.—Mr. F. W. Mee, architect, 32, Victoria-street, Manchester. Public Elementary school.

The Lizard (Cornwall).—Mr. Edwin Turner, architect, Llandudno, North Wales. Erection of private residence.

Waterloo.—Mr. H. Littler, architect, 16, Ribblesdale-place, Preston. Secondary and Technical School at Seaforth.

Weymouth.—Mr. G. P. Symes, 9 & 10, East-street, Weymouth. Elementary school.

Whitby.—W. Lawson, Sleights, Whitby. Church.

Windygates (Scotland).—Mr. G. C. Campbell, architect, Methil. Hall and houses.

Wrexham.—H.M. Office of Works, Storey's Gate, London, S.W. Erection of telephone exchange.

Yorks.—Education Committee of the East Riding of Yorks (Building Surveyor), County Hall.

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Electrical Progress at Home & Abroad.

A Review by our Special Correspondents.

TYNESIDE.

NEWCASTLE-ON-TYNE.

In Northumberland and Durham there are many fine old country seats, some of which have existed since the days of the Border wars. One of these is Blagdon Hall, the residence of Lord Ridley, and this is now undergoing a process of rewiring under the supervision of E. Wingfield Bowles, the consulting engineer of Victoria Mansions, Victoria-street, W. The system as now reconstructed consists of a supply from a private generating plant driven by suction gas producer plant by means of underground cables, the switchboard being arranged not only for generating sets, but for batteries. The wiring is throughout of high quality, carried out in screwed tubing, and, in addition to the lighting system, a complete service of bells and telephones is also being installed.

A New Electrical Contracting Firm.

Among the newer contracting firms in this area of a high class nature is that of R. M. Cairns, of 23-25, Bath-lane, Newcastle, to whom the large electrical business of Messrs. Stephen Easten, Ltd., builders and contractors, was transferred on June 1 last. At the time of the transfer, Mr. A. J. S. Pettie, the electrical engineer to Messrs. Stephen Easten, was appointed electrical manager of the new firm, and brought with him his former staff. Since the commencement of this business some important installation contracts have been secured, among them being the electric lighting of the new Conservative Club in Pilgrim-street, Newcastle. This building, the erection of which is now nearly completed, is six storeys in height and of handsome proportions. A high class piece of work has been made of the wiring, a draw-in system with screwed tubing being employed. An even more extensive contract is the electric lighting of a new theatre and other premises at the Spanish City, Whitley Bay. This group of entertainment devices caters for the large summer crowd at the nearest seaside resort to Newcastle, and is a White City in miniature. Electric lighting is being lavishly used in the new buildings, which are to the designs of Messrs. Cockett & Burns Dick, of Newcastle, and about 150 amp. of 220 volt current are up to the present provided for. Further details of this installation, which is of unique interest, will be available at a later date.

Institution of Mining Electrical Engineers.

The final meeting for the present winter session of this Institution was held at Armstrong College on Wednesday, the 6th inst. The evening was devoted to a long discussion on Mr. Young's paper on "The Relative Advantages of Three-phase Alternating and Direct Current Supplies in Mines." Mr. Young gave a brief *resume* of his paper, after which a communication from Mr. W. W. Wood was read, which pointed out that D.C. has the advantage, when dealing with a haulage gear operating on a road with varying gradients, that a series wound, or heavy compound-wound, motor will smooth out the load on the generator by automatically slowing up on the stiff gradients and speeding up when the tubs are on the level. Moreover, the torque of such a motor is practically unaffected by voltage drop, while the torque of a three-phase motor varies as the square of the voltage; this has a powerful effect at the end of a long transmission line. Mr. E. Mudd also sent a written communication dealing with the question of shocks and of costs, and pointed out that the latter was affected favourably to three-phase gear if the supply were taken from a power-in-bulk system, as large squirrel-cage motors with auto-starters could be used, with a saving in the cost of motor, switchgear, and attendance. He also dealt with the question of exhaust steam turbines.

Discussion.

A large number of speakers took part in the ensuing verbal discussion. Mr. Vesey Brown drew attention to the Thury high-tension continuous current system, largely adopted on the Continent, and suggested that it was only habit which had made us adopt A.C. so largely. He had seen one system working up to 45,000 volts, D.C., where tramways, lighting, and power load were dealt with under steadier conditions than with three-phase supply. He thought the "overload capacity" so often asked for was a fetish, and only led to false rating. He also criticised some of Mr. Nelson's arguments as summarised in the paper. Mr. Tennant referred to a new three-phase repulsion motor operated simply by switching in on a three-pole switch and rocking the brushes backwards or forwards according to the direction or speed required. Other speakers dealt with questions of time-element of circuit interruptors, overloading three-phase machines, starting torque on pumps, etc.; after which Mr. Young replied briefly to the effect that the paper did not attempt to claim that D.C. was superior to three-phases, but that there were cases in which it could be used with advantage.

THE MIDLANDS.

BIRMINGHAM.

The subject of discussion at the Birmingham and District Electric Club on Saturday evening, was a paper by Mr. R. Vernon C. Brook on "The Choice of Private Generating Plant for Factories," who said that within the next 25 years or so most of the machinery in this country would be driven by electric motor, either individually or in groups. In large centres, the power would be obtained for the most part from the public supply mains, but in outlying districts, or in steel or ironworks, where power was cheap, by a private generating plant. Where the money was available the question was whether or not the money could be spent more advantageously on additional productive machinery, or on improving the efficiency of existing plants. In most cases, he thought it would be found that taking all factors into consideration, the expenditure on machinery would not bring in so good a return as would have been the case had it been spent on generating plant which would produce current at one third of a penny per unit, a figure obtained by many private generating plants.

Cost of Transmission.

The cost of transmission was an important factor. It was seldom that a private generating system had a long distance to transmit its power except in the case of collieries and large steel works, while a public supply company had to lay out a great deal of money on its transmission apparatus. Among the instances given by Mr. Brook was that of the textile mills of Ashworth Hadwen & Co., Ltd., of Fairfield. Here, there was only one generating unit, an 800 k.w. turbine set, and a stand-by was not thought necessary. The cost of generating worked out as follows: Coal, oil, waste and stores, 0·132d. per unit; interest and depreciation, repairs and maintenance, 0·131d. per unit; total cost, 0·263d. per unit. These were probably among the lowest figures obtainable of steam driven plants. In the case of Messrs. Watson Bros., of Linwood, also a textile firm, they had a 500 kw. plant in two units of 250 kw. each. The average cost for a month's test run per unit was 0·337d; the units per week averaged about 55,000. In another factory, the name of which could not be divulged, the generating plant consisted of two 500 kw. turbo-generators, the mean average load on which was 880 kw. Ten per cent was charged on capital expenditure for interest and depreciation (certainly rather a low figure), and the total cost of current per unit generated came out at 0·32d. per unit.

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Load Factor and Efficiency.

With a poor load factor, poor results, whether a large or small plant, might be expected, though if no public supply were available this consideration, of course, might have to be disregarded. On the question of efficiency, Mr. Brook gave some interesting comparisons illustrating the relative advantages of turbines versus high and slow speed reciprocating engines. The advantages claimed for the turbine were its even turning movement (a great desideratum in the textile industry), economy of floor space and foundation work, and the reduced steam consumption of the larger sets. Turbines for power less than 500 kw. showed little if any economy over reciprocating sets. The best results with steam turbines showed a steam consumption with dry steam of 18·2 lbs. per kw. hour, equal to 14·5 lbs. per h.p. hour. These figures, he said, were not very startling for a 3,000 kw. plant, but they might be taken as fair average figures easily obtained on any large sized turbine. Comparing the steam consumption of a 750 kw. Belliss engine and that of a 600 kw. Curtis turbine, both working under practically the same conditions, the deduction was that for small sizes the turbine did not compare very favourably with the reciprocating engine, except for sizes above 500 kw. which was the smallest size of turbine other than the Delaval that the author would advise, if steam economy was any consideration.

Types of Prime Movers.

Dealing with other forms of prime movers, Mr. Brook quoted the case of the Bilston steelworks and other establishments as illustrating the use of large gas engines. Size for size, a large gas engine installation, complete with producer and all auxiliaries, was more costly than a steam installation, the gas engine was more economical in fuel consumption than any known external combustion engine, while the cost of upkeep was practically the same in each case. If fuel was cheap it would not pay to put in a large gas engine installation, unless the load factor of the plant was high, owing to the fact that gas engines are not efficient when working on light loads. Where blast furnace gases are available, the gas engine stands pre-eminent. A point to be remembered was that gas engines do not possess heavy overload capacity, about ten or twelve per cent. being the figure usually given in the best practice.

Suction Gas.

For small gas engines it was difficult in Mr. Brook's opinion, to beat the suction gas system, either in economy or in prime cost, though their upkeep was rather high even with careful handling. It was impossible to produce current with a small set of this description as cheaply as on a large scale. Fair average figures taken from plants in operation were 50 kw. set running on town's gas at 2s. per 1,000 cu. ft., working 53 hours per week, generating 106,000 units per week, with a 25% load factor, cost per unit 1·23d. The same plant working with suction gas cost per unit ·985d. The saving in fuel under these conditions would be 60% for the suction gas, but this was reduced by the cost of the gas plant and other incidentals to about 20% on the average. For a 200 kw. gas driven plant, with a 25% load factor, and producing 438,000 units per annum, working on producer gas, the figures came out at ·0735d. per unit. It did not follow that such figures would be obtained in all cases, and he advised using the public supply if that were available at a fixed charge of a penny or less. Where a public supply was not available, he recommended gas engines and producer plant for installations of from 10 to 50 h.p.; high-speed reciprocating steam engines or oil engines, such as the Diesel, and vertical or horizontal gas engines for power from 50 to 500 h.p. From 500 h.p. upwards, the oil engine dropped out, and the steam turbine came in. For small powers, below 10 h.p., the petrol and paraffin sets now marketed by many firms were particularly suitable, being both simple and efficient. The Daimler Motor Co., who had a 600 kw. installation consisting of two 300 kw. Diesel sets, found that the cost of current per unit, including everything, came out at a little over ·3d. The firm had a high load factor as the factory was working day and night. The best type of prime mover, however, was a question governed entirely by local conditions.

Electrical Equipment.

As to the electrical portion of the generating plant, the general trend of opinion had been in favour of A.C., particularly for long distance transmission. A.C. generators are at present slightly more expensive than D.C. generators up to certain sizes, but in larger sizes the reverse held. Modern practice called for an efficiency of 94% to 96% in machines of 1,000 kw., and upwards, whilst for machines from 500 kw. to 1,000 kw. the efficiency would be from 92% to 96%. The overload capacity in standard designs was usually 25% for one hour, and 50% for short periods, though some makers guaranteed 25% for two hours, and 50% for half an hour without injury. These points should receive careful consideration when comparing prices. With regard to the voltage most suitable for private plants, 200 volts was the A.C. voltage most frequently met with, whilst 220 volts for small motors and 440 volts for larger D.C. motors was the most usual practice. It was usually advisable to adopt the voltage of the nearest supply company, in view of the possibility of their mains coming near enough to be available. Where variable speed motors were required, such as in some machine shops, printing works, collieries (for winding and hauling), rolling mills, etc., D.C. only should be used.

Discussion.

Mr. Walters said he had found that there was a great deal of difference between the results in the first year or two and those of the fifth or sixth year. One combination for fairly large plants, not mentioned by Mr. Brook, was reciprocating engines and exhaust turbines. He agreed that the Diesel engine was about the most economical form of oil engine as a prime mover, but first cost was heavy, and the charges for interest and depreciation ran away with a good deal of the advantage derived from economy of fuel. With regard to turbines and reciprocating engines when they came down to a small machine like the Delaval, the first cost in both cases was almost exactly the same, with a great advantage of economy on the side of the turbine. Mr. F. W. Foster thought that Mr. Brook had over-stated the case in favour of a private generating plant. If such figures as Mr. Brook had given were generally attainable, public distributing plants would find it difficult to do business, whereas they had in that district many cases where private plant had been given up, and the public supply taken at prices varying between ·95 and ·9665 in Birmingham, and in the Black Country ranging as high as 1½d. In the cases quoted by Mr. Brook, it must be remembered that the load factors were exceptionally good. With regard to suction gas plant, he did not agree with Mr. Brook. With regard to the comparative advantages of A.C. and D.C., Mr. W. Smith said that a number of well-known engineers believed that the D.C. was more easily transmitted over long distances, though in other respects he agreed that the alternating current motor was infinitely superior. Some astonishing results had been obtained in the regulation of speed by the Ward-Leonard system, results which could not be attained with the A.C. motor. The steam consumption results given by Mr. Brook were commented upon by Mr. H. Roberts, who mentioned that in a recent discussion at the Birmingham University a figure of 13 to 14 lbs. per kw.-hour was mentioned. He thought that with plants of 200 h.p. or less it was better to take the public supply where it was available. In the Black Country the Midland Power Co. were prepared to supply for plants of 40 h.p. and upwards, with a guaranteed load factor of 33⅓% for 3,000 hours a year, current at ¾d. per unit. The actual cost of production varied between ·56 and ·5d. With regard to the Daimler Works, he would like to know whether the figures given included the cost of a stand-by service from the Corporation mains.

Public v. Private Supply.

The President, Mr. G. O. Donovan, while agreeing that there was a great deal to be said for taking the public supply where it was available, agreed with Mr. Brook as to the possibility of generating electricity cheaply in many cases by a private plant. He mentioned the plant of 260 h.p. with which he was associated. This was run by a compound Corliss engine, and at the end of six years was

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found to be producing current at 6d per kw., after everything had been charged, exactly as if they had been selling electricity to another firm. This charge included steam heating to all departments, the assumption being that the steam taken for heating by each department was somewhat in proportion to its current consumption. But, although a private generating plant might produce electricity cheaper than they could get it from the public supply, it did not follow that the money expended on the plant would be profitably invested. As Mr. Brook had remarked, the capital might possibly be better invested in machinery, provided work could be found for the machinery.

LANCASHIRE.

MANCHESTER.

Local manufacturers report that they are receiving a sufficient number of orders to keep their works busy though they think they should get much more work than they do. The cotton trade continues in an unsatisfactory condition, and the expectations of an early improvement held at the beginning of the year do not seem likely to be fulfilled for some time. Export orders account for a large proportion of the sales. Perhaps this is why the branches of foreign firms here are complaining bitterly that they find trade very bad—all the foreign work goes home direct; or is it that the buying public is really beginning to support home industries?

A Manufacturer's Criticism.

A good deal has been heard lately at the annual shareholders' meetings of the various companies about the large and often expensive additions to the—selling—staff necessitated by the strenuous competition, to get a share of the work that is going. I was surprised the other day to come across a little firm here, which so far from reaching out for more orders, cut off its travellers a year ago, and has since been receiving a constant stream of orders from its regular customers, sufficient to keep the shops full. In this case the stuff is evidently able to speak for itself. It lays no claim to cheapness—in price nor in make—but is strongly made and intended for long service, and with the better class of buyers has found much favour. During the course of an interesting conversation with the head of the firm, I was provided with many reasons—and very feasible ones, too—for the comparatively poor state of business in the electrical business, for this gentleman manages to combine with the selling of high priced goods, a turn for philosophising. One of the reasons given was the want of mechanical design in nine-tenths of the smaller electrical stuff turned out, this in turn was attributed to want of practical engineering training on the part of the designers and to want of sufficient consideration of the designs from the customers' point of view. Another reason was the general ignorance of electrical salesmen of the limitations of the goods they are trying to sell.

GERMANY.

BERLIN.

Dr. A. Eulenburg, of Berlin, has called attention to the variations in voltage in the small dynamos with multiplex shunts, used for medical purposes. These variations cause pricking and crawling sensations in the nerves and contraction of the muscles. Battery currents give an absolutely direct current, and never cause these undesirable, and often contra-indicated and dangerous, effects. The remedy appears to be to add to the apparatus a condenser of large capacity. If the current has to pass through this, it neutralises the variations to a sufficient extent, as it acts as a reservoir absorbing, as it were, the current and giving out a fresh one of its own.

The Typewriter in Telegraphy.

The use of the typewriter in wireless telegraphy is not unknown, and our Government has now under consideration Cerebotani's typewriter for ordinary telegraphing. The French Post Office has already made many tests with Cerebotani's machine, which not only transmits the message through the telegraph wires, but prints it at the receiving station, as well as at the transmitting station. A full illustrated account of the machine appears in the *Elektrotechnische Zeitschrift* of March 24, 1910.

Japanese Enterprise.

The Allgemeine Elektrizitats Gesellschaft has laid down an important plant for supplying light and power in Formosa, where, since its acquisition by Japan, the sugar growing industry has already assumed large proportions, which are certain to increase as time goes on. The power is supplied by turbines running on horizontal shafts, which are coupled direct to the dynamos. The current is stepped up in oil transformers to 33,000 volts, and is carried to the places where it is to be used through cables, with a copper core supported across country on wooden poles.

The Dusseldorf-Cologne Railway.

It is reported that after Cologne had notified Dusseldorf that it intended to co-operate in the projected railway, the latter town approached the electrical firms concerned with a view to getting offers from them. They replied that they were negotiating with Cologne, and could, therefore, not treat with Dusseldorf until their business with Cologne was concluded, and could not consider any co-operation with Dusseldorf. The roads leading into Dusseldorf are provided with tramways possessing rights not to be readily infringed. Hence it seems impossible to make the line without Dusseldorf's consent.

UNITED STATES.

NEW YORK.

It has been already indicated in these Notes that New York is to lead the way in respect of a mono-railway for public use. As a matter of fact, construction was begun last week by the American Monorail Company of a monorail from Marshall's Corners in the Bronx to City Island, by way of Pelham Park. The head of the company is Mr. B. L. Burrows, who was formerly secretary to the Rapid Transit Commission, and is also connected with the Interborough Rapid Transit Company, by whom the new line is being financed. The cars have been under construction for some weeks and are in a very forward state and it is anticipated that the railway will be in actual operation by the last week in July of this year. The experiment is not on a very tremendous scale, as the total distance to be covered is scarcely more than three miles, but if the undertaking achieves the success which is predicted for it, it will no doubt be only the forerunner of a more extended system.

Electric Refining Furnaces.

From a report which has just been published in the technical papers it would seem that the Héroult electric refining furnaces which have been installed by the United States Steel Corporation have proved a great success. One of these 15 ton furnaces is in use at the South Chicago mills of the Illinois Steel Company, and the other is at the Worcester mills of the American Steel and Wire Company. The South Chicago furnace has been producing an average of 170 tons of high grade finished steel per day, for rails, car-wheels and axles, and it is anticipated that this output will be increased to 200 tons per day. M. Héroult reports that the three months' working shows a material decrease in cost, while the mechanical test is 20% better than for metal of the same chemical composition produced by the open hearth process. Renewals and wear and tear of furnace linings have involved a minimum of expenditure, repairs to furnace roof have worked out at 2½d. per ton of steel, 10 lbs. of dolomite per ton have been found ample to keep the banks in good condition, and the furnace bottom has not been affected. As to consumption of electrodes, it is put a slow as 10 lbs. per ton of steel and in any event will not exceed 15 lbs. These electrodes weigh 3,200 lbs. and are 10 ft. long and 24 in. in diameter.

The Power Consumption.

M. Héroult indicates that the power consumption of the South Chicago furnace is between 100 and 150 kw.-hours per ton of finished steel, but no definite working

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figures have yet been published, showing how far the estimated saving in power has been realised, in these large furnaces. In the ordinary size of Héroult furnace (three tons) for cold scrap, between 700 and 864 kw.-hours are required per ton of finished metal. This is reduced to between 150 and 329 kw.-hours when the metal is charged in the molten state. The power at South Chicago is supplied by three 700 kw. transformers, and this furnace is provided with three electrodes and is worked on the three-phase current system. These are the first large Héroult furnaces to be worked in this manner, all the earlier furnaces having been operated by direct current. In a communication on this subject to the Chicago *Electrical Review*, Mr. J. B. Kershaw says that the chief feature of the electric refining process when using Bessemer steel for charging the furnace, is the elimination of the phosphorus and the sulphur by means of first an oxidising and then a reducing slag. With open-hearth steel these impurities are much less in amount, and the refining process is proportionately shortened. Mr. Kershaw adds on the authority of Mr. Turnbull, M. Héroult's representative in New York, that it is intended to build later in America (presumably for the United States Steel Corporation) electric steel refining furnaces of thirty tons' capacity. These will be employed for treating exceptionally pure raw material, since with this size of furnace only one treatment with slag will be possible, and it is believed that in this case an output of 400 tons per day will be attained.

The Conditions of Corona.

The researches which have been undertaken in the physical laboratory of the Johns Hopkins University, with a view to investigating the conditions under which the "corona" or brush discharge takes place from high voltage transmission conductors above a certain value of voltage have resulted in the general conclusion that the air is ionized at different values of electric intensity for different sizes of wire. It would also appear that while the point of break-down or ionization does not occur at a definite value of electric intensity, observations on four sizes of conductor indicate that, if there is any effect of moisture in the air, the values of the voltage at which corona is formed is not influenced by more than 2%. This applies to a range of moisture content from air which is quite dry up to the saturated condition. The influence of temperature is being studied and the preliminary results indicate that for a range of from zero to 40° C., there is a lowering of about 3% in the value of the critical voltage.

Tungsten and Low Frequency.

In the past there has been considerable discussion as to the effect of a frequency of 25 cycles on 16 c.p. carbon filaments, and the weight of opinion has been that the flicker due to this frequency is so slight as not to be noticeable in ordinary illumination. Tests made with tungsten filaments, says the New York *Electrical World*, have shown that for equal diameters of filament, flicker due to low frequency is less than with the carbon filament, owing to the more lustrous surface of the former, from which heat is not radiated as rapidly as from the dull black surface of the carbon filament. On the other hand, a tungsten filament has less than one-third the diameter of a carbon filament of the same candle-power and voltage, and owing to this greater tenuity, a 32 c.p. tungsten filament will show the effect of flicker somewhat more at 25 cycles than a 16 c.p., 3·1 watt carbon-filament lamp of the same voltage. Tests of tungsten lamps at various frequencies have shown that at 25 cycles a 25 watt, 100 volt tungsten lamp flickers objectionably; a 40 watt, 100 volt tungsten lamp flickers noticeably but not objectionably, while in the case of tungstens of 60 watts and over, the flicker is scarcely noticeable.

Electric Light on Steam Railways.

Some very interesting points with regard to the electric lighting of passenger cars on steam railroads were laid before the last meeting of the Central Railway Club at Buffalo by Mr. J. R. Sloan. After discussing the methods in use Mr. Sloan observes that what is now demanded by the railroads is a generator and regulating apparatus that will accomplish the following: First, charge the battery at its normal rate until a certain predetermined terminal charging voltage is attained. When this voltage is attained the charging current is to be tapered off, until, it falls to practically zero value, or the charging current is practically discontinued and the battery floats, neither charging nor discharging; second, the lamp load should be picked up entirely independently of the battery load; third, the lamp voltage should be maintained practically constant, regardless of whether the generator is operating and supplying current to the lamps, or whether the battery is discharging and supplying this current. By "practically constant" is meant that a variation of 1·5% above or below normal lamp voltage, or a total of variation 3%, is permissible; fourth, that the "cutting in" speed should not exceed 20 miles per hour, and that from this speed to 80 miles per hour the apparatus will perform as above. One other point which Mr. Sloan cites as having been the cause of much trouble with axle generators in the past, is the construction of the various coils and the quality of the material. It has been common practice to use ordinary cotton covered wire for these coils, painted with shellac. In service these coils become oil soaked and would then "ground" or would become overheated, and the insulation would be burned out, so that a fifth requirement could be added, as follows: fifth, that all coils should be constructed so as to be heat, oil and moisture proof. Mr. Sloan believes that if sufficiently rigid specifications be drawn covering the above points, and also covering heating, voltage, and insulation tests, and workmanship and material axle generators could be obtained that would give satisfactory service in operation.

Popularity of Electric Automobiles.

Mention has so often been made in these Notes of the giant strides which the electrically driven car is making in popular favour, and the extent to which it is displacing the petrol car with its abominable odours and its many dangers, that no apology will be needed for reproducing some editorial observations on this subject, which appear in the current issue of the Chicago *Electrical Review*. It seems that Mr. John T. Fisher, the manager of the Chicago branch of the Babcock Electric Carriage Company, while standing on a prominent corner of one of the South Side boulevards in Chicago a few days ago, counted the automobiles passing each way for half an hour. These numbered 307, of which 144, or nearly 47%, were electric vehicles, driven mostly by ladies. "It is safe to say," observes the *Review*, "in view of the growing popularity of the electric, due in no small measure to the interest the central-station men are taking in this type of vehicle, that this already large percentage will be materially increased in the near future, and that within the next year or so the great majority of automobiles used within the limits of any sizable city will be electrically propelled. Mr. Fisher stated that any first-class garage will charge the batteries of an electric automobile, wash and polish the vehicle, and deliver and call for it, whenever the owner may desire, at a cost of from $30 (£6 3s. 1½d.) to $35 (£7 3s. 9d.) a month, which charge also includes the care of the batteries. When the owner of an electric car cares for his own machine and charges the batteries himself, Mr. Fisher estimates the cost at from $4 (16s. 5d.) to $6 (£1 4s. 7½d.) a month. For the lady shopping down town," adds the *Review*, "or driving out on the boulevards or in the parks, for theatre-going or for social calling, for the physician making his calls, and for any similar purposes, the electric automobile is unrivalled. Its moderate first cost, its small upkeep expenses, its noiselessness, cleanliness, reliability, and lack of objectionable odours, and its remarkable ease of control and operation make it unequalled for city purposes, and the central-station man who does not make a special point of catering to the needs of the electric vehicle operator will lose a large and profitable business which would add materially to his day load and thereby considerably improve his station load factor."

Hydroelectric Projects.

Further details of the plans of the Colorado River Power Company, of Marble Falls, Texas, show that the company will soon have completed a great dam across the Colorado River at Marble Falls, and the erection of a hydro-electric plant will soon be begun. The plant will have an initial

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capacity of about 5,000 h.p. and provision is made to double the amount of power of the original plant. The company is preparing to build transmission lines to San Antonio, 90 miles; to Austin, 35 miles; to Waco, 100 miles, and to a number of smaller towns within a radius of 150 miles. It has also contracted to furnish electric power for a cotton mill and other industries at Marble Falls. The dam is 750 ft. long, 50 ft. high and has an 80 ft. base with a 16 ft. crown. It is a sluice dam, with chambers in the interior, and is made of concrete reinforced with steel.

The Columbus Power Company is beginning the construction of a hydro-electric power plant on the Chattahoochee River, at Goat Rock. The dam will be 70 ft. high and 800 ft. in length; the ultimate development will be 24,000 h.p., and will involve an expenditure of $1,500,000. A railroad will be built from Motts, Ala., on the line of the Central Railroad of Georgia to the site of the dam, a distance of seven miles, for the purpose of hauling machinery and building material. The machinery used in construction will be operated by electricity, which will be supplied from the power house in Columbus; a transmission line will be erected from Columbus to the site of the proposed dam. Electrical energy developed at this plant will be transmitted to Columbus, West Point, Ga., and Opelika, Ala., to be used for industrial purposes in those places. This will be the fourth plant of the Columbus Power Company.

The Spokane Railway & Power Company will spend $1,500,000 on a hydro-electric plant at Le Pray Bridge on the Spokane River. The Seattle-Tacoma Company will spend $500,000 for 10,000 h.p. addition to the Snoqualmie Falls hydro-electric plant. The Port Angeles Power & Electric Company, of Port Angeles, Wash., will build hydro-electric plant on Little River. J. B. Daniel, of Wonder, Nev., will build $50,000 hydro-electric plant on the Truckee-Carson irrigation canal near Fallon, which will supply Wonder and Fairview with light and power. The Edison Electric Company, of Los Angeles, has made plans for a steam plant on the coast, upon which $2,000,000 will be spent initially, and $5,000,000 within ten years, the total development to be 100,000 h.p. The Pomona Power Company has been capitalised for $2,000,000 to erect hydro-electric plants in the San Jacinto Mountains.

CANADIAN HYDRO-ELECTRICS.

News comes from Toronto that, in reply to a question put in the Dominion House of Commons, the Hon. Adam Beck, chairman of the Hydro-Electric Commission, made an important announcement of the policy of the Commission in an entirely new territory.

Mr. Pugsley had declared that the only reason the Hydro-Electric Commission had for opposing the plans of companies for water power development along the St. Lawrence was that they wanted a monopoly, and, indeed, had no intention of developing or supplying power to municipalities in Eastern Ontario.

"So far are we from having no intention of taking up the field in Eastern Ontario, that it is only a question of getting through the enormous amount of work that has arisen in connection with the supply of power to Toronto and Western Ontario that has prevented us from doing so before," said Mr. Beck.

"In three or six months at most we will take up and prosecute vigorously the question of a supply of cheap power east of Toronto, Ottawa, of course, has been arranged for. We have been dealing with ten or eleven municipalities down east, Brockville, Kingston, Belleville, and others, and they have made application for over 12,000 h.p."

In spite of this policy of the Government body, there is plenty of enterprise on the part not only of municipal, but private interests.

Commenting on this state of activity, the *Canadian Engineer* says that there have been many signs of improvement in trade conditions during the past few months, and most manufacturers are experiencing the benefit of returning prosperity, but it is doubtful if the remarkable record of the Canadian General Electric Co. can be duplicated, not only because of their largely increased volume of business, but more particularly on account of the fact that several contracts have recently been closed for electric generators which for size and importance have no counterpart in the world to-day.

Some of the recent contracts closed by the Canadian General Electric Co. are with the Electrical Development Co., of Ontario, who are duplicating their output at Niagara Falls, this order calling for three enormous generators of 15,000 h.p. each, which establishes a world's record for size of individual units. Another contract of equal importance has been closed with the Ontario Power Co., who are also largely increasing their output at Niagara Falls, and have placed their order for three generators of 12,500 h.p. each. Still another contract of record-breaking magnitude has been closed with the Western Canada Power Co., of Vancouver, for two generators of 10,000 h.p. each, making a total of over 100,000 in these three contracts alone, in addition to about as much again made up of a multitude of smaller contracts.

All of this has been accomplished so quietly that one hardly realises its tremendous importance, not only to the manufacturing company, but to Canada as a whole. The addition of 200,000 h.p. to the output of producing electrical companies means that they must see ahead a market for the use of that amount of power, which in turn means that millions of dollars will be spent in new mills, factories and machinery, and additional employment given to thousands of workmen in our own country.

The lessons to be learned by those not directly interested in the company are as follows:—

(1) That Canada stands unrivalled in the number and magnitude of her water powers.

(2) That the rapid growth of the Dominion in population and enterprise has created an enormous demand for hydro-electric power.

(3) That capital is being invested in vast sums in the development of hydro-electric power undertakings.

(4) That the largest generators in the world to-day are being built by a Canadian company, which has the necessary enterprise and manufacturing facilities to take such foremost rank.

SAILING UNDER THE OSRAM LIGHT.

Science has advanced so rapidly during the past century not the least in electricity as applied to use on board ship. Consider for a moment the conditions existing on our sailing vessels of some few years ago—stuffy, evil-smelling, badly-lit, badly ventilated sleeping berths and dining rooms—the like of which were vastly inferior to the present day accommodation provided for the crew. Picture the horrors of sleeping for a night in a small, low-roofed cabin, in which for two or three hours previously had been burning a smoking, smelling and health injuring oil lamp. Nowadays one is able to enjoy all the comforts of home life whilst travelling from continent to continent. Ventilation in plenty can be obtained by means of electric fans, heating by means of electric radiators, and clean, healthy, and wholesome illumination by means of electric light. For obvious reasons gas has never found a notch in the evolution of lighting on board ship, and it has been left to electricity to provide the long and keenly needed improvement in shipping illumination.

Practically the whole of the large liners trading between countries all over the world are now equipped with their own electric lighting plant, and in this direction the Osram metal filament lamp has come very largely into favour on account of its remarkably long life and low current consumption. One of the White Star Liners, upon which Osram lamps are fitted throughout, has just returned to port after a five months' cruise, and the engineer's report states that only one lamp has failed throughout the whole period of absence, although the average life of the lamps in question is already over 700 hours. As we go to press we learn that this liner is again leaving for another cruise with identically the same lamps and are taking only half the usual number of spares, on account of the present perfect condition of the Osram lamps now installed, and the remarkably satisfactory results given on the previous voyage.

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SOME CHEMISTRY OF LIGHT.*

By DR. W. R. WHITNEY, Director of the research laboratory of the Schenectady Works of the General Electric Co.

From the dawn of history, chemistry has had much to do with the production of artificial light.

Turning to electrical methods of generating light, we find the chemist early at work. Sir Humphrey Davy and others, at the dawn of the nineteenth century, showed the possibilities which since that time have been developed into our various types of incandescent and arc lamps. We naturally attach Mr. Edison's name to the development of the carbon incandescent lamp, because it was through his indefatigable efforts that a practical lamp and illuminating system were both developed.

It had long been known that platinum, heated by the current, gave a fair light, but it melted too easily. A truly enormous amount of work was done in attempts to raise the melting point of the platinum, and the effect of occlude gases, of annealing, of crystalline condition, etc., were most carefully studied, but the results were unsatisfactory. He was therefore led to the element carbon as the next most promising conductor of high melting point. Edison's persistent and finally successful attempts to get a dense, strong, practical filament of pure carbon for his lamps, is one of the most encouraging lessons to the chemist of to-day.

From our point of view, all subsequent changes in choice of material for incandescent lamp filaments have been dictated by the knowledge that high melting point and low vapour tension were the first requirements. The desired property of high melting point is a periodic function of the atomic weight. And it is this fact, which was independently disclosed as a general law by Meyer and Mendeleeff, in 1869, that has aided in the selection of all the new materials for this use.

A study of the laws of radiation also soon played a part in incandescent lamp work. The early rough and black filament of bamboo was first replaced by a polished black carbon filament, and later by one which had a bright, silver-grey coat of graphite. A black body at any temperature radiates the maximum possible energy in all wave-lengths. Heated to incandescence, it will radiate more invisible and useless infra-red rays than any other opaque material at the same temperature; a polished metal is therefore a more efficient light source than the same metal with a black, or even rough surface. This fact is derived from Kirchoff's law of radiation and absorption, which was early established.

With an incandescent lamp containing a platinum wire filament, the intensity of its light is not very great, even when the current is sufficient to melt the wire. A much greater luminosity is produced by a plain carbon filament, and a still greater by the graphite-coated and metallized carbon before they are destroyed. In the case of carbon, the useful life of the lamp depends much more on the vaporization of the material than on its melting point, and these lamps will operate for a short time at very much greater efficiencies or higher temperatures than is possible when a practical length of life is considered. Thus, besides the physical effect of surface quality, we have evidence of differences in the vapour pressure of different kinds of carbon. It looks as though carbonised organic matter yielded a carbon of much greater vapour pressure for given temperature than graphite, and that even graphite and metallised graphite are of quite distinctly different vapour pressures at high temperatures. It may be interesting to note here that if the carbon filament could withstand for 500 hours the maximum temperature which it withstands for a few moments, the cost of operating incandescent lamps could be reduced to nearly a fifth of the present cost.

It was discovered by Auer von Welsbach that the metal osmium could be made into a filament, though it could not be drawn as a wire. The osmium lamp was the first of the recent trio of metallic filament incandescent lamps. The tantalum lamp, in which another high melting point metal replaces the superior, but more expensive osmium, has been in use six or eight years. This surpasses the carbon in its action, and on running up to its melting point it shows still brighter light than carbon.

More recently the tungsten filament lamp has started to displace both of the others. At present this is the element which withstands the highest temperature without melting or vapourising, and on being forced to its highest efficiency in a lamp it reaches higher luminosity; it is similar to carbon and tantalum in that an enormously greater efficiency may be produced for a very short time than can be utilised for a suitable length of life. The inherent changes at these temperatures, distillation, or whatever they are, quickly destroy the lamp. The lamp will burn an appreciable time at an efficiency fifteen times as great as that of the common operating carbon incandescent lamp (at 3 watts per candle). In other words, light may be produced for a short time at an energy cost one-fifteenth of common practice, so that there is still a great field for further investigation directed towards merely making stationary those changing conditions which exist in the burning lamp.

While it is generally true that the light given by a heated body increases very rapidly with the rise of temperature above 600°, the regularity of the phenomenon is commonly over-estimated. A certain simple law covering the relation between the temperature and the light emitted, has been found to apply to what we call a black body. This so-called Stefan-Boltzmann law states that "the total intensity of emission of a black body is proportional to the fourth power of the absolute temperature." There are, however, very few really black bodies in the sense of the law. The total emission from a hole in the wall of a heated sphere has been shown experimentally to follow the law rigidly, but most actual forms and sources of illumination do not. Most practical sources of artificial light are more efficient light producers than the simple law requires. This may be said to be due to the fact that these substances have characteristic powers of emitting relatively more useful energy as light than energy of longer wave-length (or heat rays). Most substances show a power of selective emission, and we might say that an untried substance, heated to a temperature where it should be luminous, could exhibit almost any conceivable light effect. A simple illustration will serve to make this clear: If a piece of glass be heated to 600°, it does not emit light; if some powder, such as clay, be sprinkled upon it, light is emitted, and the proportion of light at the same temperature will depend upon the composition of the powder. Coblentz has shown, both for the Auer mantle and for the Nernst glower, that the emission spectra are really series emission bands in that portion of the energy curve which represents the larger part of the emitted energy. This is in the invisible infra-red part, and so the laws which govern the emission at a given temperature depend upon the chemical composition of the radiant source. Silicates, oxides, etc., show characteristic emission bands.

One of the most attractive fields of artificial light production has long been that of luminous gases or vapours. It has seemed as though this ought to be a most satisfactory method. The so-called Geissler tubes in which light is produced by the electrical discharge through gases at low pressure are familiar to all. The distribution of the energy emitted from gases is still further removed than that of solids from the laws of a black body, and a large proportion of the total electrical energy supplied to a rarefied gas may be emitted as lines and bands which are within the range of the visible spectrum. These lines, under definite conditions of pressure, etc., are characteristic of the different elements and compounds. The best known attempts to utilise this principle are the Moore system of lighting (in which long tubes of luminous gas are employed), and the mercury lamps, which, while more flexible on account of size, are still objectionable because of the colour of the light.

It is rather interesting that the efficiencies of all of these various sources of electric light are not nearly so widely different as one would expect from a consideration of the widely divergent methods of light production employed.

From the light of a vapour or gas to that of an open arc is not a wide step, but the conditions in the arc are apparently quite complex, and there is a great deal of room for interesting speculation in the phenomena of an arc. Briefly, there are two kinds of arcs to be considered

* Abstract of presidential address to the American Chemical Society.

in lighting. One has been in use for a century, the other for a few years only. The first is the successor to Sir Humphrey Davy's historical arc between charcoal points. In this kind of arc the current path itself is hardly luminous, and the light of the lamp is that given by the heated electrodes. In case of direct current, it is the anode, or positive electrode, which gets the hotter and gives far the greater part of the light. In this carbon arc, it can readily be seen that the light is emitted by the heated solid carbon of one electrode; this gives a steady source of light, but is not so efficient as an arc in which material in the arc stream itself is the source of light. The arc may be made to play upon rare earth oxides, and these, being heated to incandescence, increase the luminosity, but this has not proved useful. The more common way is to introduce into the carbon electrode certain salts, which volatize into the arc and give a luminous effect. Here cerium fluoride, calcium fluoride, etc., are used, and the colour of the arc, just as in the case of gas mantles, may be varied by varying the composition of the electrodes. This is seen in the arc from the carbon electrodes containing such salts.

In the case of the flaming arc, the greater part of the light is due to the incandescent metallic vapours in the space between the electrodes. Substitution of one chemical for another in such flaming arc electrodes has covered quite a wide range of chemical investigation. Salts are chosen which give the greatest luminosity without causing the formation of too much ash or slag. Some compounds of calcium, for example, are practicable, while others are not, though all of these would, under suitable conditions, yield the calcium spectrum. If such salts as calcium fluoride were conductors at ordinary temperature, useful electrodes for flame arcs would probably be made from them. Such conducting materials as iron oxide, carbides, etc., have been used for flame arc electrodes, and a great many of the so-called magnetite arcs are now in use. The electrodes in this case are largely magnetic oxide of iron, with such other ingredients as titanium and chromium oxides, to increase the intensity of light, to raise the melting point of the mixture, etc.

As will be seen from observing this arc, the light is very white and intense, and is generated by the heated vapours of the arc proper. A great many modifications of this arc principle are possible. Titanium carbide and similar substances give characteristic arcs, and some of them are very intense and efficient.

A distinct species of electric incandescent lamp is that invented about ten years ago by the well-known physical chemist, Professor Nernst. This employs for filaments a class of bodies which are not electrical conductors at all at ordinary temperatures, and which, at their burning temperatures, do not conduct the current as metals and carbon, but as a solution does. This kind of conductivity, the electrolytic, involves electrochemical decomposition at the electrodes, and in the case of the Nernst filaments these otherwise destructive reactions are rendered harmless by the continual oxidising action of the air. For this reason this type of lamp will not burn in vacuo.

For its most perfect utility the principle of the Nernst lamp seems to require a mixture of oxides, because a single one is not so good a conductor nor so luminous. It uses oxides because these are the most stable compounds known, and it uses the rare earth oxides because they have higher melting point than other oxides. As the efficiency rises very rapidly with temperature, there is a great advantage in using the most infusible base possible. For that reason zirconia, thoria, etc., are usually employed.

In this lamp a rod or filament of an oxide mixture, much like those used in Welsbach mantles, is heated by the current, externally applied, until it reaches a temperature at which it becomes a good conductor itself. Here, again, the peculiar laws of light emitted at a given temperature being determined by the nature of the substance. Just as the pure thoria gives a poor light compared to the mixture with 1% ceria, so a pure zirconia rod, heated by the current, gives much less light than a rod containing a little thoria, ceria, or similar oxide. Work done by Coblentz on the energy emission of such rods shows the emission spectra, at least in the infra-red, to vary with the nature of the substance. In general, the spectra are not continuous like the spectra of metals and black bodies, but seem to occupy an intermediate position between these and luminous gases, which we know have usually distinct line spectra.

This recalls the subject of selective emission. Coblentz has shown selective emission in the long wave-lengths for a Nernst glower. This can be shown in comparison with the emission of a black body. The two sources when compared at the temperatures where they exhibit the same wave-length for maximum emission, differ very considerably in emission in the infra-red, the black body giving more energy at the blue end, and less at the red end of the spectrum.

This is still more noticeable in the curves prepared for testing such substances as porcelain, magnesia, and glass.

The curve for the ideal, or black body radiator, gives a picture of the total energy, and its distribution over the different wave-lengths. It is the peculiarity of the black body to radiate more energy of any given wave-length than does any other body at the same temperature. Therefore, in case of all substances acting as thermal radiators, the black body will always give the greatest brilliancy. Since this body at the same time radiates a maximum in all wave-lengths, it will be surpassed in light efficiency by any substance which is a relatively poor radiator in the invisible or non-luminous part of the spectrum.

In energy curves it is found that the energy emitted rises very rapidly with the temperature, *i.e.*, as the fourth power of the absolute temperature. It will be noted also that the point of maximum energy or wave-length corresponding to maximum energy, shifts gradually towards the left, or towards the visible wave-lengths.

It is this rapid shifting of the position of maximum energy which makes the search for substances which can withstand even only slightly higher temperatures of such great interest.

Professor Lummer has said that at red heat, bright platinum does not radiate one-tenth the total energy which the ideal black body radiates at the same temperature, and at the highest temperature still less than one-half. The deviation of platinum from the black body law is a step in the direction of getting improved light efficiency without corresponding increase of temperature. This method is practically without limit in its extension, for there seems to be no limit to the forms of energy curves which different substances may possess. The curves are apparently determined not only by physical state, but also by chemical composition of the emitting substance.

In the production of artificial light, the tendency will always be in the direction of increasing the practical efficiency, *i.e.*, reducing the cost of light. We have seen that there is still much room for this. In the case of the kerosene oil lamp, we know that much less than 1% of the energy of combustion of the oil is radiated as light from the flame. In the case of the most efficient source—the electric incandescent lamp at highest efficiency—we are still far from ideal efficiency. A still higher temperature would yield a yet higher efficiency. We do not know exactly how much light might possibly be yielded for a given consumption of energy, but one experimenter concludes that it is about 10 candles per watt. Fortunately, it is not now clear just how the chemist is to realise all the advances which he will make in more efficient lights.

No consideration of this part of the subject is complete without a brief reference to the efficiency of the firefly. The source of his illumination is evidently chemical.

The light-giving reaction is made to cease by the removal of the air, and to increase in intensity by presence of pure oxygen. It is extinguished in irrespirable gases, but persists in air some time after the death of the insect. Its production is accompanied by the formation of carbon dioxide. These all indicate a chemical combustion process. Professor Langley has shown that such a flame as the candle produces several hundred times as much useless heat as the total radiation of the firefly for equal luminosity. In other words, the firefly is the most efficient light source known. The difficulties attendant upon the accurate determination of the curve for the firefly are so great that we ought not to expect very great accuracy in this case. These curves, which in each case refer to the energy after passing through glass, which cuts off energy of long wave-lengths, represent the same quantities of

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radiant energy. While the sun is much more efficient than the gas flame or carbon arc, it still presents far the largest part of its energy in the invisible long wave-lengths (above 0·8), while the firefly seems to have its radiant energy confined to a narrow part of the visible spectrum.

THE SCHÖN FRESH AIR APPARATUS.

The fundamental requirement of modern hygiene is fresh air. The continual freshness and, as far as is possible, freedom from germs, is an indispensable quality of the air in every hospital or sanatorium. Fresh clean air is also required in all much frequented public and business places of resort, such as musems, theatres, restaurants and offices, and is equally a desideratum in private dwellings. All the contrivances for improving the quality of the air in a room which have hitherto been placed upon the market are of three types. The best known of the three is the ventilating fan placed in various situations on tables, or in the walls or roofs. The action causes eddies in the atmosphere of the room, but thereby the air is neither made worse nor purified, but rather made worse by the dust that is raised. The second type consists of arrangements whereby water is sprayed into the air, a method that is incapable of securing the desired result to any appreciable extent. In the third type the air is made to pass through a reservoir containing water to a spraying or atomising arrangement. This type is as ineffective as the others.

An apparatus which, while very simple, avoids all these drawbacks and exerts an action which is irreproachable from a hygienic point of view is the new arrangement invented by Schön. The principle on which it works can be readily understood. The air is drawn into the room from above through a wide funnel-shaped opening by means of a fan, and then passes through water or other suitable liquid whereby it is completely freed from dust, purified, moistened and cooled more completely than is possible with any apparatus previously constructed. On leaving the apparatus the air enters the room in the best possible state for reception by the human lungs, being free from dust and other injurious particles, and also cool and not too dry. As the air is drawn at a uniform rate by the fan and escapes from the liquid without pressure, no draught is produced, and dust which may be lying about in the room is not disturbed. The water in the reservoir must be renewed often, partly on account of the dust that accumulates on the bottom, and partly to secure proper cooling of the air. In hot weather it is an excellent plan to put ice into the water. If, too, a few drops of oil of turpentine are added, or of a substance such as menthol, oil of lavender, etc., the air may be perfumed at pleasure, and any smell such as that of tobacco smoke, etc., in the room may be completely disguised. In the case of tobacco, menthol is particularly efficacious. To destroy germs, a disinfectant, such as lysol, can be added to the water, or that liquid may be replaced by glycerine, which arrests those tiny particles mechanically. As the air on leaving the liquid in the reservoir brings away with it some of whatever liquid is used, either in the form of minute drops or of vapour, the apparatus may be employed for medicating the air of a room, with such substances, for example, as may be useful in the treatment of various lung diseases. It may, in fact, take the place of an inhalation apparatus with advantage, as it acts more mildly and requires no attention.

The extreme simplicity of the apparatus is obvious. It requires no skill either to fix it or to keep it in action. The fan is driven by a small electro-motor which takes no more current than an incandescent lamp, and can be switched on or off as easily as the latter. Hence the running expenses are absolutely trifling. It is attachable to any source of current like a lamp. It can be had in any form suitable for placing on a table. When surrounded by dry plants, it is an ornament to any room.

Another form of the apparatus is intended to be hung from the ceiling on hooks. In a third form, also for ceilings, the funnel is made of ground or embossed glass, and fastenings are provided for incandescent lamps. This form is specially recommended for hospitals.

It is much to be desired from the standpoint of modern hygiene of prophylaxis that an apparatus which combines utility with appearance to such a large extent should find extensive acceptation, not only in hospitals and sanatoria, but even in private houses.

LIGHT RAILWAYS.

The Board of Trade have recently confirmed the undermentioned order made by the Light Railway Commissioners:—Cromarty and Dingwall Light Railway (extension of Time) Order, 1910, reviving the powers granted by the Cromarty and Dingwall Light Railway Orders, 1902 and 1907, for the compulsory purchase of lands and extending the periods limited by those Orders for the same and for the completion of the railway and works thereby authorised.

ELECTRICAL ENGINEERS TERRITORIALS (London Division).—Orders for week ending April 23: Saturday, April 16, "A" and "B" Companies Drill Order, 3.30 p.m., Headquarters; Monday, 18, "A" Company, Recruits' Infantry Drill, 6 to 6.45 p.m.; Company Drill, 7 to 9.30 p.m.; Tuesday, 19, Infantry Drill, 7 to 8 p.m.; "B" Company, Technical Drill, 8 to 10 p.m.; Wednesday, 20, Gymnasium, 6 to 9.30 p.m.; Thursday, 21, "C" Company, Recruits' Infantry Drill, 6 to 6.45 p.m.; Company Drill, 7 to 8 p.m.; Technical Drill, 8 to 9.30 p.m.; Friday, 22, "D" Company, Recruits' Infantry Drill, 6.15 to 6.45 p.m.; Company Drill, 7.30 to 8.30 p.m.; Technical Drill, 8.30 to 9.30 p.m.—(Signed) P. H. CAMPBELL, Capt. R.E., Adjutant.

Dr. J. Erskine-Murray asks us to state that the rumour that he has been appointed Technical Adviser to a Wireless Syndicate is untrue and calculated to injure his position as an independent consultant. He has no pecuniary connection with, or interest in any particular system, his relations with all his clients being on the same basis, namely, that of an occasional consultant.

UNITED WIRELESS TELEGRAPH CO.—This firm have recently signed contracts for the installation of the united system of wireless telegraphy on 46 ships, the owners including the Nelson Line, Royal Mail Steam Packet Co., Pacific Mail S.S. Co., Liverpool and North Wales S.S. Co., and the Lloyd Brazileiro S.S. Co.

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Business Notes and News.

LIGHTING AND GENERAL—Home.

BACUP.—A Local Government Board inquiry has been held into the application of the Corporation to borrow £3,000 for outlay in providing electric mains and supply fittings. The supply is to be taken by the Corporation from the Rawtenstall Municipal Works.

BATH.—The City Council have decided to negotiate for variations in certain clauses of the Provisional Order for the electricity extension scheme.

COOKSTOWN, IRELAND.—The proposal that the Urban Council should promote an electricity scheme for public and private lighting has been shelved in favour of a housing scheme.

DOVER.—During the year the Electricity Committee have received from consumers £272 in repayment for the free wiring installations, and this is to be transferred to the sinking fund, making the annual payment £49 instead of £81. The Electrical Engineer reported the receipt of communications from Messrs. Parsons, Ltd., with reference to the defective rotor, with regard to which they were sorry to hear complaints, and would be willing to undertake certain repairs free of charge. They also expressed their willingness to supply a new rotor on certain terms. He wrote back asking them whether, in the event of the Local Government Board refusing to grant a loan, they would be prepared to spread the payment, and they replied that they would accept 25% down, and the remainder in three yearly payments at 5%. That would mean that the committee would have to pay £419 5s., instead of £390. These terms were accepted.

DUBLIN.—At a special meeting of the Corporation the two following Standing Orders were adopted: (66) The Lighting Committee has charge of all matters appertaining to gas and electric lighting within the city, except those in charge of the Electricity Supply Committee. (66a) The Electricity Supply Committee is a special committee having charge of the electricity undertaking of the Corporation, and consists of 10 members (with the Lord Mayor *ex-officio*) appointed by the Council at the quarterly meeting of January of each year. The Secretary and staff of the Lighting Committee act as Secretary and staff of this committee.

GLASGOW.—The Corporation have under consideration the acquiring of a site at Dalmarnock-road, of a total extent of 49,200 sq. yds., for the erection of a large electricity generating station. The present accommodation is insufficient for the growing needs of the city. Mr. W. W. Lackie does not recommend the enlargement of the Port Dundas station for two main reasons, the unsatisfactory supply of water from the canal for condensing purposes, and the expense of hauling coal. Should this scheme be adopted it will mean the expenditure of a very big sum in the near future on plant and fittings.

LEEK.—The Urban Council, like the Town Council of Maidstone, are anxious to obtain Parliamentary powers to enable them to fix electric fittings. The idea is not to trade, but to give the electricity department the legal right to make their own connections.

LEITH DOCKS.—The question as to whether the Dock Commission shall generate their own electricity or continue to take it from the Edinburgh municipal station has not yet been decided. But the deputation, on their return from visits to English towns, have reported in favour of a gas producer plant for generating electricity.

LONDON, SHOREDITCH.—It has been decided to put in a new main switchboard at the Whiston-street power station, as it is not safe to use the present one with the change in pressure.

MIDDLESBROUGH.—The electricity department has succeeding during the past month in reducing the cost of production from 1·05d. per unit in March of last year to 1d. There is a proposal to light Linthorpe-road with electric lamps.

RADCLIFFE.—A Board of Trade inquiry has been held into the application of the Lancashire Electric Power Co., Ltd., for a Provisional Order to enable them to supply electricity within the borough, practically without restriction. The borough has its own electricity works, but it is alleged does not hold out sufficiently advantageous terms as regards power for manufacturers. The company have a generating station at Outwood, within the boundaries, and have long been attempting to obtain a secure footing in Radcliffe.

SOUTHAMPTON.—As the result of the reduction in the scale of charges for electricity for lighting purposes extra consumption and profits have been obtained by the borough.

ST. ANNES.—Mr. J. H. Clothier, electrical engineer to the Urban Council, has been officially complimented on the prosperity of his department. A new scale has been decided upon as from April 1: Lighting—Maximum demand indicator system, 6d. and 2d., in lieu of 7d. and 2d.; flat rate, 4¾d., in lieu of 5¼d.; heating, power, etc.: For first 200 units 2d., and for each additional unit 1½d., in lieu of 2½d. for first 100 and 2d. for second 100 units, and 1½d. for each additional unit. All these prices are subject to a discount of 5% for prompt payment. When the recommendation came before the full committee, a letter was read from Councillor Thompson against the proposal, but the committee approved the recommendations. The Council are contributing £20 towards the cost of promoting a Bill giving local authorities power to wire houses.

TAVISTOCK.—The Urban Council have agreed that they "were not opposed to the application of Messrs. Budge & Co. for a provisional order for electric lighting, provided the plans of the scheme met with the approval of the Council." Mr. Alexander seconded, and the amendment was adopted.

TONBRIDGE.—Mr. A. E. Collins, M.Inst.C.E., has reported to the Urban Council in favour of the electric pumping of sewage. Estimates show the capital cost for suction gas as £581 and for electric pumping at £595, but in the latter case the upkeep and attendance would be much less.

TORQUAY.—The public lighting improvements are to include the conversion of 121 gas lamps into electrically-lighted lamps, in which the light will be 60 c.p. instead of 15; also that the arc lights are to be kept open an hour and a half later, from 10.30 until midnight. The light for the converted lamps, he said, would be supplied at the same price as the present gas lamps, notwithstanding the additional illuminating power of the light. About £500 worth of current a year more would pass through the mains for public lighting, and the total cost of the improvements, £580, would come out of revenue. It has been decided that the salary of the Borough Electrical Engineer shall be fixed at £250, rising by £25 per annum to £300.

WEMYSS.—An inquiry under the Private Legislation Procedure (Scotland) Act, 1899, into Draft Provisional Orders will open in the Parliament House, Edinburgh, on Tuesday, May 3, at 10.30 a.m. Among the Orders is that of the Wemyss Tramways (Extensions).

LIGHTING AND GENERAL—Overseas.

CALCUTTA.—An electric power installation for working the mines of the Mohpani Colliery is, we learn, under the consideration of the Great Indian Peninsula Railway. The annual output of coal from this colliery increased from 41,332 tons in 1907 to 48,242 tons in 1908, and the output was, we believe, still larger last year.

CALGARY, ALBERTA, CANADA.—City Engineer J. T. Childs has completed plans for the proposed municipal electric power plant costing $125,000, for which the commissioners have decided to recommend to the council that a bye-law covering this amount be submitted to the ratepayers. The purpose is to have the necessary authority to go ahead with the construction of the power house in case the negotiations with the Calgary Power Co. fall through. The proposed power house is 124 by 127 ft., of steel and brick construction. It will have a capacity of 2,000 h.p., and will provide for an increase to 4,000 h.p., when needed. It will be modern in every respect, being equipped with mechanical stokers and automatic coal and ash conveyers.

PUERTO CORTEZ, HONDURAS.—Concessions have been granted to J. W. Grace and to Manuel E. Lardizabel for the supply, to the towns of Puerto Cortez and Baracoa and of San Pedro-Sula respectively, of electrical energy for lighting and other purposes. Companies have been formed, under the names of the Puerto Cortez and Baracoa Electric Co., and the Empresa de Luz Electrica de San Pedro-Sula, to make use of these concessions.

TUCUMAN.—The prospectus of the Cia. Hidro Electrica de Tucuman has been distributed. Capital $5,000,000 gold, in 45,000 Ordinary shares of $100 gold each and 5,000 deferred shares of $100. Subscriptions are now invited to 18,000 Ordinary shares. Formed to acquire and work the concessions granted to Mr. T. J. Fleming by the Province of Tucuman on January 12 and November 7, 1907; one for the use of the waters of the Rio Lules and the other to construct and work a tramway and suburban railway in the City of Tucuman and suburbs. Purchase price $550,000 gold, payable £50,000 in cash and $500,000 in 5,000 fully paid shares of $100 each. It is proposed to first build a station of 3,000 kw. capacity. Surveys have shown that a total of 15,000 kw. per hour can be obtained from the water power. Estimates of revenue are based on a 20% load factor. Tucuman has already two electric power houses, which supply current at an average price of 15 cents gold per kw. hour, and the Company estimates that it can supply current to these two concerns at 7 cents gold per kw. hour. It is also estimated that the sugar mills, which have machinery amounting to about 13,000 h.p. would become clients.

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VICTORIA, BRITISH COLUMBIA.—The West Coast Power Co., 514, Fort-street, Victoria, have given notice of their intention to develop power from the Gordon river below Big Cawpon. The quantity of water applied for is unusually large, and with the head claimed to exist, would give the company 110,000 developed horse-power. Mr. Lorenzo Alexander is a director.

TRACTION—Home.

LEICESTER.—Much interest is felt locally concerning the rumours that the Midland Railway propose to develop the old line to Swarrington. Hope is expressed that the line may be electrified. If this is not done, it is suggested that the Corporation should extend their tramways, in conjunction with the County Council, so as to form a junction with the Burton to Ashby tram line.

LONDON.—The preambles of three London electric railway Bills have been proved by a Committee of the House of Lords. The first was a Bill to provide for the amalgamation of the Piccadilly and Brompton, the Baker-street and Waterloo, and the Charing Cross, Euston, and Hampstead Companies. The other Bills, promoted separately by the Baker-street and Waterloo and the Charing Cross and Hampstead Companies, seek powers to execute new works. As regards the Baker-street and Waterloo Company powers are sought to construct a subway. Mr. Dalrymple Hay, engineer, gave evidence to the effect that the existing lifts, staircases, and corridors at Oxford Circus were inadequate at the busy times of the day. The subway would consist of a cast-iron sloping tunnel 17 ft. in diameter, inside which there would be two moving staircases, running continuously and actuated by electric power. They would carry one passenger on every step, so that 150 passengers could stand on each staircase at one time. Mr. Albert Stanley, general manager of the three railways, gave similar evidence. The Charing Cross and Hampstead Railway proposes to make a terminal station on the Embankment under Hungerford-bridge.

SOUTHPORT.—A joint meeting of the Southport Tramways and Electricity Committees has decided to amalgamate the two estates.

TRACTION—Overseas.

KANCHRAPARA, INDIA.—The Eastern Bengal State Railway authorities are preparing a scheme for the electrification of the broad gauge workshops at Kanchrapara and the metre gauge workshop at Saidpur. The railway have also metre gauge workshops at Dacca for the isolated Dacca-Mymensingh line.

MADRID.—The *Gaceta de Madrid* notifies that the Compañia del Tranvia Urbano de Bilbao has applied to the Direccion General de Obras Publicas, Madrid, for a concession to construct and work an electric tramway in Bilbao, *i.e.*, from the Plaza Circular to the Northern railway station. It appears from another notice in the same issue of the *Gaceta* that the above-named company has obtained a concession for the construction and working of an electric tramway from the Calle de Fernandez del Campo to the Santander-Bilbao railway station (Bilbao).

ROME.—A concession has been granted to the Societa per le Tramoie Elettriche di Terni for the construction and working of an electric tramway from Collestatte to Ferentillo, being an extension of the Terni-Collestatte Tramway.

TOKYO.—A company has been formed to construct and work an electric railway between Tokyo and Yokohama. The line is to have a length of about 15 miles, and a branch line nearly 4 miles long is to be built to Kamata on the State railway. The line will be double tracked, with single overhead wires, and its gauge will be 3 ft. 6 in. The cost of construction is estimated at some 3,500,000 yen (about £357,300).

VENICE.—A concession has been granted to the Societa Anonima Compagnia Italiana dei Grandi Alberghi for the construction and working of various sections of electric tramway on the Lido.

COMPANIES' MEETINGS AND REPORTS.

RIO DE JANEIRO TRAMWAY, LIGHT AND POWER CO.

A dividend of 1% has been declared.

ORIENTAL TELEPHONE AND ELECTRIC.

Final of 5% on the Ordinary shares issued, tax free, making a total of 8% for the year.

ALSATIAN JUTE SPINNING AND WEAVING.

The directors report a net profit of 125,436 marks, against 210,456 marks last year, and are paying 4%, against 7%.

METROPOLITAN ELECTRIC TRAMWAYS.

After transferring £6,000 to reserve, the directors recommend a dividend of 5% on the ordinary shares for the year 1909, carrying forward £3,578.

KALGOORLIE ELECTRIC POWER.

The directors of the Kalgoorlie Electric Power and Lighting Corporation have declared a dividend on the preference shares at the rate of 6% per annum for the six months ended March 31 last, payable April 27 next.

MERTHYR ELECTRIC TRACTION AND LIGHTING.

The profit and loss account for the year ending December 31 shows that the gross receipts totalled £4,498 13s. 10d. The balance available for distribution is £2,998 13s. 10d., and the directors recommend the payment of a dividend of 5% on the Ordinary shares.

CALCUTTA TRAMWAYS CO.

Gross receipts for 1909 were £174,430, and working expenses £107,677. The directors propose a final dividend of 2s. 6d. per share, making 4½% for the year, add £7,000 to depreciation fund, and carry forward £435. Depreciation fund will now stand at £55,941.

RHONDDA TRAMWAYS ELECTRIC SUPPLY.

The accounts of the Rhondda Tramways Electric Supply Co., Ltd., for the year 1909 show that the sale of current amounted to £8,307, while, after providing for debenture interest, there remained £577, which was transferred to debenture redemption fund (increasing it to £,1323).

GREAT NORTHERN TELEGRAPH CO.

As a result of the increased receipts in 1909 from the company's participation in other telegraphic undertakings, and still more to the fact that last year there has been a profit on exchange instead of a heavy loss as in the previous year, the directors propose, notwithstanding a considerable decrease in the ordinary traffic receipts, to distribute the same dividend and bonus for the year 1909 as for the preceding year—viz., 18% (of which 5% has already been paid), and to set aside the £55,555 to reserve and £8,333 to pension fund.

CORK ELECTRIC TRAMS AND LIGHTING.

The report states that the receipts for the year to December 31 were £51,862, and expenses £31,684, leaving a profit of £20,178. Add balance brought forward, £715, together making £20,893. Less interest on Debentures, £4,600, leaving available £16,293. Of this amount £6,163 was paid on July 1 and January 1 for the half-yearly dividends on the 5% Cumulative Preference shares, £3,500 added to reserve for depreciation and £2,665 written off building plant, etc. The directors recommend that the balance be disposed of as follows:—£3,450 to 3% dividend on the ordinary shares, leaving £514 to be carried forward.

INDO-EUROPEAN TELEGRAPH CO.

The revenue account for the year 1909 shows a balance of £67,308, and after deduction of income-tax is reduced to £63,269. To this is added the balance brought forward, making a total of £70,478. The directors recommend a dividend for the six months ended December 31 of 17s. 6d. pe share (making with the interim dividend 6% for the year) and a bonus of 20s. per share, both tax free, and to make a special distribution to the shareholders of £12,750, equivalent to 15s. per share, out of interest upon certain investments and advance accounts. This distribution, also, will be free of tax. They also propose to set aside £15,000 towards the cost of increasing the carrying capacity of the system, and to hand over £5,000 to the trustees of the retirement trust fund, carrying forward £7,978.

WYCOMBE (BOROUGH) ELECTRIC LIGHT AND POWER CO.

The annual report for the year ended December 31, 1909, states that further progress has been made by the

company during the year, the connections having risen from 49,648 to 51,025, being an increase of 1,377 equivalent 8 c.p. lamps. The result of the year's trading, including a balance of £77 5s. 2d. brought forward from the previous year, shows a profit to the credit of net revenue account of £4,900 4s. 7d., and after paying interest on debentures and outstanding accounts £3,017 4s. 2d., there remains a balance of £1,883 0s. 5d. available for distribution. The directors recommend the payment of a dividend at the rate of 2% for the year, which will absorb £800, and that £1,000 be placed to the reserve fund for renewal account, leaving a balance of £83 0s. 5d. to be carried forward to next year's accounts.

WEST LONDON AND PROVINCIAL ELECTRIC SUPPLY.

At the tenth ordinary general meeting, held at 14, Ironmonger-lane, Sir Thomas Brooke-Hitching, who presided, moved the adoption of the report, and referred to the company's steady progress. The Chiswick Council had, he said, the right to purchase the undertaking in 1915 and at other subsequent periods as a going concern, based upon the profits of the company. The time would come when this country's present one-sided Free Trade would be brought to an end, and then numerous factories would spring up on the Thames-side at Chiswick. With them would come a demand for electric motive power, giving the company's station a day load. Mr. W. B. Esson seconded the motion, which was adopted.

NORTH METROPOLITAN ELECTRIC POWER.

The report for the year ended December 31 last states that the revenue for the year amounted to £88,925, an increase of £14,051 over 1908, and the expenditure was £44,504, being £1,290 only in excess of the previous year. The balance at the credit of the account is £44,421, which compares with £31,661 in 1908. This balance, together with interest receivable and the amount brought forward from last account, makes a total of £47,040. After providing for debenture, loan, and mortgage interest, and transferring £2,000 to the reserve fund, there remains an available balance of £34,315, which the directors recommend should be applied as follows:—To depreciation account, £7,000; to be written off preliminary expenses, £3,500; dividend on the cumulative preference stock, paid to October 31, £1,976; dividend on the ordinary shares at the rate of 6% per annum, £21,001; to carry forward, £837. The capital expenditure during the year was £40,262, and has now reached a total of £535,968.

BRISBANE ELECTRIC TRAMS INVESTMENT.

The revenue account of the Brisbane Electric Tramways Investment Co., Ltd., for the year to December 31, including £1,670 brought forward, shows an available balance of £69,757, which the directors have dealt with as follows:—In payment of debenture stock interest, £19,110; in payment of preference dividend, £17,695; in payment of an interim dividend of 3s. 6d. per share on the ordinary shares, £13,125. Out of the remaining balance of £19,826 the directors recommend that a further sum of £1,000 be set aside to the accidents insurance fund (bringing the same up to £3,000), that a balance dividend of 4s. 6d. per share, free of income tax, be paid on the ordinary shares (making a total dividend for the year of 8%), and that the sum of £1,951 be carried forward. The appropriation of the available balance of the tramways company, of which this company holds all the shares, includes an allocation to renewals fund of £18,000, bringing the reserve and renewals fund of both companies to a tatol of £89,216, with an aggregate of balances carried forward of £3,975.

BATH ELECTRIC TRAMWAY.

The annual report states that the traffic receipts for 1909 show an improvement over those of the previous year to the extent of £1,740 14s. 7d., both motor buses and trams having contributed to augmentation of income in spite of the adverse weather conditions which prevailed during the greater part of the year. The expenditure has again been reduced by the efficiency of the permanent way plant, and the system generally, has, the directors say, been well maintained. An improvement in earnings for the last year has been continued during 1910 the receipts for the first 11 weeks of this year showing an increase of £915, when compared with the same period of 1909—in fact for the 11 weeks ending March 16, the earnings are in excess of those for the first 11 weeks of any previous year.

After charging the expenses of operation and administration for the year ending, December 31, 1909, there remains a balance of £13,614 0s. 5d., to which amount has to be added the carry forward from 1908, amounting to £2,493 6s. 8d., thus making the total sum available £16,107 7s. 1d.

From this has to be deducted interest on the 4½% first mortgage stock paid and accrued to date, £6,082 4s. 11d.; also the second instalment to the sinking fund for the first mortgage debentures £1,000; interest on loans £1,310 17s. 10d.; and the dividend on the preference shares for the year £3,750. These sums leave £3,964 4s. 4d., and that amount the directors propose to carry forward to the current year's account.

CITY ELECTRIC LIGHT.

The report for the half-year ended January 31, 1910, states that during the half-year the output has been 1,066,088 units, as against 976,786 for the corresponding period of 1908-9. Comparing the revenue from the sale of electricity for the same periods, the increase has been 20%, while the revenue from all sources has increased 23%. The results for the half-year's working have been such, that after placing £500 to the credit of the franchise purchase sinking fund account, £150 to the accident insurance account, and a substantial sum to the credit of renewal, replacement, and contingencies account, there remains a credit balance of £4,456 3s. 5d., which with the balance brought forward from last half-year, makes a sum of £5,860 1s. 1d. to be disposed of. The directors recommend that on March 15 next a dividend be paid at the rate of 6% per annum on the preference shares, and at the rate of 8½% per annum on the fully-paid ordinary shares, and at the rate of 8½% per annum on the contributing shares in proportion to the amount paid up thereon; they also recommend the payment on the same date of a bonus at the rate of 2% per annum on the fully-paid ordinary shares, and at the rate of 2% per annum on the contributing shares in proportion to the amount paid up thereon. The payment of the above-mentioned dividends and bonus, together with the dividend duty, will absorb £3,909 9s. 7d., leaving a balance of £1,950 11s. 6d. to be carried forward. During the half-year the machinery, plant, and mains have given entire satisfaction, and the good work of the staff has again contributed to the excellent results achieved. Good progress has been made with the new waterside power house in William-street, and as the contract stipulates for its completion within the year, the directors have ordered another 700 kw. turbo generator; this, together with the necessary complement of boilers, pumps, etc., will, it is hoped, be erected and ready for use early in 1911. The laying of mains in the City and Valley areas has progressed steadily.

SOUTH WALES ELECTRICAL POWER DISTRIBUTION.

The directors in their report for the year ending December 31, to be presented at the eighth annual general meeting to be held at the Park Hotel, Cardiff, on April 12, state that the arrangement for the construction by the Treforest Electrical Consumers' Co., Ltd., of a connecting cable between the generating station at Treforest and the Cwmbran area has been duly carried out. The connection was completed in May last, and since then the supply to the Cwmbran area has been entirely taken over by the Treforest Co. This arrangement has enabled the Cwmbran generating station to be shut down, and the expense of working it as a separate unit to supply the consumers in that area has thus been saved to this company. The revenue account only comprises the working of the Cwmbran station up to May 17 last year, as since that date the whole of the working expenses in connection with the under-

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taking has been borne by the Treforest Co. The directors are pleased to report that the Treforest Co. has made steady progress during the last twelve months, the cost of production having been materially reduced, and the output increased. Some new consumers have been connected, and negotiations are proceeding with others who are contemplating taking a supply. To meet the growing demand for current, the Treforest Co. are considering the question of providing further capital for an increase of the generating plant. On the whole, therefore, the directors consider that the position of the company has appreciably improved as compared with that in 1907, when they took office. The revenue account for the year shows expenditure amounting to £2,615, and revenue of £1,861, leaving a debit balance of £753, which brings the debtor balance at the end of 1909, excluding the interest on the prior lien Debenture Stock and Debenture Stock, to £96,621. The interest due on the prior lien Debenture Stock amounts to £1,739, and on the Debenture Stock to £10,000. The net revenue account shows that the interest on the prior lien Debenture Stock has been paid by the Treforest Electrical Consumers' Co., Ltd., and that the total debit balance now amounts to £106,621.

WILLANS AND ROBINSON.

At the thirty-second half-yearly meeting of the shareholders of Willans & Robinson, Victoria Works, Rugby, Mr. James C. Peache, managing director, was in the chair. The chairman, in moving the adoption of the report and accounts, regretted that the result of the half-year's working was not more satisfactory, and said this was due entirely to the difficult commercial situation which had recently prevailed. The state of the trade, particularly that of the production of electrical generating machinery, to which their operations were chiefly directed, was exceedingly bad, and competition had been exceedingly keen. It had been impossible to obtain a sufficient volume of orders to keep the shops fully employed, and for the orders that had been obtained it had been necessary to accept prices that had at best left but a small margin of profit. The company was not working under normal conditions. Since 1904 its resources had been largely utilised in the liquidation of liabilities incurred prior to that date, and it had not been possible to make provision for a difficult period such as the company was now passing through. Profits when they were made had to be largely used in wiping out the past, instead of safeguarding the future. The difficulties did not end with the liquidation of debts. The capital raised for the construction and equipment of the Queen's Ferry works and other obligations incurred, owing to the non-success of these works, imposed a heavy burden upon the Rugby business. While the directors were anxious that the shareholders should make due allowance for the difficulties under which the company had had to be carried on, they asked the shareholders not to be unduly discouraged by the present state of the profit and loss account. The works were better equipped than before, and the staff was certainly no less efficient. Given reasonable improvement in the state of trade there was every expectation of profits being gained again. Steps were being taken to reduce the heavy preferential charge on the business. By means of the fire fund the debentures debt had been reduced from £245,495 to £215,769, and there were other funds available for the reduction. When the Queen's Ferry works were sold the directors hoped to apply the proceeds of the sale to the further redemption of debenture stock. Until the political horizon cleared, and some measure of confidence was restored to commercial enterprise, he feared they must wait for a purchaser for these works. There was at present some evidence of improving trade, although there was no indication of improvement in the miserable and inadequate scale of prices which had to be accepted if work was to be obtained. There had recently been a well-marked increase in the volume of orders obtained, but orders must be secured in considerably greater quantity before a really prosperous period could be expected. The loss shown on the profit and loss account was £8,282, and in addition it had been necessary to draw on the reserve fund. It might be pointed out that the debenture interest and depreciation together more than accounted for the whole of the loss in the profit and loss account. It had been decided to recommend the election of Mr. Frederick R. Davenport as assistant managing director at a salary of £1,500 per annum. Mr. Davenport had given up an excellent position to accept this post, and would give his whole time to the company. By this appointment the directors hoped to effect a substantial improvement in the business of the company. Mr. Peache was re-elected a director, and the resolution in favour of the election of Mr. Davenport was adopted.

COMPANIES REGISTERED.

The Rural Electricity Supply Co.—£10,000, of which £9,500 are £1 seven per cent. participating shares. Object: To establish undertakings for the supply of electric light and power in country towns and the larger villages in the rural districts of England. Directors: E. C. Jones, B. P. Gibbons, Managing Director, G. B. Crockatt, Electrical Engineer, H. T. Harrison, M.I.E.E., T. E. Slaughter, Electrical Engineer. Secretary and offices: Hamilton Dixon, 11, Victoria-street, S.W.

A. Dean & Co., Ltd.—£1,000, in £1 shares. Business: Electrical engineers, dealers in electrical fittings, etc. Private company. Office, London House, London-road, Norbury, Surrey.

Bedford & Co. (Cardiff), Ltd.—£1,000, in £1 shares. Business: To take over that of an electrical engineer, etc., carried on by C. E. Bedford at Frederick-street, Cardiff, as Bedford & Co. Private company.

Electric Pavilions, Ltd.—£4,000, in £1 shares. Business: That of theatre proprietors, and to acquire the premises known as the Public Hall, Romford. Private company. Office, 105, Westminster Bridge-road, S.E.

Felgate Installation Co., Ltd.—£1,000, in 100 Deferred shares of 1s. each and 995 Ordinary shares of £1 each. Business: That of electricians, etc. Private company. Office, Broadway-buildings, Reading.

Lovis Patent Propeller Syndicate, Ltd.—£1,400, in £1 shares. Business: That of marine, electrical and mechanical engineers, etc. Agreement with A. Allport, P. C. Tarbutt and W. F. Hobdell. Private company.

R. J. Rodd.—£1,000, in £1 shares. Business: Electricians, mechanical engineers, &c. Private company.

West End Mills Co. (Bradford).—£1,000 (£1). To take over the business of millowners and lessors of mill, warehouse, and office premises, and generators and suppliers of steam and electrical power carried on by J. W. Firth and W. Waud on the West End Mills Estate, Bradford. Private. (£108,476.)

PERSONAL.

Mr. Henry C. Adams, the junior partner in the firm of Henry Adams & Son, consulting engineers, had the honour of being the first candidate elected a Fellow of the Society of Engineers (Incorporated), the president and council being already Fellows under the articles of association.

A few days ago, Mr. G. F. Craven, Chief Assistant Tramways Engineer for the Reading Corporation, was the recipient of a handsome silver tea and coffee service from the employees and staff of the Tramways Department, as a mark of esteem and good wishes on his approaching marriage. The General Manager, Mr. W. Binns, made the presentation.

At a meeting of the Institution of Electrical Engineers London, the following were elected Associate Members: Mr. A. Angers (Liverpool), Mr. R. Bruce (London), Mr. W. S. Burge (Watford), Mr. C. F. Button (Southampton), Mr. J. P. Chisholm (Newcastle-on-Tyne), Mr. J. Crane (Warrington), Mr. W. Cruickshank (East Finchley, N.), Mr. H. C. Eager (Liverpool), Mr. A. J. Eames (Liverpool), Mr. Georges Gollicz (Bombay), Mr. W. W. Reynolds (Lubiaco, West Australia), Mr. H. S. Hohne (London), Mr. E. J. Morrell (Upper Holloway, N.), Mr. S. T. Pemberton (Birmingham), Mr. C. H. Phillips (Wallington, Surrey), Mr. A. R. Powell (Bedford), Mr. H. Skelton (London), Mr. W. H. Starkey (London), Mr. J. P. Thomas (Westminster, S.W.), and Mr. A. E. White (Sheffield).

Mr. Atchison, Electrical Engineer to the Borough of Rochdale, has had his salary increased from £350 to £400.

Mr. S. E. Fedden, General Manager of the Sheffield Electricity Department, has had his salary increased from £800 to £900 by two annual increments of £50.

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TRADE NOTES.

The Mirrlees Watson Co., Ltd., of Glasgow, have recently received a number of important orders for steam condensing plant. For Messrs. Bolckow Vaughan's Steel Works, South Bank, they had an order for five sets of surface condensing plant working in connection with steam turbo alternators and air-compressors. They had already working in the same station four sets of simliar plant, the total duty being equal to 350,000 lbs. of steam per hour. Another order received by Messrs. Mirrlees's was for surface condensing plant from Messrs. Stewarts & Lloyds, two sets each of 60,000 lbs. duty for the Dominion Iron & Steel Co., per Mr. P. J. Mitchell; a barometric jet plant with cooling tower and pipework for Sir Wm. Arrol & Co.; a barometric plant for Messrs. Fyvie & Stewart, Melbourne; jet condensing plant for the Cadzow Colliery Co., per Messrs. G. Harland Bowden; also air pumps for Messrs. Henry Tate & Sons, Liverpool, and Mr. P. J. Mitchell, for the Dominion Iron & Steel Co.

Messrs. Thermit, Ltd., are carrying out the welding of the joints in connection with the construction of the electric tramway in Slateford-road, Edinburgh.

The British Westinghouse Electric & Manufacturing Co., Ltd., advise us that their supply department (offices, showroom and stores) for the London district has been removed from 27, Chancery-lane, London, W.C., to larger and more commodious premises at 3, West-street, and 30, Litchfield-street, Charing Cross-road, W.C., at which address they will be pleased to show anyone interested the Westinghouse-Bremer patent "Arcturus" flame arc lamps, various forms of enclosed arc lamps, their latest magazine flame lamps for street lighting, as well as to demonstrate the saving to be effected by the Westinghouse patent "Auriga" metal filament lamps.

JAPAN IN LONDON.

A FEW WORDS ABOUT THE EXHIBITION.

Successful as was the French Exhibition of two years ago, the Japan British Exhibition at the White City, Shepherd's Bush, is likely to prove even more popular and interesting. The striking enterprise of the Eastern Island Empire has attracted universal attention, and this unique opportunity of seeing so many sides of Japanese activity—intellectual, artistic and industrial—will be eagerly seized and is sure to draw crowds to the White City. What is most interesting in this connection is that there will be a peaceful invasion of London by Japanese, who are coming over in thousands, not only to take part in the Exhibition, but to study what we have to show. Thus, in the electrical domain it is we who have wonders to offer our Eastern allies, and that they have not been slow to avail themselves of what we had to give is shown by the numerous hydro-electric installations in Japan, the increasing electrification of railways and the introduction of the electric drive in factories. We find that we are even providing our friends with electric apparatus for their enterprises in Korea, Formosa and Manchuria. Distinctly, Japan is a country to be cultivated by electrical engineers. It is, therefore, well that the exhibition will have much to show our visitors in the way of electrical enterprise. Mr. Converse, the Electrical Engineer to the Exhibition, has much lavish use of electricity, not only for purposes of converting the White City into a fairy city by night when the myriad lamps are aglow, but for purposes of traction, for lifts, pumping, and in many other directions. In fact, the electrical installation under his charge is of greater magnitude than that existing in many large and enterprising towns, and certainly the ways in which it is put to use offer unique opportunites for study. It is to be hoped that really qualified visitors from beyond the seas will be permitted to have a peep behind the scenes in this matter of the electrical equipment of the show. But apart from this, in the Engineering Section electricity will, we understand, be strongly represented. Already the following firms have taken space and arranged to make comprehensive displays: T. &. J. Jackson & Co., Osram Lamp Works, Ltd., India Rubber, Gutta Percha & Telegraph Works Co., Ltd., John Dugdill & Co., The Dowsing Radiant Heat Co., The Chloride Electric Storage Co., The Western Electric Co., Ltd., Maxim Lamp Works, Lambie, Wrigley & Co., Electrometers, Ltd., etc., etc.

It is well that this department of the Engineering Section should be made as strong and representative of every branch of electricity as possible, for, as we have said, from the Japanese point of view, this Exhibition will be largely a matter of business. This is self-evident from the keen interest taken by the Mikado's Government and his subjects. We have said that many thousands of Japanese will visit the show. At the head of these will be the heir-apparent, H.I.H. Prince Fushimi. Another distinguished visitor will be Baron Oura, Minister of Agriculture and Commerce.

DIARY.

WEDNESDAY, APRIL 20.

INSTITUTION OF ELECTRICAL ENGINEERS (Leeds Section).—At the University, at 7.15 p.m., Annual General Meeting.

THURSDAY, APRIL 21.

INSTITUTION OF ELECTRICAL ENGINEERS.—The Institution of Civil Engineers, at 8 p.m., Mr. A. V. Clayton on "Hydro-Electric Installations of Sweden."

FRIDAY, APRIL 22.

PHYSICAL SOCIETY OF LONDON.—At 5 p.m., at the Imperial College of Science, Imperial Institute-road, South Kensington, Mr. C. Cheneveau with Mr. A. C. Jolley on "The Magnetic Balance of Curie and Cheneveau."

ROYAL INSTITUTION OF GREAT BRITAIN.—At 9 p.m., Mr. T. Thorne Baker on "The Telegraphy of Photographs, Wireless and by Wire."

SATURDAY, APRIL 23.

ASSOCIATION OF ENGINEERS-IN-CHARGE.—At the St. Bride's Institute, Fleet-street, at 7.30 p.m., Annual Meeting.

JUNIOR INSTITUTION OF ENGINEERS.—Excursion to Southampton for visiting the New Dock Works and the T.S.S. *Teutonic*.

ELECTRICITY FROM THE JORDAN.

According to a Jerusalem correspondent, a venture for supplying the whole of Palestine with electricity for lighting, heating, and cooking purposes is being entered upon by a French company, which has its headquarters in Paris. Power is to be supplied by the fall of the Jordan between the "Waters of Merom" and the Lake of Galilee, a fall of about 700 ft.

The generating plant is to be erected on the west bank of the river, and it will be connected with all the chief towns of the country. Some £500,000 will be required for the initial expenses, but it is expected that in five years the works will be paying well.

PATENTS.

Electric Accumulator.

67701.—1909. H. W. TWAITES, Leeds. The accumulator has leaden polar elements with solid ends and perforated sides. The perforations enable the acid used in the accumulators to pass through freely in order to act upon the enclosed ingredients for producing positive and negative poles.

Wireless Electric Fog Signal.

5685.—1909. M. A. MURRAY, New York. This is an improvement in fog-signalling apparatus of the type in which Hertzian waves are utilised for announcing the proximity of one vessel to another or to the shore. According to the invention, means are provided to control the Hertzian waves to certain distances so as to locate the vessels at these different distances as they approach in the fog. For this purpose, different sized coils are used to throw in a circle to the distances of 3, 2, 1, ½, ¼ or ⅛ miles. In this manner ships receive a timely warning, and when within ⅛ mile the compass points of the vessel are numbered and signalled.

Controlling Electric Circuits.

5418.—1909. BRITISH THOMSON-HOUSTON CO., London. The circuit controlling device comprises a movable contact, a switch arm connected in series with the contact, and arranged to move the contact to close the circuit when the switch arm is moved to open the circuit. A latch holds the movable contact in circuit closing position; a trip coil for the latch is mounted on the switch arm.

Electric Terminals.

5302.—1909. G. E TATE, St. Albans. The object is to provide a terminal which can be mounted on the outside of the apparatus to which it is fitted. The outside part of the terminal is embedded in insulating material in an outer metallic watertight casing, and screws into the apparatus. A screw cap and an insulated opening is provided for access to the outer enclosed end of the terminal.

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Electric Fuse Carriers.

12744.—1909. W. T. Henley's Telegraph Works Co., Ltd., London, E.C. The object is to produce a fuse carrier so constructed as to reduce to a minimum the arc or flame escaping from the carrier in such a manner as to constitute a source of danger to adjacent fuses. For this purpose the fuse, which consists of a number of wires extending side by side is threaded through an envelope of insulating and non-combustible material provided with closures at its ends, each having an aperture only large enough to give passage to the wires which are secured, externally of the apertures, to binding screws in electrical connection with metal tongues which make wedging contact with the fixed terminals between which the carrier and fuse are to be interposed. Provision is made for the escape of incandescent gases from within the envelope at points near the respective ends of the container by way of passages whereby the flame is directed against shields of insulating non-combustible material which serves both to disperse the flame and also to protect the metal tongues and adjacent parts.

Trolley Retrievers for Electric Cars.

11326.—1909. J. Eccles & W. E. Hadfield, Beswick. This is an apparatus to prevent accidents when the trolley of an electric car leaves the overhead wire whilst the car is in motion. Underneath the car, fitted to a driving wheel is a shaft mounted on a pedestal and brackets and carrying a toothed wheel clutch. One part of this clutch is free on the shaft and is of a piece with a balance wheel. The other part of the clutch revolves with the shaft and slides on a key. A roller chain screwed in a groove in the balance wheel passes through the end of a lever fork on the revolving part of the clutch. The chain then passes to a split bush at the back of the car and is hooked to the end of the trolley rope. There are three catches on the chain, one of which brings the clitches into gear when the trolley flies upward. The second catch forces the clutches apart when the trolley has been drawn down as far as required. The third catch passes through the split bush in the direction of the clutch, where it remains until the split bush has been opened by a weighted lever. This third catch prevents the trolley going up until the lever is released.

Unipolar Turbo Dynamo.

2814.—1910. O. Schulz, Berlin. This unipolar turbo dynamo comprises inversely running armatures rotating in the same direction and adapted to be driven by an equal number of inversely running wheels of a turbine. The inner armature and runner are connected by means of a hollow shaft through which the shaft connecting the outer armatures and runners can be passed.

Electric Switches.

2 184.—1909. Telephon Fabrik Aktiengesellschaft, vorm. J. Berliner, Hanover. This is a switching device for telephones in which a number of pivoted levers engage with a common locking bar, so that the operation of one releases another. A lateral projection is provided on the plate end of the lever, and is adapted to engage one or more contact springs beside the pivoted lever so as to complete the circuits required.

Insulators for Carrying Electric Cables.

27757.—1909. P. G. Navarro, Soria. The insulator comprises a rectangular box-like casing provided with an open top which is closable by a lid. Blocks of insulating material are placed within the casing through the open lid. An aperture is made in each side of the casing for the passage of the conductors between the insulating blocks.

Electro Magnetic Igniting Device for Arc Lamps.

27560.—1909. D. Timar, Berlin. The electrodes of the electro-magnetic igniting device are arranged beside one another. An electro-magnet armature is operated when the lamp is switched in, and is coupled at this switching in by magnetic action with one or more switch levers to which an equal number of pairs of carbons appertain, so that it takes the same by friction to the prescribed final position.

Supporting Electric Lamp Globes.

27472.—1909. Falk, Stadelmann & Co., Ltd., London, E.C. Spring pins sliding in cylinders on the galleries of electric lamp burners and made to engage with the globe are provided with arms while the cylinders are provided with slots. The arms engage with the slots, and when turned bear against the outer ends of the cylinders.

Electric Mercury Switches.

25962.—1909. Siemens & Halske, Aktiengesellschaft, Berlin. This is an improved mercury treadle switch of the type in which a vehicle passing along a rail causes a flow of mercury which establishes a series of successive contacts. An adjustable insulated contact is placed at a certain height above the vortex formed by the flowing mercury in a cylindrical vessel. The contact is established by means of the contact pin between the fall of two successive drops. The contact is interrupted by the fall in height of the mercury resulting from the formation of drops through the apertures in the vessel.

Continuous Current Motor Generator.

24306.—1909. Allgemeine Elektricitats Gesellschaft, Berlin. This is a continuous current motor generator of the dynamotor type for transforming continuous current of constant potential into continuous current, the potential of which decreases with increasing current strength. The differentially excited generator element is wholly or partially excited by a current which varies inversely as the generator or load current.

Electric Regenerative Control Apparatus.

2113.—1909. Crompton & Co., Chelmsford. The apparatus comprises a motor generator and one or more motors all coupled together on the Ward-Leonard system. To this system is applied a safety winding, which consists of a series field winding provided upon the generator element of the motor generator.

Insulation of Windings in Electrical Apparatus.

22479.—1909. R. Bosch, Stuttgart. Each layer of the winding is sub-divided into sections, which are then separated by layers of insulation which extend across the whole width of the winding in such manner that with two sections there are three layers, or with three sections there are five layers, and so on. This is effected by staggering the sections, and causing alternately one layer to rise towards the right and the next towards the left.

Electric Clock Winding.

21940.—1909. F. J. Seabolt, Schenectady, U.S.A. In this clock, in which motion is transmitted to the clock train from the driving means by a flexible cord, a spring controlled rotary contactor is provided for controlling the circuit of the winding mechanism, and is adapted to be rotated in one direction by the clock mechanism, and in the other by its controlling spring.

Arc Lamps.

20311.—1909. Gebruder Siemens & Co., Charlottenburg. The invention consists in an improved electrode for enclosed arc lamps in which the arc is cut off from the surrounding atmosphere to such an extent that only a very limited amount of air has access to the arc. The electrode consists of a number of cores which contain the light enhancing additions. Each core is enclosed by a thin uniform sheath of carbon.

Dynamo Electric Machine.

19210.—1909. British Thomson-Houston Co., London, E.C. The object is to provide a machine of the direct current type, of high efficiency, and which shall save in cost of material and labour. The field magnet has its magnetic material distributed round the armature to form a uniform air gap, and is slotted on its inner periphery. The field winding and a compensating winding are composed of uniform overlapping coils carried in slots. The two coils may be interleaved to form mechanically a single winding, and each winding may be distributed through all the slots. The proper current distribution for both field and compensating windings may be obtained with a fractional pitch of 50%, so that the end connections of the coils are short and the copper efficiently employed. By properly shaping the field magnet and connecting the field coils to produce the magnetic poles at proper points, the amount of magnetic material required may be reduced as compared with ordinary designs. In order to secure good ventilation, the slots, which are nearly closed, are made somewhat deeper than necessary for receiving the coils, so that the coils do not fill the slits. A fan carried at one end of the armature forces air axially through the spaces in the slots.

Electric Control of Clocks.

18005.—1909. Siemens Bros. & Co., London, S.W. A relay and registering apparatus, actuated only when the local shunt circuits of two or more clocks are closed at the same time, is provided in the circuit which controls the running of sub-station clocks from a master clock at a central station.

Electric Switches.

15578.—1909. J. A. Kennedy-McGregor, Birmingham. This is an improvement in fly movement electric switches in which a contact lever is locked in the on and off positions by means of two separate locks. The improvement consists in adapting the two locks so that they lock the contact bars to the immovable spindles on which the bars turn. Slots are provided in the contact arms for engagement by the two locking elements, and are disposed in angular relationship with each other. A spring presses either of the locking elements into engagement.

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Electric Lamp Shades.

15208.—1909. L. ZAMBONI & C. A. STERLING, New York, U.S.A. The shade, which comprises two disc portions with radially disposed arms overlapping each other, is held against the lamp by a sleeve which is inculcated from the conducting parts of the lamp.

Electrically Controlling Searchlights from a Distance.

12970.—1909. A. LE BLANC, New York, U.S.A. A relay device is interposed between the controller and each of the motors. The direction of rotation of the motors is controlled by a current sent in either direction through each of the relays.

Magneto Electric Ignition Apparatus.

12286.—1909. R. F. HALL, Moseley. The object is to provide a simple and cheap method of supply in a dual system of ignition for small power engines. The high tension distributor and the battery contact breaker are enclosed within a casing carried by the end plate of the machine. The contact breaker is carried by a movable cover fitted to the outer end of the casing, and is capable of making a relative angular movement with respect to the casing. The cap is retained in position by the pressure of a spring.

Conduits for Electric Conductors.

10607.—1909. KEY ENGINEERING CO., LTD., London. The cable is laid in a tube of bitumenised wood fibre. A segmental shaped piece is removed from the tube to permit the insertion of the cable and the filling in material. The segment is afterwards replaced. Bridge pieces may be employed to support the cable.

Conduit Fittings.

10348.—1909. A. BRAMPTON & F. OSBORNE, Birmingham. This is an improvement in the class of fitting which comprises two halves screwed together. The improvement consists in enclosing the screw in a sleeve so as to prevent injury to the cable passing round it.

Alternating Current Additional Machine.

8345.—1909. R. MOSER, Charlottenburg. In this self-regulating alternating current additional machine the additional voltage is dependent upon the alternating current of the main machine. The current flows through the stator of the additional machine which is constructed as a continuous current armature winding. The exciting current is derived from the alternating current through the instrumentality of a current transformer.

Electric Arc Lamps.

7471.—1909. H. J. J. JABURG, Amsterdam. Two out of the three electrodes of the lamp are arranged obliquely to each other and are self-supporting. The third electrode is guided parallel with the plane of the other two electrodes, so that the arc length remains always constant during the descent of the electrodes.

Secret Telephone Transmitters.

5114.—1909. L. HEYWORTH, Chicago, U.S.A. The telephone has a talking chamber which fits over the speaker's mouth and beneath the chin. An adjusting rim is provided to suit different contours.

Automatic Switch.

5427.—1909. W. J. ADDISON, Streatham. This is a device for automatically opening and closing a switch on the primary leads of an auto-transformer simultaneously with the opening and closing of the secondary circuit. The object is to prevent loss of energy during periods of no load on the secondary side. The switch arm is released by an electromagnet in the circuit of an auxiliary battery to close the primary and secondary circuits of the transformer when the first lamp is switched on and positively raised to an open position by a re-setting electro-magnet energised by the same auxiliary battery when the last lamp is switched off.

Electrical Regenerative Control Apparatus.

5168.—1909. CROMPTON & CO., LTD., Chelmsford. Two motors and a dynamo are connected in series on the Ward-Leonard system. Auxiliary regulating fields are employed with the motors connected in shunt to the dynamo and one motor, so as to give a series speed torque characteristic to the motors.

Rectifying Electric Currents.

5081.—1909. T. J. MURPHY, Rochester, U.S.A. This rectifier combines a source of variable currents, a common return wire connected to the source, electrodes connected to the opposite sides of the source, and electrodes opposing the first electrodes and connected to the return wire; a source of high potential current is connected to the electrodes, and a vibrator permits the high potential current to pass over the space between opposing electrodes alternately.

Generating a Synchronous Alternating Current of Defined Strength.

5003.—1909. R. MOSER, Charlottenburg. In this machine, by means of a commutator and a continuous-current armature winding ampere, turns are produced in the rotor by self-excitation. In addition to this, any desired adjustable constant ampere turns are produced by an external source of current. Short-circuited brushes may be employed on the rotor in order to do away with the alternating fields and their conversion into rotary fields.

Electrodes for Furnaces.

12507.—1909. M. RUTHENBURG, London, E.C. The electrode is made of carbon and provided with a core of the same metal as that under treatment in the furnace. By using a metal core, the conductivity of the electrode is raised and less power is wasted in passing the current through the electrode. The metal need not form a central core, but may be combined with the carbon in any convenient way.

Submarine Sound Signalling.

12309.—1909. J. GARDNER, Fleetwood. The appliance consists of a vibratory strip and a transmitter, one of the electrodes of which is operated by the strip. Two of these sound-receiving and sound-transmitting instruments are provided, one on each side of the ship. Both instruments are put into circuit with a telephone system.

Galvanic Battery.

11154.—1909. G. L. PATTERSON, New York, U.S.A. This is an improvement in battery holders in which the head is provided with two terminal pieces: one of the terminal pieces is screw threaded, and the other terminal piece fits into the screw-threaded terminal. The novelty resides in the means for connecting the battery to the bed plate. This consists of a removable reinforcing member arranged within the battery to clamp it against the bed plate.

Protective Devices for Electric Distribution Systems.

10504.—1909. GENERAL ELECTRIC CO., Schenectady, U.S.A. In protective devices for electric distribution systems in which a number of electric cells are connected in series to a conductor, provision is made for connecting the electrolytes of successive cells by means of an electric connection in shunt to the electrodes.

Electrical Sliding Contacts.

10175.—1909. B. VON UGRIMOFF, Moscow. This is an improvement in apparatus of the class in which a liquid electrical conductor is maintained in operative position by centrifugal force in an annular vessel, and is cooled by a layer of a lighter and more volatile liquid which is maintained in position also by centrifugal force. According to the invention, this method of cooling is used in connection with apparatus in which a non-rotatable member makes contact with the liquid electrical conductor.

Electric Signalling Systems for Railways.

9035.—1909. W. J. HIGGINS & C. J. SHERIDAN, Buffalo. This is an improvement in signalling systems in which a cautionary and a danger signal are given by means of semaphore arms at the side of the track and bells and lights inside the engine cab. The object is to provide means for automatically operating a steam valve in the engine cab when the danger signal is given, so as to cut off the supply of steam to the engine, and also to throw the air brakes into action if it is desired to bring the train at once to a full stop.

Overhead Wire De-energising.

6111.—1909. D. P. F. GHADIALI, Surat. The object is to prevent accidents through the snapping of aerial conductors carrying electrical currents of high tension. One terminal of a solenoid of insulated wire is connected to the furthest end of the line to be protected while the other terminal is earthed. A movable plunger in the solenoid is held by magnetic suction so long as the line is perfect. When the line breaks the solenoid is de-energised, the plunger falls, and makes contact of a set of batteries with a pilot wire which is connected at the supply end with a relay. The energisation of this relay by the battery current makes contact of the supply main current with a proper trip gear inserted at the supply end, and this trip gear into the snapped cuts the snapped main out of circuit.

Electric Cartridge Fuse Holders.

8212.—1909. J. FORD & E. E. BONSHOR, Longton. The fuse holder consists of a central tube of non-conducting material provided with screwed ends and internally screwed caps to engage with the ends. Internal washers located between the ends of the tubes, and the caps are provided with holes through which the fuse wire may be passed, and bent over to make electrical contacts with the caps. Slotted lugs on the caps allow them to be connected to terminals.

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TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns per week.		Increase or decrease.		Miles of track open.		Accounts for past year.					Receipts per	
	Ending	1909-10.	1908-9.	Week.	Current year.	1909.	1908.	Ending	Total receipts.	Passengers carried.	Car miles run.	Passenger.	Car mile.
		£	£	£	£				£				
Aberdeen Corporation	April 6	1,262	1,241	+ 21	— 520	27½	27½	May 31	71,930	17,517,304	1,566,119	·98	11·02
Ayr Corporation	Sept. 18	671	562	+ 108	—	8	8	—	—	—	—	—	—
Baker Street and Waterloo Ry.	Nov.	8,141	6,070	+2,071	—	4·25	—	—	—	—	—	—	—
Birkenhead Corporation	April 3	1,204	1,137	+ 67	—	24·003	13·52	—	—	—	—	—	—
Birmingham Corporation	April 6	7,447	6,662	+ 785	—	56·792	58·52	—	—	—	—	—	—
Blackburn Corporation	Oct. 6	1,100	1,293	— 173	— 1,036	24·53	28·3	—	—	—	—	—	—
Blackpool Corporation	Aug. 26	2,152	2,050	+ 102	+ 732	—	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams	„ 8	2,304	2,309	— 24	—	—	—	—	—	—	—	—	—
Bolton Corporation	Oct. 10	2,416	2,337	+ 79	— 259	42	42	Mar. 31	117,799	25,492,902	2,492,147	1·1	11·34
Bournemouth Corporation	July 21	1,681	1,723	— 42	— 23	29½	29½	„ 31	86,225	13,991,328	1,766,068	1·47	11·71
Bradford Corporation	April 2	1,661	1,592	+ 19	+ 19	98	54·81	„ 31	235,258	47,839,569	5,331,007	1·17	10·59
Brighton Corporation	April 10	803	1,114	— 311	— 407	9·5	—	—	—	—	—	—	—
Bristol Tramway Company	April 8	5,336	5,576	— 240	—	57	51½	Dec. 31	265,362	46,652,389	5,756,842	—	—
Burnley Corporation	April 9	1,176	1,760	— 584	—	19½	19½	Mar. 31	64,261	12,355,958	1,202,330	1·23	12·83
Burton Corporation	April 10	248	281	— 33	— 33	6½	6½	„ 31	14,918	3,221,595	430,913	1·04	8·30
Cardiff Corporation	April 3	2,000	1,957	+ 43	—	—	—	„ 31	109,979	25,058,146	2,497,169	—	10·57
Carlisle Tramways Company	June 19	170	175	— 5	— 89	—	—	—	—	—	—	—	—
Central London Railway	April 9	5,680	4,474	+ 1,206	— 665	6·32	6·32	Dec. 31	350,150	41,898,373	1,456,781	2·01	5·769
Charing X, Euston, & Hamp. Ry.	Nov.	6,822	6,092	+ 730	—	7·75	—	—	—	—	—	—	—
City and South London Railway	April 10	3,236	2,791	+ 445	— 537	7·26	7·26	—	—	—	—	—	—
Colchester Corporation	July 14	200	219	— 39	—	8	—	Mar. 31	10,983	2,308,721	349,539	1·09	7·74
Cork E. T. and L. Company	April 7	453	453	—	+ 311	9·89	9·89	Dec. 31	24,044	5,737,478	896,945	—	6·43
Croydon Corporation	Mar. 25	1,685	1,347	+ 338	+10,255	11¼	—	Mar. 31	74,132	16,277,418	1,884,137	1·06	9·56
Darwen Corporation	Oct. 1	239	256	— 17	— 201	7·23	7·23	„ 31	13,899	2,557,654	245,584	1·30	13·68
Dover Corporation	Sept. 18	230	252	— 22	— 395	7	—	„ 31	11,593	2,697,672	316,754	·98	8·78
Dublin and Lucan Electric Ry.	April 8	121	122	— 1	+ 70	7	7	—	—	—	—	—	—
Dublin U.T.	April 8	5,073	4,871	+ 201	+ 3,602	54½	54½	—	—	—	—	—	—
Dundee City Tramways	Oct. 6	1,332	1,305	— 27	— 569	—	26½	May 15	60,573	16,367,911	1,281,552	·875	1·9
East Ham Corporation	April 9	968	1,049	— 81	— 8	15	15	Mar. 31	47,430	15,355,703	1,091,586	·73	10·26
Glasgow Corporation	April 2	18,847	16,179	+2,668	+ 2,135	191	185	May 31	907,494	226,948,290	20,766,722	·96	10·49
Gloucester Corporation	Oct. 6	395	425	— 30	+ 535	15	—	—	—	—	—	—	—
G.N., Piccadilly and Brompton	Nov.	13,429	9,354	+4,075	—	9·25	—	—	—	—	—	—	—
Halifax Corporation	—	—	—	—	—	52·574	37	Mar. 31	81,872	20,378,672	1,786,390	11·40	11·19
Huddersfield Corporation	Dec. 4	1,613	1,357	+ 256	+ 2,663	28	28½	„ 31	84,704	16,200,020	1,960,329	1·29	10·37
Hull Corporation	April 9	2,586	2,657	— 71	— 435	26	26	„ 31	128,722	30,964,254	3,022,844	1·	10·22
Ilford Corporation	Feb. 12	451	391	+ 60	+ 1,969	10	10½	„ 31	25,328	6,385,466	634,446	·87	9·58
Ilkeston Corporation	April 5	155	125	+ 20	— 230	4	4	„ 31	7,214	1,968,850	198,415	9·1	7·9
Kirkcaldy Corporation	Sept. 8	259	266	— 7	—	7½	7½	May 15	14,993	4,874,199	459,066	·711	7·838
Lancashire United Tramways	April 6	1,094	1,197	— 103	+ 1,031	39	39	Dec. 31	68,904	12,554,593	2,244,344	—	—
Leeds Corporation	Sept. 18	6,896	6,624	+ 272	+ 3,662	108	96½	Mar. 31	340,368	75,734,083	7,694,989	1·06	10·62
Leicester Corporation	Sept. 11	2,162	2,130	+ 32	—	—	—	—	—	—	—	—	—
Liverpool Corporation	Nov. 19	10,803	10,687	+ 116	— 1 977	109	104	Dec. 31	572,822	124,043,239	12,231,799	1·108	11·24
Liverpool Overhead Railway	April 3	1,472	1,233	+ 239	+ 179	6·65	2·40	June 30	79,004	11,171,515	1,106,386	—	—
London County Council	Mar. 26	39,091	33,796	+ 5,295	+159354	131½	121½	Mar. 31	1,274,660	279 166,461	25,591,028	1·08	11·74
Lowestoft Corporation	Dec. 11	155	150	+ 5	+ 30	3½	—	Sept. 30	11,399	2,645,206	370,320	1·03	7·36
Maidstone Corporation	Mar. 6	157	100	+ 57	—	7·4	—	—	—	—	—	—	—
Manchester Corporation	Sept. 11	15,631	15,297	+ 334	— 2,871	183	181	—	—	—	—	—	—
Metropolitan District Railway	April 9	10,778	8,954	+ 1,824	+14,616	24	24	—	—	—	—	—	—
Metropolitan Railway	April 10	16,410	15,259	+ 1,151	+ 8,221	24½	24½	June 30	680,357	99,846,735	—	1·46	—
Nelson Corporation	Oct. 16	151	131	+ 20	+ 7	2½	2½	Mar. 31	7,362	2,060,712	204,740	·85	8·63
Newcastle-on-Tyne Corporation	April 2	4,362	3,852	+ 510	+ 37	60½	59½	„ 31	211,085	46,203,164	4,411,745	1·10	11·48
Newport (Mon.) Corporation	Oct. 9	663	638	+ 25	— 311	14½	14½	„ 31	35,531	8,174,003	798,029	1·04	9·89
Oldham Corporation	Jan. 24	1,778	1,516	+ 262	— 386	—	—	—	—	—	—	—	—
Portsmouth Corporation	Oct. 10	2,046	1,809	+ 237	—	28½	28½	Mar. 31	97,741	21,247,048	2,309,439	1·10	10·15
Reading Corporation	April 7	562	575	— 13	—	13½	13½	„ 31	32,769	7,933,572	915,481	—	8·93
Rochdale Corporation	Dec. 26	1,240	1,126	+ 114	+ 746	20·9	20·93	„ 31	56,558	10,196,148	1,252,925	1·32	10·83
Rotherham Corporation	Feb. 4	555	587	— 32	—	—	—	—	—	—	—	—	—
Salford Corporation	Sept. 27	4,596	4,662	— 66	— 3,326	78	74½	Mar. 31	244,065	45,771,611	5,486,150	1·25	10·67
Scarborough Tramways Co.	—	—	—	—	—	—	—	—	—	—	—	—	—
Sheffield Corporation	April 3	6,429	5,586	+ 842	+ 445	39½	37	Mar. 25	289,745	17,568,686	7,065,380	·896	9·842
Southampton Corporation	Mar. 30	1,201	943	+ 258	+ 1,024	18	18	„ 25	52,647	10,121,887	1,157,451	1·25	11·33
Southend-on-Sea Corporation	Aug 21	995	557	+ 438	+ 1,483	—	—	—	—	—	—	—	—
Stockport Corporation	—	—	—	—	—	25	25	Mar. 31	52,004	9,155,172	1,335,911	1·34	9·342
Sunderland Corporation	Jan. 27	1,310	1,336	— 26	— 7,984	—	—	—	—	—	—	—	—
Swindon Corporation	Mar. 30	122	122	—	—	—	—	—	—	—	—	—	—
Torquay Tramways	Aug. 26	630	647	— 30	—	8·41	—	Dec. 31	15,065	2,880,420	353,297	1·40	1·023
Wallasey U.D.C.	April 9	797	967	— 169	—	12·68	12·45	Mar. 31	43,823	8,331,038	891,540	1·2	11·79
Warrington Corporation	—	—	—	—	—	—	—	—	—	—	—	—	—
West Ham Corporation	Mar. 31	3,051	2,115	+ 936	+ 10 008	27	14·7	Mar. 31	122,881	35,502,836	2,556,854	·789	10·95
Wolverhampton Corporation	Nov. 8	841	823	+ 18	— 206	21¾	—	„ 31	44,432	9,440,369	975,714	—	10·929

a Train Miles. *h* Half-year's figures.

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WITH WHICH IS INCORPORATED "ELECTRIC LIGHT."

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NOTES.

FUTURE GROWTH.

A soundly optimistic article from the pen of Mr. Henry A. Mavor, M.Inst.C.E., M.I.E.E., has appeared in the columns of the *Glasgow Herald*, in which he reviews the whole field of British and foreign competition in the electrical industry. He points out that the fundamental inventions are due to Britain, France, and Germany, while the two countries looked upon as our keenest competitors are really exploiters of these inventions. He holds that our slower progress is for the ultimate welfare of the industry, for he does not favour standardisation carried too far. "Standards," says Mr. Mavor, are better suited for temporary success in new countries, where factories and mines start *da plano*, if we may be permitted the expression. But in older countries, with more complicated industrial organisations and vested interests, it is better for the electrical machinery not to be too hampered by " standards," so that it may remain more flexible and capable of adoption and growth.

PROGRESS ENTAILS CHANGE.

Mr. Mavor preaches the doctrine that we must beware of becoming " groovy," a state that standardisation, carried to extremes, fosters. But he is hopeful, for: " The breed of men who have directed electrical industries in this country, with the help of the greatest and most learned experts in the world, is fit to cope with new problems in every direction, and such men have done, and are doing so, striking out new lines and making new applications calling for fundamental changes of method. This attitude towards enterprise does not in the first instance make for a rapid, limited growth on established lines, but it lays a broad foundation for unlimited expansion. The country whose industry is so based is not going to be left entirely behind in commercial importance. The British manufacturer is fairly justified in feeling that he can hold his own on this footing in the electrical industry." The bane of the industry is hasty legislation and unwise adoption of " flash-in-the-pan " methods. Mr. Mavor concludes in the cheery note: " There is no question of the superiority of the British manufacture, and no difficulty in getting a preference for it where the buyer has a free hand, and a little patience and perseverance will probably have the same result in the South African colony as it has had at home, and the bogey of German competition will gradually disappear." The whole article is well worth reading.

CROPS AND ELECTRICITY.

Supplementing our remarks on Sir Oliver Lodge's experiments in " electrifying " crops and those of Professor Breslauer, we find some useful data and comments by the Bath and West and Southern Counties' Agricultural Society, published in their *Journal*. The notion is propounded that the electric current is merely equivalent to intensified sunlight, but that is certainly not borne out by the curious drifting phenomena noted by Professor Breslauer as reported in our last issue. The Bath Society favours the system for ground fruit, such as strawberries, hinting that fruit trees are over stimulated, and wheat practically uninfluenced, and leguminous crops rather damaged, though it is acknowledged that the increased yield under stimulation is about 65%. All the percentages of increase allowed by the Bath Society are far in excess of the average claimed by Dr. Breslauer.

A " SMOKELESS " COLLIERY.

An excellent type of electrified colliery is the New Winning Coal Mine, Lumley near Chester-le-Street. It belongs to the Lambton Colliery, Co., who began sinking operations about three years ago, and now the mine is in full working order. It is a " smokeless " mine, being entirely equipped with electrical hauling, winding, ventilating, etc. A sub-station has been put up near the pit head, and here, too, are elaborate electrically fitted workshops. The whole of the work has been carried out under the supervision, and to the designs, of Mr. S. Tulip, the company's chief engineer.

" WIRELESS " ITEMS.

Marconi's Wireless Telegraph Co. have not remained idle since their agreement with the Post Office. Great improvements have been carried out at Clifden and at Glace Bay, New York, and now the company claim they can transmit 25 words per min., or 20,000 per day. The new tariff is to be at the rate of 5d. per word for private messages and 2½d. for Press messages, *plus* land charges, about 1½d. per word more. Meanwhile progress is being made in the establishment of coast radiotelegraphic stations, and the experiments in equipping trawlers with a modified form of transmitting and receiving gear is answering well.

" WIRELESS " TELEPHONE.

Substantial improvements have been introduced by Mr. H. Grindell-Matthews in his wireless telephone system, which does not require poles or towers. He has done away with the large drums he formerly used, his new transmitter-receiver being a compact apparatus. He has succeeded in speaking from machine to machine placed a distance of 7¾ miles apart on sea, and has also spoken from a motor car travelling at 45 miles an hour, to a station in a busy part of London, half a mile away. Moreover, he has succeeded in transmitting speech through the steel walls of a strong room. His next attempts will be to speak from Cardiff to Chepstow.

IRON AND STEEL INSTITUTE.

The annual meeting of the Iron and Steel Institute is to take place at the Institution of Civil Engineers on May 4 and 5. Several papers of direct interest to electrical engineers are down for reading. Among these are: " On the Girod Furnace and the Electric Smelting Works of the Paul Girod System," by Professor Dr. W. Borchers, of Aachen; " On the Progress of Electro-Smelting," by Mr. Donald F. Campbell, of London; " On Development in the Production of Electric Power: its Application and Bearing on the Iron and Steel Industries," by Mr. D. Selby-Bigge, of Newcastle-on-Tyne; and " On the Economy and Design of Modern Reversing Rolling Mill Steam Engines," by Herr E. G. Sehmer and Herr Dr. Rudolf Drawe, of Saarbrüsken.

THE STORAGE BATTERY TRAMCAR.

The announcement from New York that the trials of Mr. Edison's storage battery tramcar on the Twenty-eighth-street crosstown line in New York have proved so successful, that 16 more of these cars have been ordered, has aroused fresh interest in the invention in this country. Full details of the new battery were given by the New York correspondent of THE ELECTRICAL ENGINEER some three months ago, but it may be useful to remind those interested that it is claimed that the storage battery car costs rather less than a halfpenny per mile to operate as

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against a cost of 2½d. per mile for the ordinary electric car, and that Mr. Ralph Beach, who manufactures these cars for Mr. Edison, claims that, apart from their many advantages for surface traction, they can be utilised for underground traction to such effect that the present cost of maintenance (£3,000 per mile) can be reduced to £200 per mile.

LONDON COUNTY COUNCIL SCEPTICAL.

The attention of the Tramway Department of the London County Council has been directed to the successful issue of the New York experiments with Mr. Edison's car, but they find the Council Engineer cold and sceptical. He says that the application of batteries to tramcars has been discussed for many years, but in no case have the experiments proved financially successful, the upkeep of the battery proving a very serious matter, and its heavy weight making the cars difficult to handle. The circumstance that these are the very points with regard to which it is claimed that the Edison-Beach has scored its greatest triumph does not apparently affect the attitude of the Council's Engineer. He says that crosstown traffic in New York is only one-fifth of the ordinary traffic, and that the success attained in New York is no measure of possible success here. If we can get a battery, he says, which is a great advance on those already existing for application to tramcars, under certain conditions, it may prove practicable for use on routes that are not very busy, and where there are no hills; but he does not yet see in the published accounts from New York any indication that this stage has yet been reached. We fancy that the Council's Engineer is scarcely doing justice to the New York experiments, but London, of course, is always very conservative with regard to developments of this kind. Mr. Edison should send one of his cars over here and let it be tried on the Aldwych single-deck route.

INDIAN PATENT LEGISLATION.

At the meeting of the Viceroy's Council on March 23, Mr. Robertson introduced a Bill to amend the Inventions and Designs Act of 1888. The Bill follows the English patent statute of 1907 as closely as possible, except in so far as material variations are necessitated by the different conditions prevailing in India. The new Bill has been rendered necessary owing to the rapid growth of invention in India, a growth that is sufficiently evidenced by the fact that within the last 10 years the receipts at the Patent Office have nearly doubled. The most important provision of the new Bill is that it will no longer be necessary to file two separate documents explaining an invention. The application will be accompanied by a specification defining the nature of the invention. If defective, the specification will be returned for amendment, but up to the date on which it is either accepted or refused, the whole of the proceedings will be confidential, and no publication can take place. As soon as the specification is accepted, provisional protection will be granted, and the specification will then be printed and published for a period of three months, during which objections to the grant of a patent may be lodged. At the end of three months, if there is no opposition, or if the objections are over-ruled, the patent will be sealed. As regards administration, a Patent Office is formally constituted, so that most of the powers previously exercised by the Viceroy in Council are delegated to a Controller of Patents and Designs, who will, as in England, be accessible to the inventor and the public. The wording is such, however, as to retain the paramount authority of the Viceroy and the Law Courts. The Bill is to be submitted to various bodies, such as the Chambers of Commerce and the provincial governments for criticism, before it goes before a select committee.

AUSTRALIAN INSTITUTE OF WIRELESS TELEGRAPHY.

An Institute of Wireless Telegraphy has been formed in Sydney, for the purpose of facilitating conferences of investigators and inventors, with a view to obviating the repetition of mistakes to which each in turn is liable, another object of the organisation being to protect legitimate experimenting.

ELECTRIC CONTRACTS IN AUSTRALIA.

All is not plain sailing in the attempts by the Commonwealth and States Governments to secure electrical appliances actually manufactured in Australia. Two instructive instances have occurred quite recently. To begin with, Sir John Quick, the Postmaster-General, some months ago, called for tenders for the supply of 100,000 Australian-made telegraph insulators. Only one tender has been received, that of Messrs. Drew & Poole, Melbourne. They offer to start a factory for the manufacture of porcelain insulators, and to supply the Commonwealth to the number stipulated at the price of 6¾d. each. This price is 15% above the average price paid for imported insulators during the past two years. Nevertheless, the Postmaster-General has accepted this tender, to give the industry a start, hoping that with the establishment of an Australian factory competing with the importers the department may have the advantage of competition. The insulators to be supplied by Messrs. Drew & Poole will be made of Australian porcelain material, of which, it is said, the successful tenderer can obtain an abundant supply.

Another disappointment occurred in the matter of telephone supplies. For it appears that there are no makers of telephones in Australia, or, at least, none with sufficient capital to compete with makers in other countries. Again the Postmaster-General called for tenders for 20,000 telephones, to be made in Australia of Australian materials. The result was that the following memorandum on the result had to be issued by the Minister:—

"Tenderers had the option of submitting any design of telephone that would comply with the departmental requirements in regard to communicability. Only one tender has been received. It is from a gentleman in London, who, however, has not complied with the conditions requiring tenderers to submit a deposit. He gives very few particulars, and states he is trying to form a syndicate for the manufacture of telephones in Australia, and is relying upon his success in securing this contract for assistance to obtain the necessary capital to start the work. The price asked per instrument would be about 40% higher than that for which the Ericsson instrument can be purchased. In these circumstances the Postmaster-General states he regrets that no suitable or practicable tender has been sent in, and, according to the outlook, he says, there does not seem much prospect of telephones being made in Australia for the present. The policy of the department will for the time being be simply to accept tenders for the supply of instruments to meet current requirements, and not in large quantities."

ELECTRICITY IN HOLLAND.

According to Mr. W. A. Churchill, H.B.M. Consul at Amsterdam, the cost of the engineering works likely to be undertaken in the Netherlands and in the Dutch East Indian colonies during the next few years is estimated as follows:—

	£
Netherlands—	
Electrification of light railways and extension of steam tramways ..	2,000,000
Erection of about 10 electric power stations	500,000
Gas and water works	1,250,000
Total	3,750,000
Colonies—	
Electric light and power works in 12 towns in Java, electric water power stations in four towns in Java, electric high tension transmission in three provinces in Java, and two electric motor 'bus services in Sourabaya and Samarang (Java)	5,000,000
Electrification of the Java State Railways	13,000,000
Railways and harbour works in Sumatra	15,000,000
Total for the Netherlands and Colonies ...	36,750,000

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HYDRO-ELECTRIC INSTALLATIONS OF SWEDEN.*

By AUBREY V. CLAYTON, M.I.E.E.

The general idea is that Sweden is a little place somewhere up North, excellent for tourists and for winter sports, but of the serious side of Swedish life there seems to be no conception whatever. The length of Sweden is 986 miles, or nearly three times the length of England. Its area is 170,713 square miles, or about three times that of England and Wales together. The population is 5,377,713, so it will be seen that it is very sparsely inhabited when compared to England, the average population of Sweden being 32 inhabitants per square mile, while that of England and Wales is about 500 per square mile. The population is more dense in the South, where in one county it goes up to 240 per square mile, while in the North it is only 2·6. It seems remarkable that a country having such a small population should be able to supply itself with all its wants. Industries, such as locomotive building, shipbuilding, carriage and car works, linen, cotton, and woollen manufactures, all classes of engineering and foundry work, electrical trades, electro-chemical works, brick and glazed tile works, pianoforte and organ works, etc., are in the very highest stages of development, and whereas the country's requirements of the articles produced in these various trades were formerly important, the products of the home industries now supply nearly all wants, and in many cases an export trade in them has been built up.

The country is very hilly, abounding in lakes and watercourses, and the falls on these waterways have made it a busy hive for the electrical industry since the commercial development of electrical power transmission. At the same time, it may be stated that the present flourishing condition of many Scandinavian industries is due to the successful commercial development of electricity, whereby cheap power has become generally available. The area of lakes in Sweden is 13,900 square miles, and from this some idea of the enormous quantities of water available will be gleaned. My colleague, Lieutenant Lübeck, has estimated that the amount of water-power available in Sweden is equivalent to 3,800,000 h.p. Of this only 550,000 h.p. is at present harnessed, so that there is plenty of scope for further development. That the equipment of the falls is proceeding very rapidly, however, may be gathered from the fact that in 1900 only 253,000 h.p. was utilised, or less than half of what is now employed. In the neighbouring country, Norway, there is available 4,800,000 h.p., of which in 1906 only 250,000 h.p. was utilised. However, since the advent in the last few years of new electrical processes for the production of fertilisers from the air, considerable additions have been made to this figure, so that now the falls harnessed, or in course of being harnessed, represent approximately 550,000 h.p., or about the same as Sweden.

The use of water-power dates back to the very earliest ages; and there may still be seen in many places good examples of old-world waterwheels.

With the advent of electricity a new era began, and between the years 1885 and 1889 power transmission by this means was touched on slightly. It was not, however, until the invention of the three-phase alternating-current system that any real advance with electrical transmission was made. The first three-phase transmission in Sweden was tried in 1890, and in 1893 a transmission on what was for that time quite a large scale was inaugurated. This transmission, the forerunner of the present enormous business in this branch, was of 400 h.p. capacity, and this power was sent from the Hellsjön falls to the Grängesberg iron mines—a distance of about 10 English miles. By courtesy of my friend, Mr. Edström, the managing director of the General Electric and Manufacturing Co., of Sweden, who carried out the original installation at Hellsjön-Grängesberg, I am enabled to give the following particulars of this pioneer power house.

The original plant consisted of four water-turbine-driven generators each of 100 h.p. Three of these are of three-phase design, and supply power to the pumps, haulage gears, hoists and other machinery at the mines, while the fourth is a single-phase generator for lighting purposes. All operate at 70 cycles, and run at 600 r.p.m. Current is generated at low voltage and transformed up to about 9,000 volts for the line transmission. It may be remarked that for a pioneer scheme built 17 years ago the voltage of 9,000 was quite high. The generators are of the rotating armature type, having inwardly projecting field poles, just like an ordinary direct-current multipolar machine. The carcase, or yoke and poles, are of cast iron. These machines very closely resemble the earliest make of American alternating-current machines, and, in fact, the type was introduced to Sweden by the late Mr. Ernest Danielson, who before his connection with the Swedish Co. in 1892 had been a designer of electrical machinery in America. This type of machine, while it presents some advantages, has been abandoned in favour of the rotary field type, except in the very smallest sizes.

Before leaving this Hellsjön station, which has no interest beyond an historical one, it may be mentioned that the original machinery installed is still at work 24 hours daily. As illustrative of the enormous development of the use of electrical power, it may be noted that the Grängesberg mines now employ about 6,100 h.p. electrically, and on account of scarcity of power have recently acquired new waterfalls of about 15,000 h.p., and the work of harnessing these electrically is at present in progress.

Alby.

Alby has been chosen among the power stations to be described on account of its having been partly acquired by English capital, and the name may be familiar to many. It is one of the older power stations, and was built in 1898–1899, 15 months being taken for its completion. The power from the Alby falls (which are situated on the Ljungan river) is used partly for the production of calcium carbide and partly for the manufacture of potassium chlorate. The carbide is exported to all parts of the world, principally to the English Colonies and South America, while the chlorate of potash is employed in the manufacture of matches.

The original power plant installed at Alby consisted of two generators of 1,100 h.p. each, generating direct current at 220 volts for the manufacture of the chlorate by electrolysis; one two-phase 26-cycle 2,000 h.p. generator, and two 500 h.p. single-phase generators for carbide production; besides two 360 h.p. continuous-current generators for excitation. All these machines are direct driven from horizontal shaft turbines. A few years later the power station was extended by erecting another 1,100 h.p. direct-current generator for chlorate manufacture, and another 2,000 h.p. two-phase generator for carbide, with corresponding extensions to the chlorate and carbide works. With the addition of some smaller sets for driving light railways, and some auxiliary machinery for making packing barrels, boxes, etc., these extensions brought up the total power installed at Alby to its present figure—9,760 h.p. The current from the 2,000 h.p. two-phase generators is delivered at 2,000 volts, and is transformed to the voltage required for the carbide furnaces by transformers situated immediately behind the furnaces. 1,000 h.p. is required for each of the larger furnaces, each phase of the two-phase generator supplying a furnace, while the 500 h.p. generators are of low-voltage type, work in parallel, and supply three smaller furnaces directly. In 1906 the carbide works were still further enlarged, and the power for these extensions is supplied from falls lower down the river at Ringdalen, about 1½ miles from Alby, and is transmitted at 10,000 volts.

We now come to the construction of the power plant. The first portion of the water intake canal is built of ordinary earthwork, and the latter portion near the power house end is constructed of stone masonry, the fall at this point being too high for earthworks. The total length of the canal is 700 yards, of which 170 yards are built of masonry, and there are no less than 280,000 cub. ft. of stonework in it. The velocity of the water in the earthwork part of the canal is 1 ft. per second, while in the stone part it is 1·6 ft. In constructing the earthworks of the canal a sponting or core of tongued and grooved planking has been left in the middle of the earthworks to prevent percolation. From the end of the canal where it opens out into a large basin or settling pond, tubes of wrought iron convey the water directly down to the turbines which are situated in the power house itself. There are seven

* Abstract of the paper read before the Institution of Electrical Engineers.

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tubes, five of these are 6 ft. diameter, and two are 8 ft. diameter. Of the five smaller tubes, three supply the turbines of the 1,000 h.p. direct-current generators, and two the turbines of the 500 h.p. alternators and exciters. The remaining two large tubes supply the turbines of the 2,000 h.p. two-phase generators. The length of these tubes is 72 ft. and the velocity of water in them is 5·5 ft. per second. The turbines work under a head of 69 ft. to 75 ft., of which 15 ft. is obtained from the suction draft tubes, the turbines being placed in flumes on the machinery hall floor, above the tail race level. The length of the tail race is 160 yards, and the velocity of water in it from 2·3 ft. to 3·3 ft. per second.

The base of the power house is built of concrete, the station floor on which the turbines and generators are situated being supported on arches which form separated chambers for the water discharge from the turbines. The power station itself is of brick. As regards the machinery in the power house, such enormous strides have been made of recent years in this direction that it cannot be considered as an example of good modern practice. In this power station the outer cases of flumes of the turbines were made of cast iron, a practice now abandoned for large-sized modern turbines. On one occasion, one of the outer cases burst owing to a flaw in the casting, causing much damage to the station and loss of life, before the water at the inlet gates could be shut off.

Ringdalen.

The new power station at Ringdalen supplies part of the power to the Alby carbide works. At Ringdalen the fall is 52 ft., and in the power station are five 1,100 h.p. single-phase generators, one 600 h.p. three-phase generator for supplying motor and lighting load, and two 200 h.p. exciters. All the generators supply at 10,000 volts directly, at which voltage the power is transmitted to Alby and transformed down to suit the carbide furnaces and the three-phase motor and lighting supply. Each 1,100 h.p. generator supplies one carbide furnace and has its own transmission line with step-down transformers, so that they form five complete separate and independent units. All the generators are driven by direct-coupled single-wheel turbines. The length of the water intake canal is 450 yards, and the speed of the water in it is 1 ft. per second. There are six iron tubes to convey the water from the settling pond down to the turbines, one each for the five 1,100 h.p. three-phase generators and the two exciters. All the tubes are 6½ ft. diameter. The power station is built much on the same lines as that at Alby, but is more modern in its arrangements in the machinery hall.

Gullspang.

The next station to be described is Gullspang, and it possesses several points of interest. This power station is in the southern part of Sweden, and the falls are situated on a short river between the lakes of Skagen and Vänern. The falls are now owned by the Gullspang-Munkfors Power Supply Co., which was formed in 1906 to acquire and develop these Gullspang falls together with some other falls at Munkfors, and to supply the power from them to a number of neighbouring towns, iron works, and other industrial undertakings. The power is transmitted at 40,000 volts, and the greatest distance to which it is at present delivered is about 50 English miles. The level of the water in Skagen is about 79 ft. above the level of the water in Lake Vänern. Lake Skagen has an area of 50 square miles, and forms an ideal natural storage for the water supply, allowing of regulation for the wet and dry seasons. An idea of the value of this natural water storage in Lake Skagen may be gained when it is stated that, whereas the lowest water flow observed in 1906 was 950 cub. ft. per second, it is calculated that by damming up the water in Lake Skagen and regulating the flow, an average flow of 1,600 cub. ft. per second can be obtained all through the low-water period, an increase of 70% over what could otherwise be obtained. The mean water flow at Gullspang for high and low-water periods is about 2,550 cub. ft. per second. The distance by land from Lake Skagen to Lake Vänern is at one point only 1¼ miles, but the length of the river connecting the lakes, and upon which the Gullspang power station is situated, is 8 miles. In its course are two falls, or, more strictly speaking, rapids, namely, Gullspang Rapids, having a fall of 67 ft. in a distance of about half a mile, and Aras Falls, of about 10 ft. The Gullspang Rapids are about 5 miles down the river from Skagen, while the Aras Falls are at the outlet to Lake Vänern. The power station is at Gullspang, and it is intended eventually to utilise the second falls at Aras by deepening out the tail race from Gullspang down to Aras. At the point where the power station is situated the river runs through steep walls of rock, and in order to build a dam across the stream, the water had to be diverted from its natural course through a temporary tunnel blasted through the rock. This was a very costly proceeding, but under the peculiar circumstances no other way of doing the work satisfactorily was possible. This tunnel was about 60 yards long and 30 ft. diameter. After the dam was completed the tunnel was closed up. When the course of the water was diverted through this tunnel and the river bed was laid dry, it was found that the bed of the river did not as had been expected, consist entirely of rock, but that in order to get to the solid rock considerable excavation would be necessary in the middle and towards one side. As this would have entailed immense expense, the original plan of building a gravity dam straight across and supporting it on the solid rock bed was abandoned, and instead an arch-formed dam was built on that portion of the river where the solid rock could not be got to without excavation.

The front of the dam is faced off with cement, and the bottom caulked with stamped clay to prevent leakage. A very large number of regulating sluices are provided. In all there are 50, and they are grouped in 10 openings of 5 sluices each. The sluices are of wood, working in I-section steel girder frames. A large opening or spillway in the centre of the weir is provided for clearing off loose ice. A salmon pass and two eel passes are, as is usual, also provided. The water is led from the head race to the turbine house in an open canal. The bottom part of this canal has for a great part of the way been blasted out of rock, and is built with concrete walls, while the upper part consists of earthworks. Where the junction between the concrete walls and the earthworks is made, a sponting of concrete prevents leakages, and the earthworks are for part of the way constructed with wood sponting, as was described in the case of the Alby canal.

The power station proper and the forebays are built close together. Fig. 1 shows a section of a forebay with ice-racks, sluices, turbine flume, turbines with draft tube, tail race, tunnel, and power house. The forebays are built of reinforced concrete, and the power station partly of concrete and partly of brick. The turbines are of twin type, and are placed in open vertical tubes or flumes of boiler plate. These flumes are 43 ft. long and 18 ft. diameter. When completed there will be six turbine flumes, each constructed for a pair of 4,500–5,000 h.p. turbines for driving the main generators, beside the auxiliary turbines for the exciters. Only four pairs of turbines and generators with exciters are installed at present, the remaining two being reserved for extensions. Each of these turbine flumes is separate in itself, and provided with its own forebay, ice-rack, and head-gate. The head-gates are 18 ft. wide and 15 ft. high, and are of an interesting and novel construction, for which patents have been applied for. They consist of cylindrically bent iron plates stayed with horizontal struts, and are provided with oak sliding surfaces. As these gates are too wide to be manœuvred against the water pressure, by passes are arranged to fill the forebays previous to operating the gates. The gates themselves are raised or lowered by a travelling crane, which can be moved over each sluice. In order to avoid subjecting the materials to the strains consequent on unequal expansion, very great attention was paid to this point in the construction of the forebays, thereby eliminating the risk of cracks occurring in the concrete. Thus each of the forebays stands for itself; they are not connected to each other, and are free from the rock at the sides, being supported solely from the bottom on concrete walls which stand up between the turbine flumes. The joints between the boiler-plate turbine flumes and the concrete floor of the forebays are also of expansion type. In order to effect this each flume tube was well greased before the concrete was stamped in round it, while to ensure a watertight joint between the concrete and the tube, a V-shaped groove was left round the top

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of the tube in the concrete, and into this groove a packing of tow steeped in paraffin wax was inserted. The pressure of the water forces this wedge-shaped tow packing ring in against the tube, just in the same way as in an ordinary hydraulic ram joint, and makes a perfectly tight joint. The backs of the forebays are made of thin half-circle walls, while the sides are of heavy straight construction. The side walls are held together at the top by heavy straight steel girders, and one pair of the girders forms a track for an 18-ton travelling crane used for erecting or repairing the turbines. It will be noticed on the sectional elevation (Fig. 1) that in the front of the forebays, between the front of this travelling crane rail and the head-gates, there is a heavy filling of ballast. This is intended to counterbalance the force of the water pressure acting against the back of the forebay. As before stated, these forebays are supported solely on walls having their bases at the turbine floor-level, and this ballast is provided to counteract the horizontal tilting force of the water pressure.

The turbines, with their supply tubes and draft tubes, as well as the concrete walls supporting the forebays, rest on a floor of massive steel girders and reinforced concrete, which is built on the solid rock. This floor is of immensely strong construction, as it has to carry not only the weight of the turbine chambers, etc., but also the volume of water in them. The draft tubes have cement coatings to protect them from rust, and discharge into a tunnel, blasted out of the rock, running lengthwise under the power station. Further down the discharge tunnel opens out into an ordinary open tail race.

The power house building itself is in three storeys, and is built on the solid rock, which has been blasted out to a depth of 33 ft. to accommodate it. The lower storey is constructed of armoured concrete, with a view to better resistance to the damp from the adjacent rock; and, further, the walls of this chamber had to be of great strength in order to support the heavy transformers situated on the iron girder and concrete floor of the second storey. The upper portion of the building is of brick. In the bottom storey, the floor of which is about level with the floor on which the turbines rest, the generators are situated. On the first floor are also the transformers and switchgear, while the top is devoted to the lightning protection devices and outgoing lines. The first floor is level with the ground outside, and on this floor run rails connected with a siding on the main railway lines. A 20-ton electric crane can take goods off the railway trucks and deliver them on to this floor, or drop them through an opening into the machinery hall below, which is served with another 20-ton electric travelling crane. A very complete system of ventilation has been arranged to keep the machinery hall cool, and there are channels running under the floor connected with the generator pits to conduct cool air to the generators.

The runners of the turbines are made with boiler-plate buckets, bent to the correct shape and cast into a cast-iron hub and ring. This method ensures a smooth and even bucket, which minimises skin friction, and so improves the efficiency, and at the same time the bucket is stronger and less likely to be damaged by sticks, stones, ice, or rubbish which may get in, than is a cast-iron bucket. This style of making runners is much employed for turbines working on falls up to about 65 ft., and up to sizes about as large as these—*i.e.*, 2,000 to 2,500 h.p. per wheel. For larger sizes and bigger falls, cast-steel runners should be used. The guides or chutes leading the water into the wheel are movable on pivots, and by the movement of these chutes the openings between them are varied, and the amount of water admitted is regulated to suit the power required. This method of regulation ensures the water being always projected at the correct angle to the wheel buckets, and improves the efficiency at light load enormously. Fig. 2 gives the efficiency test curve of the turbines. Regulation of speed is effected by automatic hydraulic regulators operating directly on the shafts connected to the links of the afore-mentioned movable chutes. The governor balls are driven from the turbine shaft. They control a little valve, and in rising or falling with variations of speed admit water into either end of a cylinder. The piston in this cylinder operates, through a rack and segment gear, the shaft connected with the movable chutes. Speed regulation with regulators of this class is exceedingly sensitive. Tachograph records taken on the Gullspang turbines show that with the instantaneous application of full load to the turbine running light, or the throwing off of full load, there is a variation of only 5½% in speeds, while for load variations of half of full load the speed varies only 2%, and, what is still more important, there is absolutely no hunting even with these large changes of load.

The machinery in these power stations is much alike, and therefore the electrical plant in one station may be taken as typical of all. The chief interest centres about the hydraulic constructions and general layout of the installations. Before leaving Gullspang, however, there is just one point, namely, that of the cost of the equipment. At the present time there is installed machinery aggregating 16,500 h.p. exclusive of excitation, and this has been erected at a total cost of £173,000, or about £10 10s. per horse-power. It must, however, be remembered that the hydraulic part of the scheme has been calculated for an equipment when completed of 25,000 h.p., and in order to carry out this extension there is little expense to be incurred beyond the cost of the machinery. Therefore, when completed for its full capacity of 25,000 h.p., the power station will cost £192,000, or about £7 15s. per horse-power.

The Hydraulic Association of Scandinavia, or "Vattenbyggnadsbyran" (with which the author has the honour of being connected), was retained as the consulting firm for the scheme, and not only prepared the plans, but supervised the carrying out of the entire work.

Graninge.

In the north of Sweden, at Graninge, a new power station has been completed which deserves notice. This station is built for a capacity of 10,000 h.p., of which 5,000 h.p. is now installed and at work. The units are each of 2,500 h.p. capacity, running at 300 r.p.m., and generate at 5,000 volts, at which voltage part of the power is used in the immediate neighbourhood, while the remainder is transformed up to 40,000 volts for the long-distance transmission.

In this case there are not separate feeder tubes for each turbine, but three tubes lead into a common header from which the four turbines are fed. In addition to the gates on the turbines themselves, there are throttle-valve sluices between the turbine flumes and this common header. As regards the electrical outlay of the power station, all the low-voltage or 5,000-volt busbars, apparatus and outgoing lines have been kept on one side of the building, and all the high-tension 40,000-volt apparatus on the other. The central portion of the buildings is devoted to the turbines and generators, and forms a fine lofty one-storey machine hall. On one side of this hall a three-storey wing is devoted to the switchboard, the 5,000-volt busbars and apparatus, and the 5,000-volt outgoing transmission line, while on the opposite side of the machine hall a five-storey building contains the step-up transformers, etc. The transformers are situated over the feeder pipes and throttle-valve sluices of the turbines, while the three floors above the transformers contain the 40,000-volt busbars, switching apparatus, and outgoing 40,000-volt transmission lines. The turbines are situated in the power house on the same floor as the generators. They operate under a 60 ft. head, and consist of twin wheels mounted on horizontal shafts. Each pair of wheels is mounted in a steel flume, and the discharge is through cast-iron quarter turn discharge pipes and draft tubes, each discharge pipe and draft tube being common to a pair of twin wheels.

As the flywheel effect of the generators is not in itself sufficient to enable the fulfilment of the speed regulation required, heavy flywheels are placed between the turbines and the generators. These flywheels have their own bearings, and are connected through leather band flexible couplings to the turbines, and through fast flange couplings to the generators. Governors of the type previously described are provided, and on test the speed variation was found to be 2½% for sudden variations of load equal to 20% of full load. Tests were also made to see if any injurious shocks due to water-hammer took place with an instantaneous removal of full load. For this purpose instantaneous application and removal of full load was made three times in quick succession, but no dangerous shocks occurred.

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The three-phase generators are of 2,150 kw. capacity each, 50 cycle, 20 pole, 300 revolutions, and, as already mentioned, generate at 5,000 volts. Their tested efficiency is 95·4% on full load of unity power factor, and 94·2% on full load of power factor 0·8. The inherent regulation is 1·5% for unity power factor, and 6·3 for power factor 0·8. It will be remarked that this inherent regulation is very good, but in general the regulation of generators employed in Sweden is not nearly so good, 7% and 16% being the more usual figures. It happened, however, that in cases of some large generators tendered for by the firm manufacturing the Graninge generators, doubt was expressed as to the possibility of attaining the regulation figures guaranteed, and so in designing the Graninge generators special attention was paid to the point of regulation, with a view of showing what could be done.

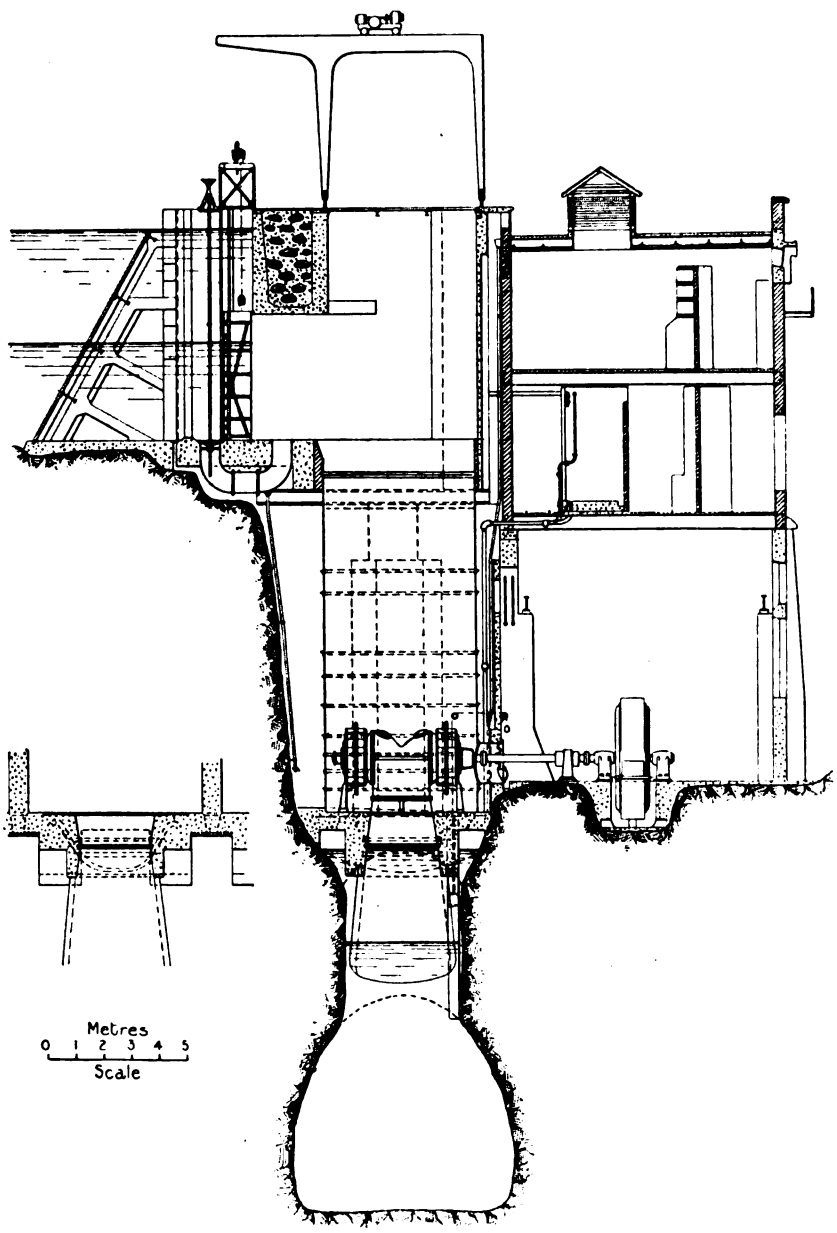

FIG. 1.—SECTION OF POWER STATION AT GULLSPANG.

The rotating magnet-wheel with poles, arms and boss is in one single steel casting, and the pole-shoes are of forged steel screwed to the poles with countersunk bolts. The flanges formed by the pole-shoes hold the field-spools in place. The stator winding consists of bars, one in each slot, and the slots are partially closed. The stator frame with punchings is in halves, and one of the feet on which the frame rests is bolted to the frame. By removing this loose foot the whole stator can be let down on to the field, and so turned round on the shaft to bring any part of the windings situated below the ground-level into a convenient situation for inspection or repairs. The bearings are of the ordinary spherical-seated self-aligning type, with babbit linings and ring lubrication.

Almost all the Scandinavian hydraulic power stations are employed for power transmission, hence they nearly all employ three-phase generators, and with the exception of the varied constructional details of different designers and manufacturers, and the modifications due to local circumstances, such as high or low-voltage generation, etc., the generators described may be taken as typical of the general run of plant in Scandinavian hydraulic power stations. With the exception of a few electro-chemical works where low periodicity is necessary, 50 cycles has generally been accepted as the standard periodicity. The new State power scheme which is building at Trollhättan is, however, designed for 25 cycles, partly with a view to the use of the power for railways. The City of Stockholm primary transmission is also at 25 cycles, but with these exceptions, it may be said that for supply companies 50-cycle three-phase is universal. This is a very great convenience, as it simplifies matters and standardises plant considerably.

Fig. 3 shows drawings of an interesting generator at Svälgfos, of 10,500 kw. capacity, 1,000 volts, 50 cycles, and 250 r.p.m. This machine was built by the General Electric & Manufacturing Co. of Sweden, to the designs of Mr. Holmgren, the chief designer of 3-phase generators to that company. It is one of four supplied to the Notoddens Saltpetre Works in Norway. In this generator the steel poles and ring are cast together, and are supported on a cast-iron arm system. The magnet ring and poles are divided transversely, and an air duct is left between the halves. The width of iron axially in this machine is no less than 49 in., the bearings are of ring lubrication type, and are provided with water cooling in case it be required – this has, however, never been necessary. Using water cooling, however, reduces the temperature of the bearings 10° C. ordinarily. It will be noticed that the stator is in four pieces. This was necessary because the generator had to be slung on wire hawsers across a gorge to get it to the power station, and hence the parts were required to be as light as possible. Although these generators are of enormous output, 10,500 k.v.a., they have been quite eclipsed in point of size by other generators which the same company are building for the above-mentioned Trollhättan State power scheme. These are of 12,500 k.v.a. output, and recently the company has received orders for generators for Rjukanfos, which are of 14,500 k.v.a. capacity. There are two unique generators, built and designed by the same company, working at Brattfors. They are of 2,000 h.p. output each, and generate at 20,000 volts direct, at which voltage transmission is made, no intervening transformers being required. There are many instances of 10,000 volt directly generating and transmitting plants in use, even with machines down as small as 250 kw. output, but these 20,000 volt generators are the only ones of their kind in Sweden. Another rather interesting generator, designed and built by the author, is one in which no machining has been done to the stator frame. The diameter of the stator of this machine was larger than could be turned in any of the machine tools available, and so the segments of the stator punchings were built up against a ring of 1¼ in. bolts passing through the rough cast-iron frame. These bolts at the same time serve the purpose of clamping the press-rings against the packet of laminations after the latter was built up. It often happens on old machines that the laminations shrink, probably on account of shrinkage of the insulation material between the plates. In order to safeguard against the possibility of the entire package of laminations dropping

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out of the stator frame, should the upper half of the latter be lifted after some years when the laminations had shrunk, ¾ in. steel pins were passed through holes in the laminations and the cast-iron flanges on each side of them and riveted over after the laminations were built up in place. This machine has been running night and day at full load and frequently for long periods (weeks at a time) at considerable overloads since the beginning of 1906, but no loosening of the laminations can be noticed, although it has been subject to frequent short circuits.

Having digressed to describe briefly the subject of generators we will now return to Graninge. The current from the generators is led to the 5,000 volt busbar-room for distribution to the outgoing lines of the 5,000 volt transmission and the primaries of the step-up transformers. This room is on the ground floor-level, and in it are situated all the necessary transformers for the measuring instruments, the oil switches, and connectors. All busbars are laid in closed tunnels, and the only openings in these tunnels are at junctions to the busbars. Further, it has also been arranged that the only insulators supporting the busbars are placed at these openings, so that they are easy of access for inspection, etc. The distance from the conductors to the walls of these tunnels is 6 in. for the 5,000 volt leads, and 12 in. for the 40,000 volt. All the busbar connectors, instrument transformers, etc., are isolated and placed in respective fireproof cells. The switching apparatus is very simple, no fuses are used, oil switches with maximum relays taking their place. Between the generators and 5,000 volt busbars there are maximum relay oil switches, and likewise the 5,000 volt outgoing line is provided with maximum relay oil switch. Each generator is provided with its ammeter, voltmeter, wattmeter, and synchronising apparatus. The 5,000 volt busbars are in sections so that the generators can be worked on separate sections or in parallel as required. Between the 5,000 volt busbars and primaries of the step-up transformers there are no oil switches, but simply link connectors. The transformers are of single-phase type, of 720 kw. capacity each, and are used in sets of three to form complete 2,160 k.w., 3-phase transforming systems for each of the three generators. On the high-tension secondary side of the transformers are 3-pole maximum relay oil switches for each set of transformers, and beside these there are connector links which permit of coupling any one of the transformers on to either of two sets of high-tension 40,000 volt busbars. There are two outgoing transmission lines, each having its maximum relay oil switch, and they can be fed from either of these duplicate sets of 40,000 volt busbars by means of connectors.

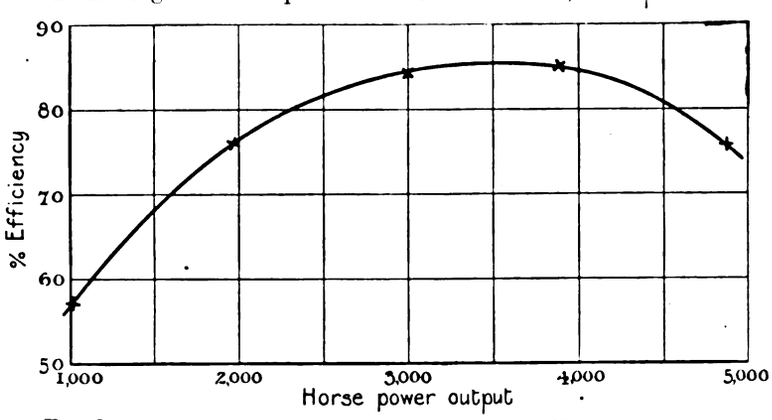

FIG. 2.—GULLSPANG EFFICIENCY TEST CURVE OF 4,500 H.P. TURBINES.

Great precautions must be taken against the effects of lightning discharges, or over-tension due to other causes on aerial transmission lines of this kind, and the difficulties increase enormously when the transmission voltages get into high figures. Moreover, the very severe climatic conditions obtaining in Sweden, especially so far north as this power station is situated, call for special attention to this point. In the present case zinc roller tension limiters and horn lightning arresters are used, while powerful impedance coils are placed between these protective devices and the 40,000 volt busbars. On each phase of the outgoing lines there are two horn arresters in series, one of which is nected in parallel with a water resistance. The water resistances consist of very large glazed earthenware bent pipes filled with water. The up-bent open ends of the pipes are covered with loose brass covers through which are brought conductors terminating in spiral wire ends immersed in the water. The horns and resistances of each phase are placed in separate chambers. It has been found that a gap of 32 mm. for the first horn and one of 40 mm. for the second horn, which is in parallel with the resistance, give the best results. Another means of preventing over-tension on transmission lines, and one which has proved exceedingly effective, is to make connections from the lines to earth through fixed resistances. The resistances are adjusted so as to allow a very small current constantly to flow to earth, and these connections to earth lead off the small static charges which would otherwise accumulate on the line. Experiments have been made with carbon and other classes of resistances for this purpose, but a circulating water resistance has proved best.

The switchboard is placed on the first storey over the 5,000 volt busbar-room. It is in the form of a circular sloping-top desk, while behind this desk are a number of cast-iron pillars on which are mounted the instruments corresponding to the switches on the panels of the desk switchboard. All the switches situated in different parts of the building are electrically controlled from the switchboard, as well as all rheostats and also the turbine gates, so that from this point the entire station is controlled. Signal lamps show whether the switches are closed or open. The board being of circular form permits an operator standing opposite to it to see all the instruments at once without running from one to the other, and, moreover, he has a full view of the entire station and the transformer cells, as there is a clear space to the machine house at the back of the instrument pillars. The transformers, as mentioned, are of single-phase type used in sets of three, all insulated and water cooled, having the water circulating through cooling coils immersed in the oil. Each is placed in its own little fireproof cell, the cells being in a row on the first storey of the 40,000 volt building, on a level with, and immediately opposite the switchboard alcove. The cells have fireproof iron doors front and back, the doors on one side opening to the machine hall and on the other to a long gallery having rails leading to a repair shop. The transformers stand on little trucks, so that any transformer can with the greatest ease be removed and replaced. The doors of the transformer cells on the machine hall side usually stand open, mainly with the object of seeing if the circulating water for the cooling coils is running properly. This can be observed from the machine hall and the switchboard alcove. There are signals to show if the temperature of any transformer rises too high, and in case of fire the iron doors of the cells can be instantly closed by operating a lever.

The cooling coils of the transformers may present some novelty, in that instead of having one or a few circulating pipes of large diameter, or a water jacket, they consist of a number of small diameter copper tubes placed in parallel, like a little water-tube boiler. In this construction the tubes are expanded or sweated into headers which form one side of distribution boxes for the inlet and discharge of the circulating water. The entire system of cooling tubes is placed at the top of the transformer box over the transformer itself, and is attached to the transformer box lid, so that when the lid is removed the coils are removed with it. By employing this construction an enormous cooling area can be got into a very small space, practically the only limit to the room required for the cooling coils being the amount of space which must of necessity be left between the tubes in order to obtain good circulation of the oil. Moreover, the cooling coils are at the top of the box, where the oil is hottest, and hence in the most effective and best position. A very complete arrangement is provided for tapping out the oil, boiling, and refilling. It consists of a system of pipes to and from the transformers connected with oil-boiling tanks.

While on the subject of transformers it may be in keeping to offer a few general remarks on them. The first 3-phase

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transformer made in Sweden in the year 1890 by Jonas Wenström, the well-known inventor, upon whose inventions the present General Electrical & Manufacturing Co. of Sweden was founded, had the primary and secondary windings in two spools per leg or phase placed one above the other. The end yokes were in the form of hexagonal plates, and their lamination crosswise to the lamination of the leg-pieces. With modifications of the arrangements of the windings and the introduction of air-blast cooling, these transformers were made up to quite large sizes—to wit, 700 kw. output. The use of oil-cooled transformers has, one might say, only of recent years become general in Sweden; in fact, the writer believes that the first oil-cooled transformers built in Sweden for general commercial use were made at the Clayton-Unger Works in 1903. On account of the larger units now employed and the high voltages used for transmission, the use of oil-cooled transformers has become general. In the water-driven power stations it is, of course, easy to get water for cooling purposes, but in most sub-stations it would be a very troublesome job to have to arrange for circulating water, and hence in them oil-insulated transformers with ordinary air cooling must be used. When oil transformers were first built they were of small capacities, and an ordinary cast-iron or wrought-iron box large enough to hold the transformer gave quite sufficient cooling area to dissipate the heat due to the losses of the transformer. As the sizes became bigger, however, extra radiation surface had to be obtained, and this was done by casting ribs on to the outside of the boxes. As demands arose for still larger sizes, it was found that the oil would not transmit its heat quickly enough to the smooth inside circular box in order to get the full advantage of the increased area of the outside ribs. The suggestion of casting radiation ribs on the inside as well as on the outside of the boxes was a failure, the difficulties in casting being too great; and, in fact, even with ribs on the outside alone, the percentage of wasters in casting was very high. Therefore the next step was to make the walls or sides of the boxes with a very deeply corrugated section, in which case the area exposed to the oil inside and the air outside was practically the same. Even these boxes, when of great depth, were difficult to form and cast, and therefore they were cast in sections 20 in. deep and bolted together with a lead packing between. These sections were of fixed diameter and represented roughly the losses of a given size of transformer, so that with increased size a greater number of sections were added. Thus, for instance, a 2-section box with top and bottom would be for a 100 kw. transformer, a 3-section box for a 150 kw. transformer, and so on. These boxes, however, became very heavy and costly in larger sizes, and were abandoned in favour of boxes of wrought iron having similar deep corrugations. As in the case of the previously described water-cooled transformer boxes, the idea of keeping the radiation surface concentrated towards the top of the box where the oil is hottest has been carried out in these air-cooled boxes also. The small cistern placed on the top of the box is provided to allow the extra space required by the oil when hot, on account of its expansion, and to keep a constant head of oil pressure against the lid of the box. This is necessary to prevent moisture condensing on the under side of the lid in cold weather, which happens if an air space be left between the top of the oil and the lid of the box. Such drops of moisture will fall through the oil on to the transformer, and may cause serious damage. The oil in this little cistern is connected to the main body of oil in the transformer box by a small tube, the upper end of which is some inches above the bottom of the little cistern, so that any moisture that may condense on the under side of the lid of the little cistern will not be drawn into the transformer box, but will lie at the bottom of the little cistern, and can periodically be drawn off from this through a pet-cock. The bottom of these boxes is circular and is of ¼ in. boiler plate, and the top part is corrugated and of 14-gauge sheets. Another idea of the heavy circular bottom is that it will stand pinching with crowbars and other rough handling in transport in places where proper lifting devices are lacking. In order to stop small leaks the whole box is galvanised after it is riveted and complete. The eventual successful commercial evolution of these boxes is in a large measure due to Mr. Alfred Fraser, of Messrs. John Fraser & Sons, Millwall, the makers of the boxes. While it may superficially appear a simple matter to make such boxes, the technical difficulties met with were very great indeed. It is remarkable what a difference there is in the radiation properties of cast-iron and wrought-iron surfaces.

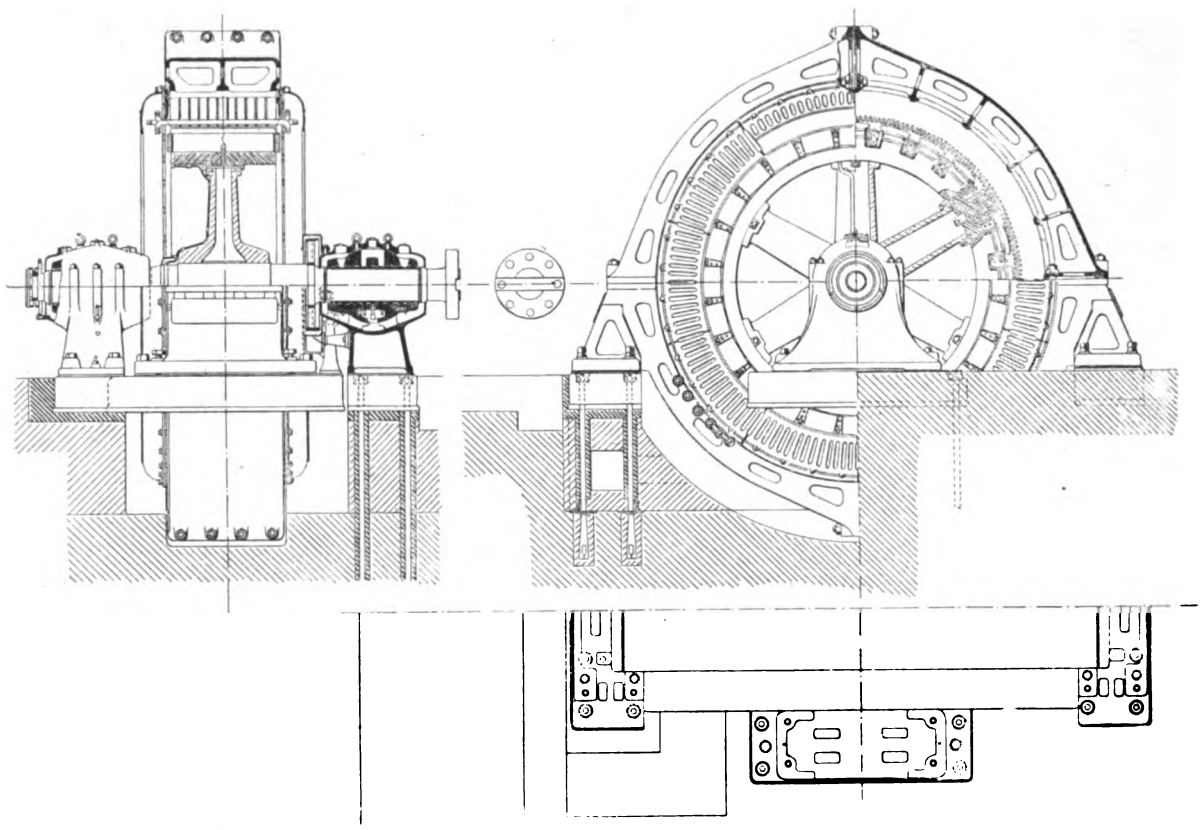

FIG. 3.—SVALGOS 10,5000 KW. GENERATOR.

The greatest distance of transmission from Graninge is about 40 English miles. There are, of course, much longer transmissions than this in service in Sweden: for instance, Hemsjo, 96 km.; Yngredsfors-Varberg, 90 km.; and many very long transmissions are in course of construction. It has even been suggested by the State engineer of the Trollhättan Falls to transmit power from there to Copenhagen, a distance of about 350 km., including 8 km. across the sea between

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Sweden and Denmark. The Graninge line consists of three single wires of 4·5 mm., about 0·18 in. diameter, carried on wooden poles. The pin of the top insulation is mounted on the wooden pole directly, while the two lower insulators are supported on an iron cross-bar. The insulators are of triple petticoat type, made in two pieces cemented together and supported on iron pins fixed to them by a tight packing of oakum between the pin and the inside of the insulator. Formerly it was customary to cement the insulator caps to the pins, the cement used being mostly the litharge and glycerine mixture, but with this cementing it was found that the insulators split, owing to unequal expansion, with the extremes of heat and cold pertaining to the Swedish climate.

The wires are suspended in positions corresponding to the tips of an equilateral triangle, the distances between wires being 50 in. The distance of span between the poles is about 45 yards generally, but at river crossings there are two spans of about 140 yards each, and one at the estuary of nearly 400 yards. In the case of this latter span the conductors and their insulators are supported on triangular frames which are suspended from a steel hawser. The steel hawser passes over rollers on towers 120 ft. high, situated on the opposite shores, and is anchored to rocks at each end. Where transmission lines cross public highways or railways the law requires that such crossings shall be protected so that in the event of a conductor breaking the free end cannot fall down and thus be dangerous. This is effected by enclosing the transmission lines at these points inside a casing of iron lattice work supported on iron lattice poles situated each side of the crossing.

All the preceding power stations described are built with horizontal shaft turbines, and are typical of the most general run of power stations. In many cases, however, vertical shaft turbines and generators of the umbrella type are employed, principally on very low falls, where this type offers advantages. In these cases the turbines are placed in ordinary open flumes, over the top of which is the floor of the generating-room, and the advantages are chiefly as regards variable levels of backwater in the tail race as well as cost.

In the attempts made to get up high speeds on low falls quite freakish designs are sometimes met with. It may be remarked here that the Swedish practice in this respect is quite different to the American custom of employing gearing to increase the speed of generators driven from slow-speed turbines, in Sweden direct coupling being the rule. Only one case of gearing being used has come under the author's notice there, and the users of it would be glad if they could now dispense with it. At Nyqvarn there is a power station in which the turbine units consist of two pairs of wheels—that is, four runners—with vertical shafts. The fall in this case is on 13½ ft. and the speed of the turbines is 150 r.p.m. The quadruple turbines are of 500 h.p. Each pair of turbines has a common discharge, the upper pair of wheels having a short cement draft tube. Fig. 4 shows an arrangement of twin turbines of 680 h.p., 107 r.p.m., working at Avesta Lillfors, on a 10 ft. fall. This equipment was designed specially to be placed in an existing flume intended for an older type of single turbine. It will be noticed that the upper wheel has a draft tube, while the lower wheel does not require one. This is a good instance of a case where vertical shaft turbines should be used. It will be noticed in the figure that the level of the backwater is sometimes considerably higher than the upper part of the discharge case of the upper turbine, while, on the other hand, during periods of low backwater, the water is only level with the bottom of the lower wheel, and the draft tube of the upper turbine then comes into use. If in a case of this kind horizontal shaft turbines had been used, the backwater would at times have a considerably higher level than the floor-level of the generator station. This would have necessitated placing the generators in a sunken chamber, the lower part of which would have to be watertight as the backwater would at times be higher than the floor-level of the power house.

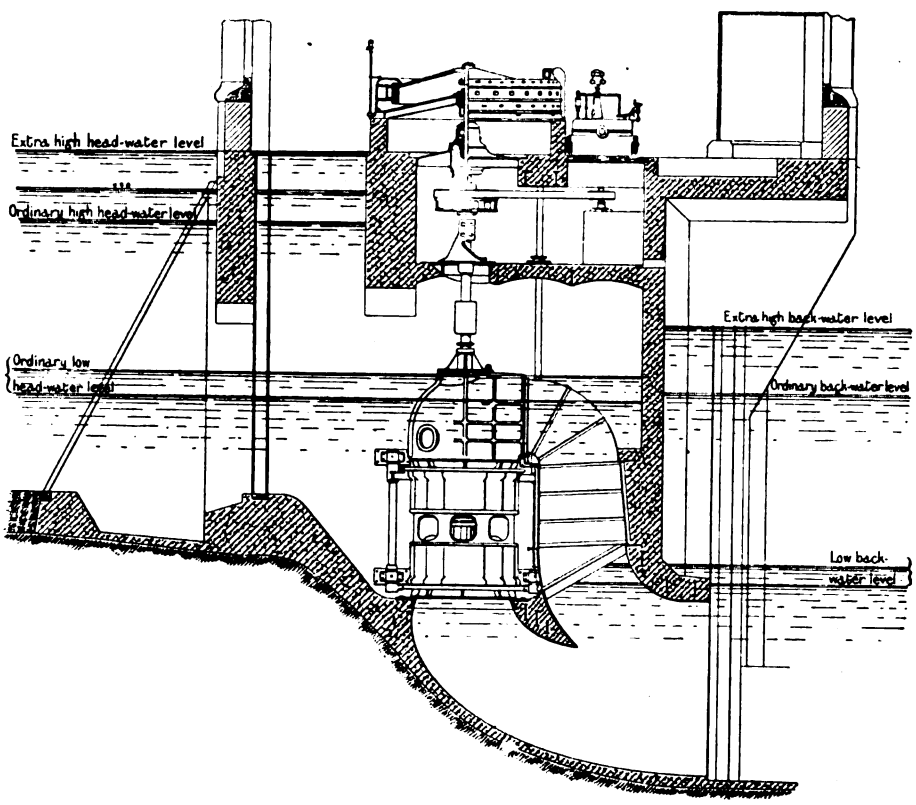

FIG. 4.—AVESTA LILLFORS POWER STATION.

Another class of turbine generator set which is very interesting, and for which Mr. Böving has obtained patents, consists of two wheels running in opposite directions, the shaft of one being hollow and having inside it the shaft of the oppositely rotating turbine. To these two shafts are attached respectively the field and the inductor of the generator, both of which rotate, but in opposite directions. The result is that, for a given periodicity, and speed the generator has only half the number of poles that would be required if the field alone rotated; in other words, it is equivalent to doubling the speed of the generator. Several of these have been at work at Hellefors for many years past, and are quite satisfactory. In vertical shaft turbines the rotating parts have, of course, to be suspended, and with the generator rotating field, the long and heavy vertical shaft, and the turbine wheels themselves, it will be seen that the weight to be supported is often very great. Many unsuccessful attempts were made to take up this weight on ball bearings, but now it is almost general to use hydraulic bearings, which float the entire system where the weight to be supported is too great to be taken up on the ordinary

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lignum vitæ turbine footstep. Another unique case is seen at a power station at Korsnäs, in which no less than four pairs of turbines—that is, eight wheels—are used on one shaft. The fall in this case is only 6 ft., and despite the use of eight wheels, the speed is only 107, while the power is only 420 h.p. Installations with such very low falls utilising enormous quantities of water per horse-power developed are, of course, excessively costly compared with their power output. This can be best seen when it is remembered that the same turbine wheels used in this case would, on a fall of, say, 40 ft. (that is considerably less than the fall in any of the previously described power stations), develop not 420 h.p., but about 7,000 h.p., and the same applies more or less to the generators. Twin wheels are, of course, the ideal; but in many cases quadruple wheels must be used to enable the use of large-size electrical generators at reasonably high speeds. Of course, on high falls the obverse obtains, and in such cases single wheels having high peripheral velocity are used in order to get reasonable speeds for the generators. A single-wheel turbine of this class, with an output of 3,300 h.p., is in operation on a 290 ft. fall at the works of the British Aluminium Co., at Stangfjorden, Norway. Even with this single wheel of large horse-power capacity the speed is 300 r.p.m., and at this speed the generators, which are of continuous-current type, had to be divided into two units of 1,100 kw. each.

On high falls, and even on only moderately high falls where pipe-lines are used, very great precautions must be taken against the dangers of water-hammer arising from the operation of the turbine gates with sudden variations of load. To protect against these, relief bypass valves are used, which open automatically in the case of the water supply to the turbines being suddenly cut off, and thus prevent any sudden checking of the velocity at which the water is flowing in the pipe-line. On still higher falls Pelton or impulse-type wheels must be used, but I do not know of anywhere in Sweden where wheels of this type are at work. There are, however, two installations being carried out in Norway where Pelton wheels are being used. One of these is at Tya, where a head of about 3,300 ft., probably the highest in the world, is utilised to develop about 70,000 h.p.; the other Pelton wheel power station is at Rjukanfos, also in Norway, where the head is about 1,000 ft. The units at the latter station will be of 14,500 h.p. each. It is interesting to note the low capitalisation cost of these latter big schemes. From calculations made by my Association, the Hydraulic Association of Scandinavia, the installation at Tya is estimated to cost about £525,000 or £7 10s. per electrical horse-power developed.

Where open intake water canals cannot be built—such, for instance, as on sloping ground—wooden pipe-lines are often used for the sake of cheapness. They are made of wooden planking about 3 in. or 4 in. thick, and bound at frequent intervals with strong iron hoops, the spacing between the hoops being dependent upon the pressure due to head of water in the pipes. These wooden pipe-lines cannot, of course, be used with advantage on anything but moderate heads, and they are often used for the first portion of a long, sloping pipe-line until the head gets too great.

ELECTRICAL THEORY OF DYEING.

DISCUSSION.

Professor W. W. Haldane Gee and Mr. W. Harrison's paper on "The Electrical Theory of Dyeing," read before the Faraday Society, was discussed.

In a communication, Dr. W. C. McC. Lewis drew attention to the importance of the work of Professor Gee and Mr. Harrison, especially their beautiful method of showing the gradual transition from the charged colloidal state to the state of a non-electrolyte in true crystalloidal solution, as well as the remarkable temperature effects which the potential difference of the particles undergo. Had the authors determined the potential difference water.glass? This was of great importance in endosmotic work. The potential gradient at the surface of the particles can be shown to be of the order 10^{-6} volts per cm. Could this be withstood by water without something analogous to sparking taking place?

It was possible that the high values obtained by Lodge for the velocity of the hydrogen ion as measured in a set gelatide solution were really owing to the velocity with which the solvent as a whole carried the hydrogen ion along with it as it was impelled through the network of the jelly by the external E.M.F.

Hydrolysis would seem to complicate the simple electrical theory, because the conditions of temperature and dilution under which dyeing took place were favourable to hydrolysis as well as to ionisation.

Dr. V. H. Veley remarked on the peculiar maxima values obtained by Messrs. Gee and Harrison at 40° C. Remarkable effects occurred at this temperature in many physical and chemical actions, such as the evolution of carbonic acid from leaves, or the coagulation of muscle and nerve stuff.

Dr. H. Borns drew attention to some recent ultramicroscopic work in which had been observed the movements not only of colloidal suspensions, but of ions, or groups of ions, themselves.

Mr. W. P. Dreaper, commenting on the paper of Messrs. Gee and Harrison, showed that in many cases of dyeing the conditions favourable to electrolytic dissociation were not obtained. The dissociation of the dye salt into ions and transference of one of these to the fibre area required further confirmation. Possibly the function of the electrical action was merely one of concentration of the dye within the fibre area rather than controlling the true dyeing action. Anyhow, there were many difficulties, which the speaker instanced, in the way of accepting the electrical theory so far as the fixation of the dye was concerned.

Dr. E. Feilmann also mentioned some facts that seemed difficult to reconcile with the electrical theory, such as that many dyes were used in the form of paste, and not in solution at all, and that a large class of fast dye stuffs formed true colloidal suspensions. There were, he thought, a great variety of dyeing processes.

Mr. W. R. Cooper asked whether basic dyeing would take place if a positive charge were impressed on the fabric; if not, support would be lent to the electrical theory.

Mr. F. J. Farrell quoted instances in which the splitting of the ultimate fibre, without any chemical alteration, prevented the dyeing action in the case of silks. He agreed with Mr. Dreaper that the maximum effects found at 40° C. bore no relation to actual results in practice. As a rule no good results were obtained at less than 95° C.

The *Chairman* was of opinion that many of the phenomena observed in dyeing could be explained merely from a mechanical point of view; the effect of temperature was an instance of this. At the same time, the electrical theory might be useful in explaining the initial attraction between the dye and the fibre, even if it did not explain the fixing, which perhaps was to be attributed to the ultimate attraction of matter for matter, namely, cohesion.

TRADE NOTES.

Owing to the increasing business in Messrs. Siemens Bros. Dynamo Works, Ltd., Supplies Department, 39, Upper Thames-street, E.C., it has been found necessary to provide extra telephone facilities. They have now four lines; Telephone No. London Wall 8270 (instead of London Wall 6520).

PERSONAL.

The Council of the Glasgow Local Section of the Institution of Electrical Engineers have nominated the following as office-bearers for the year: Chairman, Mr. Samuel Mavor; vice-chairman, Mr. J. A. Robertson; hon. secretary and treasurer, Mr. James E. Sayers; for the four vacancies on the committee, Messrs. William M'Whirter, T. B. Murray, T. C. Parsons, and John Ferguson.

It is proposed to raise the salary of Mr. Fedden, manager of the Sheffield Electricity Department, from £900 to £1,000 a year.

Mr. J. E. Kingsbury has removed from Norfolk House, Victoria-embankment, to 7, Serjeant's-inn, Temple, London, E.C.

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THE

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ELECTRO-HYDROPHOBIA.

A certain learned German—to wit, Dr. Krüger—recently delivered himself of a remarkable criticism on the hydro-electric enterprises now so much the fashion in his own country and other parts of the continent. The attitude he assumes is at once made manifest by his quaint declaration that he was voicing the protestation of the potato against hydro-electric schemes. In a few words, his original contribution to science is the assertion that engineers, in utilising rivers to generate electrical power, are starving agriculture by depriving it of water for irrigation! This, to say the least, shows a singular mental state, whether due to inability to grasp facts or to sheer prejudice it would be hard to say. He may be justified in labouring an incontrovertible truth, and that is that water power, even from a swift river with a good fall, costs money. It is probable enough that there are still people who fail to take into consideration the cost of constructing barrages, flumes or what not to control and train the water-course, to say nothing of the upkeep of engineering works and plant. We hope that there are not many responsible persons who would be guilty of such folly, though we acknowledge that it is too common for a certain amount of loose thinking and argument when water is being compared with, say, coal. We will not, therefore, quarrel with the doctor on this point. But when he comes to the stage of estimating, liberal as he apparently is, he goes wrong. Taking two hydro-electric plants utilising respectively falls of 3·35 metres and generating 540 h.p., and one of 2 metres generating 240 h.p., then comparing them to a steam power station, he arrives at a co-efficient

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(after making due allowances for interest, depreciation, etc.), by which he finds a saving of ·13d. per horse-power hour in favour of the hydro-electric installation. Next assuming that a natural fall is available, and that 100% of the effective power can be utilised, he finds that 2·7 cubic metres of water will produce 1 h.p. hour, thus coming to the conclusion that one cubic metre of water costs ·05d. Undoubtedly, these are far too liberal allowances, but as will presently be seen, they are only conceded to be swept away. For, having worked out fairly satisfactory figures so far for hydro-electric power, he then enquires, What is the value of water for irrigation purposes? Naturally, this is a little difficult to answer, but, taking a wide review of German practice, and again allowing for expenses of upkeep, depreciation, etc., he arrives at the figure of ·78d. per cubic metre delivered on the land. But when the extra crops raised on irrigated land are taken into consideration, the value of cubic metre of water may attain the figure of nearly 1½d. Therefore, he roundly declares, it is far more profitable to utilise water for purposes of irrigation than for generating electricity! Could prejudice be carried much further? Water is not dissipated, destroyed, merely because it has been passed through a turbine or over a water wheel. There is no reason why the water should not first be harnessed, and its power utilised, and then be delivered on the land for irrigating. That is what is being done in America on a very large scale, and, as we recently remarked, a plan now adopted in India. Indeed, we find the water captured by irrigation engineers made to give up its force to generate electricity, a percentage of which is then used to pump the water to lands otherwise outside the range of irrigation. It is absurd to put forward arguments such as those advanced by Dr Krüger, which by their apparent scientific backing are likely to impose on rural district authorities. The whole question of hydro-electrics is one of relative expense, depending upon the amount of work that has to be undertaken, the cost of plant and of upkeep. Certainly the adoption of a hydro-electric scheme does not prevent, but may indeed facilitate, the adoption of an irrigation policy, on one and the same stream. So much stress is often laid on German professorial theories, that it seemed distinctly worth while to combat this special case, all the more so as we hold that small streams both at home and abroad are not utilised to the extent that they should be by electrical engineers.

ELECTRIC SALES SOCIETY.

The staff of the St. Marylebone Electric Supply have formed a society called "The Electric Sales Society" for the furtherance of business getting in connection with electricity supply. This society meets every fortnight in the winter, and every month in the summer. At present the society is confined to the staff of the St. Marylebone Electric Supply, but it is hoped in a short time to extend the scope of membership. Papers are given by experts on business getting, points relating to electricity supply, electrical apparatus and work of all description, particular attention being paid to all papers concerning the commercial side of the question. The papers given and discussion following will be printed for sale and embodied in a monthly publication on electric sales.

CORRESPONDENCE.

TO CORRESPONDENTS.

All communications intended for the Editor should be addressed "The Editor, 149, Fleet Street, London, E.C." Anonymous communications will not be noticed. Letters should reach the Editor not later than Tuesday afternoon to be included in that week's issue of the Journal.

The Editor is not responsible for, nor does he necessarily endorse opinions advanced by correspondents.

ELECTRICALLY DRIVEN STEAMSHIPS.

Sir,—In the interest of the electrical engineering trades, I respectfully wish to draw attention to a statement that Mr. Charles A. Parsons made at the discussion on a paper that I recently had the pleasure of reading before the Institution of Naval Architects, to the effect that: "If a short-circuit occurred on board of an electrically driven ship, that all the men in the engine-room would be killed by copper poisoning, and therefore its adoption involved grave risks, etc."

This statement he again repeated in the reply which he gave to the discussion on his paper the next day on "The Transmission of Power by means of Mechanical Gears to Slow Speed Propellers from High Speed Turbines."

In view of such a strange statement being made by Mr. Parsons before one of our technical institutions, in which proceedings vast interests are at stake in the shipping world, it would be one of the many great things that electrical engineering has accomplished if this advanced profession and trade were to ask Mr. Parsons to publicly withdraw such a statement, which is not only untrue, but is not a proper item to embody in any discussion on electrical power generation and transmission for ship propulsion, at the same time may mislead a number of interested ship-owners to the extent of overlooking the great advantages that are to be obtained by its adoption and for the purpose named.

I have endeavoured to find out a case in which anyone has been poisoned by means of a short-circuit on a generator of large power, and have had many under such conditions myself. Perhaps some of the readers of this letter will kindly give their views, as it is of the utmost importance especially bearing in mind that Mr. Parson's Patent Specification has been published on the 7th inst., and reading same I can see he is following the ground over which I have gone years ago, as anyone can see by reference to my Patent No. 17248 of 1905. I might point out that it has no connection with my recent Patents, which are under what is now well-known the "Paragon" system. Trusting you will be so good as to find room for these few remarks, thanking you in anticipation.

Yours faithfully,

William P. Durtnall.

11, Bush Lane,
Cannon Street, London, E.C.
April 14, 1910.

JAPAN-BRITISH EXHIBITION.

Sir,—Might I ask you through the medium of your columns to impress upon all participating in the British Section of the Japan-British Exhibition, the necessity of taking advantage of the facilities afforded by the Administration in order to have their exhibits completely installed in ample time before the opening, early in May.

The Japanese have already made great progress, and there is no reason why British manufacturers, who are on the spot, should be one whit behind their Far Eastern colleagues.

In the past, many a valuable exhibit has been entirely passed over by both Press and public, because on the first visit to the exhibition they had no opportunity of forming a judgment upon its merits.

As the advantages of preparedness are therefore so evident, I trust that all those taking part in the Japan-British Exhibition will do their utmost to ensure that no reproach shall attach to the British Section when the day of opening comes.

Norfolk.
(President, Japan-British Exhibition.)

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TELEPHONE CURRENTS IN LOADED AND UNLOADED LINES*

By B. S. COHEN.

The author dwelt on the relationship between the sent and received currents in telephone lines under the various conditions which occur in practice. As mentioned by Prof. Perry in his paper read before the society a few weeks ago, it is of little or no practical value to make calculations on the current attenuation in lines of infinite length and with the terminal conditions neglected. The effects of the line length and of the terminal apparatus must be taken into account. By the aid of Prof. Kennelly's formulæ it is possible to calculate the relationship between the sent and received currents under any conditions met with in practice, and for some of the conditions used in the demonstration the calculated results had been obtained. Four essentials were necessary for the experiments shown: (1) A current comparable to the actual telephonic speech current. This was obtained from a vibrating wire interrupter giving a wave with a fundamental of about 100 ~ per second with a damped oscillation of about 800 ~ per second superimposed. (2) A telephone line with or without its load in the shape of inductance coils. (3) Terminal apparatus. The lines were terminated by receivers and induction coils as used in practice for what is known as local battery working. (4) Current measures. For this purpose barretters arranged as alternating current ammeters were used. The first experiment showed the relationship between the received and sent current for various lengths of standard cable unloaded. The second experiment illustrated the variation in the current sent when the receiving end was open or closed circuited and the length of cable was varied. The third experiment showed the current distribution along the loaded cable by inserting a barretter at different points along the cable. The author gave explanations of the various phenomena illustrated in the experiments. He pointed out that it is now possible to make both calculations and quantitative telephonic tests which give mutual confirmation.

Discussion.

Dr. A. Russell congratulated Mr. Cohen on the admirable demonstration he had given of the effects of "loading" a telephone cable with Pupin coils. He pointed out that much of the success of the demonstration was due to the barretters and the vibrating wire generator which Mr Cohen had himself perfected. It was now well known that the effect of the loading coils was to improve both the volume of the sound and the clearness of the articulation. He asked whether the diminution in the value of the attenuation constant and the consequent increase in the volume of the sound, or whether the equalising of the velocities of the damped trains of waves proceeding along the wires was of the greater importance in practice. He asked also whether the Pupin coils were inserted in such a way that the going and return currents tended to magnetise the cores of the coils in the same direction. He suggested that the higher efficiency of the loaded cable might be partly due to the diminution in the value of the current and the consequent increase in the value of the potential at the sending end, the gain in efficiency due to this cause being due simply to the smaller expenditure of energy in heating the wires.

Mr. A. Campbell asked what was the minimum current which would give reasonably clear speech, and what was the usual ratio between the current received and the current sent in good working conditions. The author had used frequencies of 800 ~ per second. If a line were loaded so as to transmit well at this frequency, would it transmit equally well at frequency 2,000?

Mr. Whaley remarked that the experiments shown did not quite conform with working conditions where constant currents were flowing. He asked whether the results would agree with those which would be obtained with constant currents flowing in the circuit.

Dr. W. H. Eccles called attention to an apparent paradox which arose when the barretter at the receiving end was giving a larger reading than the similar instrument at the sending end of a cable. The barretter deflexions were of course a measure of the *power* being spent in the instrument, and the paradox might be expressed by saying that in the above circumstances the power indicated at the receiving end was greater than that indicated at the sending end. The series of detached trains of oscillations produced by the author's vibrating wire interrupter led to difficulties in the mathematical discussion of cable problems which were vastly greater than those met with in the sine wave problem, for which alone the currently used formulæ were correct. He asked how far experimental results obtained with damped trains disagreed with the sine wave formulæ. For practical purposes the damped trains used by the author were a better imitation of speech sounds than pure sine oscillations. He asked if the indication of a barretter when used with ordinary speech sounds or with damped trains, corresponded strictly with the volume of sound.

The Author, in reply to Dr. Russell's remarks about the diminution of the attenuation constant, said that, by loading, both advantages referred to were obtained. The limit was determined in practice by the volume of sound transmitted, and not by articulation conditions. In reply to Mr. Campbell, he said he was working with an attenuation of 1·5%, and the sending current was 3 or 4 milliamperes. The apparatus would work quite well up to frequencies of 1,500. In reply to Mr. Whalley, he said that increasing the current in the circuits up to 0·1 ampere would have no effect on the inductances. With regard to the remarks of Dr. Eccles, he said that the barretters he was using were measuring current and not energy. The current received was a most important factor in determining the volume of sound transmitted.

* Abstract of paper read before the Physical Society of London.

ELECTRICITY IN VICTORIA.

(From our Melbourne Correspondent).

The use of electricity for domestic lighting is making progress in Melbourne. Where the electric mains are conveniently situated, architects advise their clients to instal the electric light in preference to gas in all fairly large houses, basing the recommendation on the superiority of the light, its cleanliness, its preservation of books, pictures and ornaments, its smaller initial cost of equipment, and its economy in general use. In some residential districts houses of moderate size have been wired.

One of the great difficulties in the way of popularising electric lighting in Melbourne has been the enormous area over which the metropolis extends. This disadvantage, of course, applies equally to gas, water and sewerage. All these services required much higher capital expenditure in the laying of mains than cities of similar size in Europe. But the drawback is intensified in the case of electric lighting, because its chief rival is already in the field, and has all the advantage of priority, familiarity and immediate application. The Melbourne Electric Supply Co., which exercises electrical powers over a considerable part of the suburban area, has had a severe struggle against the competition of gas, and will probably not reap the reward of its enterprise for some years to come. The company's operations have not reached all the suburbs, and in districts covered by the company its mains are not universal like those of the Gas Co. Consequently, many people who would like to use electric light are unable to do so because it can only be brought to their door at heavy expense. The Melbourne Electric Supply Co. is selling current in Fitzroy, Collingwood, Kew, Richmond, Prahran, Malvern, Caulfield, St. Kilda and South Melbourne. Its sphere of action will be extended shortly to Brighton, and if there is no disposition on the part of municipalities to provide their own electric supply, the company will in time embrace other suburbs in its undertaking. The city proper, including Carlton, North Melbourne and Essendon, is supplied by the City Council. The charge for current for lighting in Melbourne is 4½d. per unit; in the suburbs it is 5d. and 5½d. At this price, and with the new wire lamps, it has been proved, by carefully ascertained tests in actual every day practice, and not under any special conditions, that electricity, apart from its simplicity, safety and convenience, is cheaper than gas.

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At an average price of 5d. per unit, electricity should more than hold its own in Melbourne with gas at 5s. per 1,000 ft. If the gas company does not reduce its price to 3s. 6d. per 1,000, which it could well afford to do and make a handsome profit, the demand for electric lighting is sure to increase. The greater consumption will naturally tend to reduce the price, and the competition of the two systems of lighting will be to the benefit of the public.

Wiring and fittings for electric lighting is not expensive. A house can be electrically equipped for less than the cost of installing gas fittings. It depends entirely on individual taste. Elaborate stands, clusters, and shades are costly, the same as ornamental chandeliers. But on an average the householder who is thinking of adopting electricity will find that the cost is about £1 per lamp. A seven-roomed house would probably be amply furnished with a dozen lights. The cost of an electric equipment on this scale would be from £10 to £12. Electric lights are so convenient, and the current used in the modern lamp is so small, that lamps are often placed in pantries, sculleries and closets, where no one ever thinks of putting a gas bracket. The light is switched on and off so easily, saving matches and candles, or where gas is used, avoiding the necessity of turning down or using wasteful pilot lights, that fittings are put in all over the house; even the verandah is illuminated, which is impossible with gas. A house of seven rooms was recently fitted with 21 lights, about twice as many as were actually necessary, but it was done, to some extent, as an object lesson in electric lighting. Not only is every room and passage fitted, but some of the lamps are movable and can be placed in that part of a room where light is most required. There is a lamp on the verandah, and the owner of the house considers it a great convenience after an evening at the club to be able to switch on a light to see the keyhole.

In a small household the gas bills are not heavy, but it would be a very modest establishment which did not consume 1,000 ft. of gas per month, even in summer. The cost in this case would be 5s. per month. In the house with the 21 electric lamps, the bill for current is only about 4s. per month, and the owner attributes the low consumption to the fact that when lights are not in use they are turned off, not left burning until they are again required, as is the case with gas or oil lamps. Electricity is not only cheaper than gas in actual consumption, but the use of switches that illuminate the room with a touch produce in the course of the year a substantial saving. Gas will, no doubt, continue to be used in houses with a complete service of pipes, chandeliers and brackets, because owners are reluctant to make these things worthless, and tenants will not go to the expense of wiring houses for the future advantage of the landlord. But all new houses should be electrically equipped, and with the cheapening of current and the gradual realisation of the superiority of electric lighting over gas, the day is not far distant when gas, as an illuminant, will be as antiquated and as despised as the cable tram.

Electricity is making very satisfactory progress in Victoria generally, though it is not being used for power purposes on the same scale as it is in Western Australia, or even in New Zealand.

LONDON COUNTY COUNCIL TRAMWAYS.

The official accounts just published show an aggregate capital expenditure to March 31, 1909, of £9,483,562.

After deducting £282,520 which has been received in respect of the sales of old material, surplus lands, etc., the net aggregate capital expenditure at the end of the financial year stands at £9,201,042. This latter sum is classified in the accounts of the Council as: Electric traction, £7,324,769; horse traction, £532,179; capital expenditure on obsolete lines, etc., £1,344,094.

The net capital expenditure during the year under audit amounted to £1,068,971. This sum is made up as follows:

	Expenditure during year 1908–9.	Expenditure transferred from horse traction.	Total.
	£	£	
Electric traction power supply ..	586,936	—	£586,936
Construction of permanent way and erection of car sheds	449,948	12,416	462,364
Street improvements	22,161	12,000	34,161
Pimlico site ..	509	—	509
	1,059,554	24,416	1,083,970
Horse traction ..	9,417	399,430*Cr*	390,013*Cr*
Obsolete capital (horse traction) ..	—	375,014	375,014
	£1,068,971	—	£1,068,971

COST OF STREET WIDENINGS CHARGED TO TRAMWAYS CAPITAL ACCOUNT—ELECTRIC TRACTION.

The amount charged to the tramways capital account during the financial year under audit, in respect of street widenings, was £22,161, making the total sum charged to March 31, 1909, £258,557.

DEBT.

The total sum charged against revenue towards the repayment of the debt created by this expenditure up to the end of the financial year amounted to £1,074,345, made up as follows: Electric traction, £660,206; horse traction, £111,501; capital expenditure on obsolete lines, etc., £302,638.

The debt oustanding at March 31, 1909, was £8,126,697. If, however, the sum of £83,558, the estimated value of surplus land acquired by the Council for tramway purposes, is deducted, there remains a net debt of £8,043,139.

TRAMWAYS REVENUE ACCOUNT.

The total income during the year from lines worked by electric traction amounted to £1,572,251, and from lines worked by horses to £275,199, equal to 11·81d. and 9·23d. per car mile respectively.

The total expenditure on lines worked by electric traction amounted to £896,286, and on lines worked by horses to £305,402, equal to 6·74d. and 10·24d. respectively per car mile.

The sum of £675,965, representing the surplus from lines worked by electric traction, was carried to the credit of net revenue account, and the sum of £30,203, representing the loss on lines worked by horses, was debited to net revenue account.

After all proper charges have been debited to the net revenue account, a surplus is shown of £107,570, which amount has been transferred to renewals fund.

RENEWALS FUND.

The expenditure on renewals charged against this fund during the year under audit amounted to £5,796, and the balance on the fund at the end of the year, amounting to the sum of £264,837.

The Council, by resolution passed on June 23, 1908, agreed that provision should be made for renewals in respect of the Council's electric tramways at the rate of two-thirds of a penny per car mile run. Calculated on this basis, the balance standing to the credit of the fund should be £285,632. It will be observed, however, that the actual balance fell short of the last-mentioned amount by £20,795.

GENERAL RESERVE FUND.

This fund was established in the year ended March, 1908, by a transfer of £34,634 from renewals fund for the purpose of providing for general contingencies.

No charge was made against the fund during the year to March 31, 1909.

The balance of the fund at the end of the year amounted to £35,270.

DANISH NORTHERN TELEGRAPH CO.

The *Revue Economique et Financière* learns that, thanks to participation in other telegraph enterprises, and also to a recovery from the generally adverse trade conditions of 1908, the Northern Telegraph Co. of Copenhagen will, in spite of a diminution in receipts from its own telegraph system, maintain its dividend and bonus at the same figure as for the previous year—namely, 18%, or 45 francs per share, of which 12 frs. 50 per share has been already distributed. The reserve and renewal fund is to receive 1,388,900 frs., and the pension fund 208,300 frs., as in previous years.

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PUBLICITY.

In this Section of "The Electrical Engineer" we give Publicity to New Inventions and Specialities.

ELECTRIC WATER STERILISER.

We illustrate herewith an ingenious water steriliser, in which the ultra-violet rays emitted from a Cooper-Hewitt lamp are used, whereby all organic life in water is destroyed.

Fig. 1 shows the exterior of the apparatus, which is hung against the wall over a sink, and a connection is then made to the water tap.

Fig. 2 is a section, showing the interior mechanism. The lamp operates on a direct current circuit of 100–130 volts, the consumption being 3·5 amps. The wiring having been prepared and the regulating resistance, a 5 amp. switch and a 10 amp. fuse connected in circuit, the polarity of the wires is tested from the mains by means of the pole-finding paper delivered with the outfit, and connection is made to the terminals of the same polarity found on the

Fig. 1.

cover of the apparatus. This has to be carefully attended to, because an error in the polarity will speedily destroy the lamp. The switch should be installed alongside the water control valve. The lamp is suspended inside the cover of the apparatus, and the electrodes are connected to the adjacent thumb-screw terminals.

The valve A presents a double regulation: (1) Controlling the maximum delivery of the apparatus to 132 gallons per hour in accordance with the pressure of water available. (2) Controlling the delivery at any rate up to the maximum. When the apparatus leaves the works, as a measure of security the first adjustment is made in such a way as only to permit of a very feeble delivery; to modify this proceed as follows:—Unfasten the face plate marked "open shut" by unscrewing the central nut and two small screws. Give the plate a complete turn in a clockwise direction by turning the valve handle, measure the delivery of the apparatus while the cock is full open, by filling a vessel of which the capacity is known. If the delivery is below 132 gallons per hour, the face plate is given another complete turn and the discharge again tested. When a delivery of 132 gallons per hour is obtained, the plate is secured by means of screws removed in first instance.

The operation is both electrical and mechanical. (A) Electrical: 1. Close the switch. 2. Gently tilt the lamp by pulling the chain, and let it return slowly to its working position. If the lamp does not light on first tilting, repeat the operation. In cases where the lamp refuses to light,

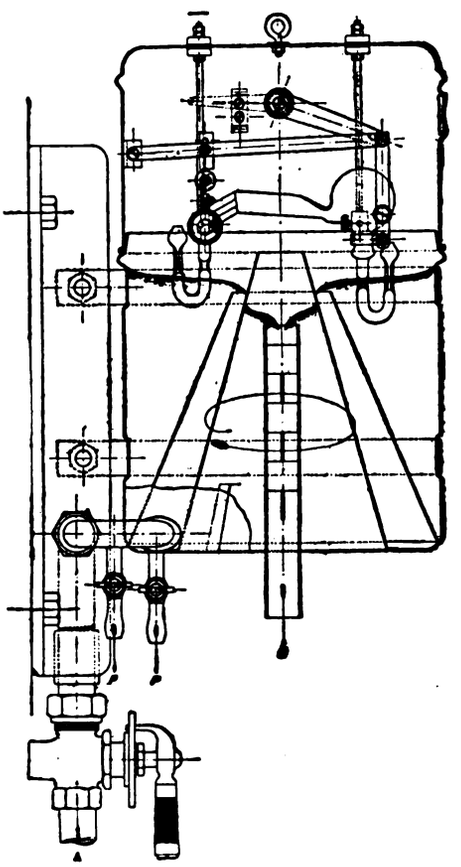

Fig. 2.

verify: (*a*) If the fuse is intact; (*b*) if all the connections are tight; (*c*) if the lamp is still in good condition. If, on giving the lamp a slight shake, the mercury knocks the sides with a dry clear sound, the vacuum is still good. If the sound is dull, and if the tube is badly blackened, the lamp has probably given out, and should then be returned to the works for repair. 3. Regulate the adjustment of the resistance in such a manner that, after running for 20 minutes, the difference of potential at the terminals of the lamp is 70 volts.

(B) Mechanical: The lamp being lighted, open the water-valve. At the end of two minutes the running water will contain no pathogenic microbes, and is therefore good for alimentary purposes. If it is desired to have

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water absolutely sterile, see that the lamp has reached its normal conditions before collecting the water. (See A, 3).

When the apparatus is being stopped, the water-valve is first closed, then the lamp switch is opened. If after the apparatus has been in service for some time, impurities can be seen floating on the surface of the water in the outer compartment, the dome with the lamp should be lifted up and this foreign matter removed by passing a sheet of white blotting-paper over the surface of the water, in a direction opposite to the normal movement; in this way all floating matter can be skimmed off.

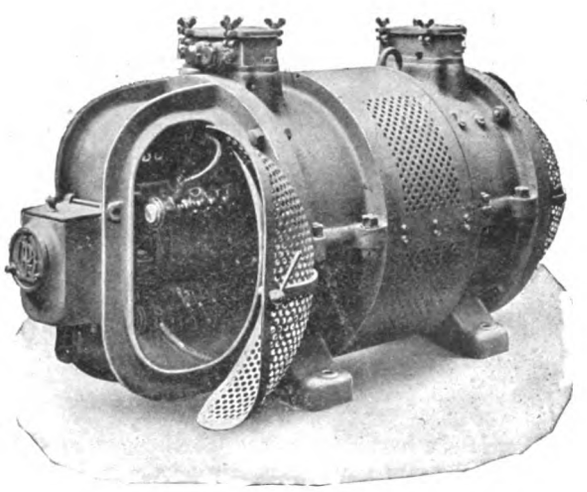
In frosty weather, or in the event of a prolonged stoppage of the apparatus, it is advisable to open the two drain-cocks *P*. It should be noted that ultra-violet light, as obtained from a quartz lamp, is injurious to the eyes when looked at without the interposition of a glass plate. The lighted lamp should not be looked at through delivery pipe; nor should the hands be exposed to the light.

This apparatus is being put on the market by the Westinghouse Cooper-Hewitt Co., Ltd.,

SELF-REGULATING DYNAMO FOR USE WITH SEARCHLIGHTS.

The advantages of using a source of electric supply giving a current of constant value, for the lighting of arc lamps of any description, is well-known. For searchlight work, where the lamps are used independently of each other, the advantages of such a supply are still more noticeable, and the want of a suitable dynamo for generating a constant current has been the main reason for resorting to less efficient means of operating searchlights.

A dynamo which Messrs. Mather & Platt, of Park Works, Manchester, have designed and put on the market for this class of work completely solves this difficulty. It generates current at practically constant value throughout a range of voltage far beyond the limits required for arc lamp working, and it is further entirely free from any objections which might be raised on the score of complication. The regulation of the machine is entirely automatic, and that without the use of any external regulating "devices," either mechanical or electrical in their nature. The terminals of the machine may be completely short circuited, or may be closed on a resistance of a value sufficient to maintain a potential of over 100 volts at its terminals, with a variation in current of practically negligable amount.



The current can be further increased or diminished within wide limits without in any way affecting the self-regulating properties of the dynamo, merely by an alteration of the exciting current. The same generator may, therefore, be used for arc lamps of varying current requirements, thus much increasing its utility, it being perfectly practicable to run a 15 amp. or a 125 amp. projector off the same size of machine.

Apart altogether from the chief advantages which this system possesses, in virtue of its high efficiency, it has other recommendations no less interesting. Not only is the dynamo itself simple in construction and operation, but the whole management of the projector is much simplified by its use. The current is switched on by merely closing the circuit of the dynamo, and an arc forms immediately and is drawn out to the correct length, either automatically by the solenoid of the projector, or by hand, if no automatic regulation is used. There is no sudden rush of current, no flickering of the arc and jumping of the carbons, and the time required to get the full brilliance of the arc is very much shortened.

There is absolutely no risk of fuses blowing, due to excessive current being taken, and no need to burn the arc a moment longer than is actually necessary, as it can be re-started instantaneously. The saving on this score alone, both in carbons and in energy, is by no means insignificant, as frequently arcs are kept burning solely on account of the difficulty in re-starting them.

Owing to the steadiness of the current obviating the slightest tendency of the arc to hunt, the candle power of the arc, if found to be appreciably greater for the same current consumption and p.d. across the arc, or, in other words, the same candle power can be obtained with a lower p.d. across the arc.

The difficulty often experienced on low voltage circuits of the arc being extinguished by being drawn out too far, or too quickly, is almost entirely absent, as the dynamo voltage accommodates itself to the conditions of the arc, and it is possible to draw out an arc 25 to 40 mm. long, with a current of 50 amps.

The dynamo can be arranged either for direct coupling to a prime mover, bolt driving, or for coupling to a motor in cases where a supply of current is available, as shown in the illustration.

SYDNEY ELECTRIC SUBWAYS.

Particulars have reached us from Australia of the proposed subways, underground and under the harbour, to connect Sydney with its suburbs.

The project first came before the Public Works Department, Sydney, on February 28, when Mr. V. J. Hanna, Under-Secretary to the department, stated that the proposed underground railway from the tunnel at Fort Macquarie was intended to come into the city, under the tramway sheds, and under Government House grounds, at a good depth below the surface, to a station at Moore-street. It would, he said, be carried 900 ft. further before it would be brought to a dead-end, so that space would be provided for shunting. He thought, however, a lot of difficulty would be avoided with the net-work of drainage —sewers, etc.—by carrying the underground line along Macquarie-street to a station about where the Queen's Statue stands, and from there towards the Central station by a subway under Hyde-park to a point where it would join the proposed opencut. The Chief Railway Commissioner's report read to the Committee stated that the chief engineer's estimate of cost, £753,000, was exclusive of electric power, rolling stock, etc. "The desirability of adopting electric traction on the Hornsby-Milson's Point line has been kept in view." Including a power house, sub-station and transmission lines, rolling stock, signals, car sheds, and a repair shop, the capital outlay would amount to £1,045,500. It was explained that two lines of way would leave the existing Milson's Point-Hornsby railway near the head of Lavender Bay, and would follow in cutting between the cliffs and the existing line, but falling below the latter to between Dind and Paul-streets. At this point the line would enter into tunnel, and an underground station with two platforms 400 ft. long would be provided. After leaving the station, the line would curve under Campbell-street (still in tunnel), under which it would follow to near its intersection with Beulah-street, where it would curve to the water's edge and enter the subaqueous tunnel, which would be constructed in a straight line to Fort Macquarie. The rail level on this section would be about 62 ft. 6 in. below h.w. S tides. From Fort Macquarie the line would rise in tunnel to Moore-street station. The ruling grade on the northern side would be 1 in 50, and on the city side 1 in 40. The station at Moore-street would consist of three platforms, each 500 ft. long.

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Electrical Contractors' Section.

A Survey of New Things and Business Prospects.

NOTICE.

Contract and Miscellaneous Advertisements should reach this Office by Mid-day on Wednesday. For rates apply to the Manager, 149, Fleet Street, London, E.C.

CONTRACTS.

NEW SOUTH WALES.

TENDERS FOR EIGHT SECTIONS, COMMON BATTERY SWITCHBOARD.

Tenders will be received at the office of the Deputy Postmaster-General, Sydney, until 2.30 p.m. on Wednesday, June 1st, 1910, for the—

Supply and erection at the Telephone Exchange, General Post Office, Sydney, of 5 Subscribers and 3 Junction Line Sections of Common Battery Switchboard, in accordance with Schedule N.S.W. E.E. 118/09.

Schedules, etc., may be obtained, and sealed patterns seen, at the General Post Offices, Sydney, Melbourne, Adelaide, Brisbane, Perth, and Hobart, and at the offices of the Commonwealth Representative in London.

Preference will be given to tenders complying most closely with the Department's requirements for early delivery.

Tenders must be endorsed "Tender for 8 Sections, Common Battery Switchboard," and be addressed to the Deputy Postmaster General, Sydney. They may be deposited in the Tender-box at the General Post Office, Sydney; if sent by post they must be prepaid and registered.

A deposit, or receipt for deposit, must be enclosed with each tender of 5% on the amount thereof up to £1,000, and 2½% on the amount over that sum.

If the deposit exceeds the sum of £20, payment need not be made in cash, but a banker's certificate should be forwarded by the tenderer to the Deputy Postmaster-General to the effect that the amount of the deposit is held at the call of the Deputy Postmaster-General.

The Postmaster-General does not bind himself to accept the lowest or any tender.

The accepted tender will be notified in the *Commonwealth Gazette*, and such notice will be considered as an intimation to the unsuccessful tenderers that their tenders have been declined.

JOHN QUICK,
Postmaster-General.

Postmaster-General's Department,
February 23rd, 1910.

BOROUGH OF NUNEATON.

ELECTRICITY DEPARTMENT.

The Electricity Committee of the Borough of Nuneaton are prepared to receive Tenders for the supply of Water-tube Boiler, Feed-Pump, Pipework, Valves, etc., as follows:—

Section A.—WATER-TUBE BOILER, PIPEWORK, VALVES, and FITTINGS.

Section B.—BOILER FEED PUMP, SUCTION and DELIVERY PIPES, VALVES, etc.

Tenders are invited for either section or for both sections, but not for part of a section.

A copy of the Specification covering Sections A and B, with General Conditions and Form of Tender, may be obtained from the undersigned on and after April 9th, 1910, on payment of a deposit of one guinea, which will be returned on receipt of a *bona-fide* Tender.

Drawings may be inspected at the Engineer's Office, Coton-road, between the hours of 9 a.m. and 5 p.m.

Prints of the Drawings may be obtained upon payment of £1 1s. for each set, which will not be returned.

Sealed Tenders on the prescribed form, addressed to "The Chairman," Electricity Committee, Electricity Works, Nuneaton, and endorsed "Tender for Section A," "Tender for Section B," or "Tender for Sections A and B," as the case may be, must be received on or before April 25th, 1910.

The Committee do not bind themselves to accept the lowest or any Tender.

S. CAMERON GIBSON,
Borough Electrical Engineer.

Electricity Works, Nuneaton.

CONTRACTS OPEN.

HOME.

CASTLEFORD.—Whitwood Urban District Council.—Copper cables, steel, and poles, support arms, insulators, street fittings, connectors, meters, switchboard instruments, etc. (Specification, £2 2s., H. Marsden, Electricity Works, Honley, near Huddersfield). April 28.

LITTLEBOROUGH.—Urban Council invite tenders for the supply and laying of electric cables and the supply and erection of plant as follows: (1) High tension feeder cables, low tension distributors, road work, etc., for private lighting; (2) transformer kiosk, with transformers and equipment and switch-gear in sub-station. Specifications (£5) from Mr. G. H. Wild, Clerk to the Council. May 2.

NUNEATON.—Borough Electricity Committee.—(*a*) Water-tube boiler, pipework, valves and fittings; (*b*) boiler feed pump, suction and delivery pipes, valves, etc. (Specification, £1 1s., Borough Electrical Engineer). April 25.

PERTH.—Town Council invite tenders for the supply of 3,500 tons of small coal during the period ending May 15, 1911, delivered free at their electric lighting station. Forms of tenders from Mr. J. Lambert, Borough Electrical Engineer, Perth. May 11.

ROCHDALE.—Electricity Committee invite tenders for 4,000 tons of steam coal, and the removal of ashes, during a period of 12 months from May 1. Particulars from Mr. C. C. Atchison, electrical engineer, Dane-street, Rochdale. April 27.

OVERSEAS.

ANTWERP.—Lower Scheldt Works.—Electric lift for vehicles on floating pier. Dep., £320. Specification No. 19, 2d., plans 1s. 5d., Direction du Service Spécial de l'Escaut Maritime. June 16.

ANTWERP.—The Municipal Authorities invite tenders for the supply of electrical appliances for the town workshop at the new North Docks. Tenders must be sent in sealed envelopes to the Burgomaster, Hôtel-de-Ville, Antwerp, to arrive not later than May 9. Copies of the *cahier des charges* may be obtained (price 50 centimes) at the Hôtel-de-Ville, Antwerp.

BRISBANE.—The Imperial Trade Correspondent at Brisbane reports that tenders will be received, up to noon on June 8, at the office of the Deputy Postmaster-General, Brisbane, for the supply of common battery telephones and small switchboards and protectors. A deposit will be required with each tender. Local representation is necessary.

BUDAPEST.—H.M. Consul-General at Budapest (Mr. Esme Howard, C.V.O., C.M.G.) reports that tenders are invited by the Municipality of Pécs for the building and working of an electric railway in that town. Tenders will be received up to noon on June 6, by the "Pécs varos gazdasagi tanacsnokanak, Varosi Székhaz," Pécs, Hungary, from whom also detailed conditions and forms of tender may be obtained at a cost of 2 kronen (1s. 8d.). The plans and other documents can be examined on personal application at the Engineering Office of the town of Pécs.

CONSTANTINOPLE.—Public Works Department.—Distribution of electric current in the European part of Constantinople and suburbs except that required for telegraph, telephone and public traction purposes. Prov., £E10,000. May 28.

TOULON.—Arsenal.—Copper and bronze wire and cables, submarine cable, etc. (Particulars, Ministere de la Marine, Paris). April 27.

TENDERS ACCEPTED—Home.

HAMPSTEAD.—Borough Council Electricity Department.—Messrs. Myers, Rose & Co., whose tender was accepted by the Council on March 10 for the supply of 5,000 tons of Norton Cannock 2 in. Nutty Slack coal, for 12 months from April 16 next, at the price of 10s. 8d. per ton delivered on the Council's siding in the Electricity Yard, having withdrawn their tender owing to the Cannock Colliery being unable to accept the contract. As a matter of urgency the following tenders, being the next lowest for the coal most suitable for use at the Electricity station, during the period of 12 months from April 16 next, were accepted, subject to the usual conditions, viz.:—Messrs. E. Foster

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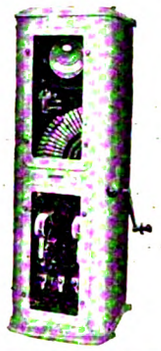

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APPOINTMENTS.

GOVERNMENT OF CEYLON.

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Required by the Government of Ceylon. Period of engagement, 3 years.

DUTIES.—To carry out and supervise under the control of the Assistant Superintendent in charge of Telephone Branch the erection, maintenance, adjustment and minor repairs of all classes of telephone instruments and other routine duties connected with Telephone Exchange work. To instruct and supervise the local Eurasian and native telephone inspectors, and to perform such other duties as may be assigned to him by the Superintendent of Telegraphs.

QUALIFICATIONS.—He must have a special and practical knowledge of multiple switchboards fitted for magneto or common battery working and arranged for local and trunk lines, and have a knowledge of testing methods and fault-finding.

Age, 24 to 35; unmarried.

Salary, £200, equal to Rs.3,000.

No free quarters allowed. Salary not subject to abatement for Widows' and Orphans' Pension Fund. An allowance of Rs.6 per day will be made to cover the cost of subsistence when away from headquarters. Free second class passage to Colombo and home at end of agreement.

Applications, with copies of testimonials and certificates (not originals) and statements of services, to be addressed to Messrs. Preece & Cardew, the Consulting Electrical Engineers, of 8, Queen Annes-gate, S.W.; on or before April 30th. At head of application the reference No. M/4151 is to be quoted.

TRAVELLERS calling upon Electrical firms, Electrical Engineers and Manufacturers and Dealers can earn additional commission. No samples to carry.—Address Box 40, c/o THE ELECTRICAL ENGINEER, 149, Fleet-street, E.C.

TRAVELLERS already calling on Ironmongers, Motor Engineers, Garages, Electricians, &c., wanted to carry as a side line on commission S.A.L. Aluminium Solder and S.A.L Non-Incrusting Battery Zincs, &c. Only first class men with sound connections required. State full particulars (in confidence) and ground covered.—STANDARD ALLOYS, LTD., Stratford, E.

SITUATIONS WANTED.

SITUATION WANTED.—Knowledge of Wiring, Arc Lamp Work, X-Ray Apparatus, etc.—Box A. D., c/o THE ELECTRICAL ENGINEER, 149, Fleet-street, E.C.

FOREMAN WANTS SITUATION with Arc Lamp firm; well up in Theory and Practice of Mechanics and Electricity; 32 years of age, and 17 years' practical experience.—Box W. E., c/o THE ELECTRICAL ENGINEER, 149, Fleet-street, E.C.

WIREMAN, Experienced in all branches, requires situation —Box A., c/o THE ELECTRICAL ENGINEER, 149, Fleet-street, London, E.C.

ELECTRICAL ENGINEER desires berth in Central Station, or charge of private installation.—Box C., c/o THE ELECTRICAL ENGINEER, 149, Fleet-street, London, E.C.

ELECTRICIAN, young, requires situation; could take charge of small plant.—Box H., c/o THE ELECTRICAL ENGINEER, 149, Fleet-street, London, E.C.

MEN OUT OF EMPLOYMENT in all branches of the Electrical Trade should write to Box No. 20, c/o THE ELECTRICAL ENGINEER, 149, Fleet-street, London, E.C.

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SWITCH DRAUGHTSMAN, used to all classes of D.C. Switch Gear, crane controllers and overload and no voltages starter expert. A.M.I.E.E.—Address, Box G.C., c/o. THE ELECTRICAL ENGINEER, 149, Fleet-street, London, E.C.

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PLATINUM UTENSILS, SCRAP, LAMP TOPS.—Best prices given by DERBY AND CO., LTD., 44, Clerkenwell-road, London, E.C. N.B.—Platinum Sold.

WANTED, Electric Motor, 2 to 5 h.p.; 240 or 480 volts, and 3 h.p., 230, continuous.—Box S.B., c/o. THE ELECTRICAL ENGINEER, 149, Fleet-street, E.C.

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Advertisements under this heading: Twenty-four words, 1s. per insertion; three insertions for 2s. 6d.; or each additional line of eight words, 4d.

ELECTRIC MOTOR, by Parker, 15 b.h.p., No. 20, open type, for 460 volts, 40 amperes, 600 revs. continuous circuit; £75. Box 31, c/o. THE ELECTRICAL ENGINEER, 149, Fleet Street, E.C.

FOR SALE, 20 h.p. Suction Gas Plant and 14 b.h.p. Engine; also 10 h.p. Vertical Boiler and 6 h.p. Vertical Steam Engine.—Box C.E., c/o THE ELECTRICAL ENGINEER, 149, Fleet-street, London, E.C.

ELECTRIC MOTORS.—Two 15 h.p., 500 volts; one 20 h.p., 100 volts; one 10 h.p., 460 volts; tramway controllers.—Box W.G., c/o THE ELECTRICAL ENGINEER, 149, Fleet-street, London, E.C.

& Co., of 21, John-street, Adelphi, W.C., for the supply of 2,000 tons (additional) of Ibstock Small Peas, at 10s. 8d. per ton, delivered on the Council's siding in the Electricity Yard. Messrs. Stephenson, Clarke & Co., of 4, St. Dunstan's-alley, E.C., for the supply of 3,000 tons of New Hucknall 1¾ in. Nutty Slack, at 10s. 10d. per ton, delivered on the Council's siding in the Electricity Yard.

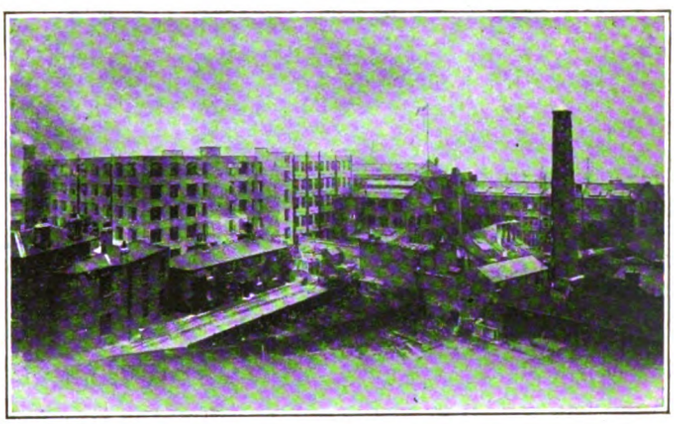
LONDON.—London County Council Tramways Committee.—For the supply of six conduit cleaning trucks for the Council's tramways. The amounts of the tenders, after allowing for the correction of any arithmetical errors, are as follows: Deptford Engineering Co., Ltd., Deptford, S.E. (accepted), £152 9s.; East Ferry-road Engineering Works Co., Ltd., East Ferry-road, E., £206 18s.; Peter Hooker, Ltd., Walthamstow, E., £229 10s.; Johnson & Phillips, Ltd., Charlton, £273 9s.; Fraser & Fraser, Ltd., Bromley-by-Bow, E., £343 5s.; Warren & Sons, Camberwell, £357 7s. Each tender includes a provisional sum of £25 in respect of extra works if required. The estimate of the chief officer of tramways, comparable with the tenders, is £250.

LONDON.—London County Council Tramways Committee.—For the supply of (i.) 500 moulded rubber plough bases, and (ii.) 916 moulded rubber plough leads for electric cars and traversers: J. G. Ingram & Son., Hackney-wick, N.E., (i.) 37s. 6d. each, (ii.) 3s. 3d. each; India Rubber, Gutta Percha and Telegraph Works Co., Ltd., Cannon-street, E.C., (i.) 55s. each, (ii.) 3s. 10d. each (less 2½% discount); Dermatine Co., Ltd., Camberwell, S.E., (i.) 95s. each, (ii.) 6s. 6d. each; David Moseley & Sons, Ltd., Aldermanbury, E.C., (ii.) 11s. 2d. each. The estimate of the chief officer of tramways, comparable with the tenders, is £1,280.

NOTES.

SUCCESS OF THE METAL FILAMENT LAMPS.

The wonderful popularity of the metal filament lamp is attested on all sides. For, as contractors know, the demand is great, and early arrangments for supplies are wise. But that manufacturers are doing their share in coping with the demand is evident. A good example is



OSRAM LAMP WORKS.

afforded by the Osram Lamp Works, at Brook Green, a view of which we give herewith. It will be seen how this factory has grown, and we have seen a *facsimile* of the certificate signed by Messrs. Edmund Bull & Darton, the chartered accountants, showing that no less than 946 persons are on the pay-roll of the works.

ELECTRIC LIGHT IN COUNTRY HOUSES.

Among the electric light installations in country houses undertaken by the go-a-head firm of Messrs. Drake & Gorham, 66, Victoria-street, London, S.W., are the following: H. Tubb, Esq., Chesterton Lodge, Bicester; C. Carter Page, Esq., Woodside, Burstow, Horley; C. Nix, Esq., Tilgate Forest Lodge, Crawley, Sussex; Sir David Baird, The Mount, Ascot; Rt. Hon. the Earl of Derby, Cowarth, Sunningdale, Berks; E. Hain, Esq., Treloyhan, St. Ives, Cornwall. The increase in the use of electric light in country mansions offers splendid opportunities for enterprising contractors all over the country.

"LEA" RECORDERS.

The "Lea" Recorder Co. are very busy, their appliances finding favour near and far, as the following list of orders recently received will testify: J. Jameson & Son, Ltd., Dublin; Nitroglyeerin Aktiebolaget, Stockholm; Glasgow Corporation Electricity Works; Stockport Corporation Sewage Works; Star Bleaching Co., Horwich; J. B. Abbey & Son, Huddersfield; Corporation Electricity

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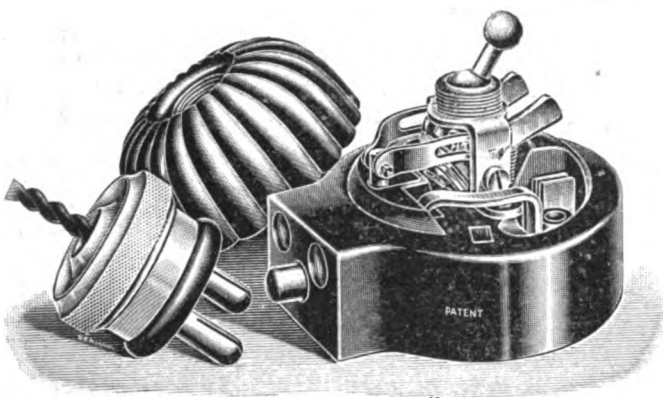
Works, Brighton; General Post Office (three sets), London; J. G. White & Co., Ltd., London; Corporation Electricity Works, Cardiff; Glen Printing & Finishing Co., Newtownards (hiring); Ryde Pumping Station, Australia; London Hydraulic Power Co., London; J. & P. Coats, Ltd., Glasgow; London Hydraulic Power Co., London; Ryde Pumping Station, Australia; Corporation Electricity Works, Halifax; Municipal Tramways, Adelaide (Australia); Municipal Tramways, Adelaide (Australia); West Bromwich Corporation Electricity Works; Broken Hill South Silver Mines, Australia; Sydney City Council, Australia; Cheltenham Sewage Works, Cheltenham; E. Hulton & Co., Manchester; and the Electricité de Paris.

AUTO-COMBINATION.

Last week we gave some particulars of Messrs. A. P. Lundberg & Sons' new combination switch and wall plug, which we now illustrate. The manufacturers claim the following advantages as resulting from the use of such a device :—

(1) The contact arm flies automatically into its "off" position before the plug can be withdrawn, and remains there.

(2) The rupture of the circuit on withdrawal of the plug is rapid and independent of the operator, the break occurring at its proper place, viz., at the switch contacts.



(3) While the plug is in position, the device does not prevent actuation of the switch in the usual way. Withdrawal of the plug is thus only necessary when the apparatus connected requires removal.

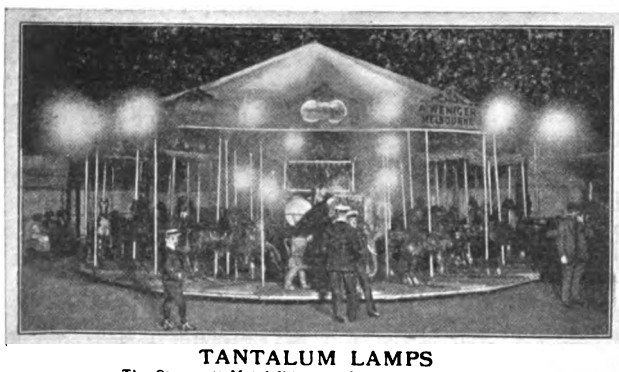
(4) The plug must first be pushed into full contact before the switch arm can be made to remain permanently in its "on" position.

(5) As the circuit cannot be broken where the plug pins leave the socket tubes, any destructive arcing at these points is effectually prevented.

The article can be fitted with any of our standard plugs, and is suitable for ordinary or locked-type covers.

"TANTALUM" LAMPS ON A MERRY-GO-ROUND.

"Tantalum" lamps, as we have previously remarked in these columns, are used in a great variety of places. This week we are illustrating "Tantalums" on a merry-go-round at St. Kilda Beach, Melbourne, Australia. The post card reproduced here illustrates the general effect of "Tantalum" illumination at night time, and at the same time demonstrates that they will withstand very severe vibration. Many people in the provincial towns are familiar at certain seasons of the year with the ear-splitting noises of the so-called "Fairs" or "Wakes," and anyone who has spent five minutes in close proximity to them will agree that there is sufficient din created there to break some of the more fragile types of lamps now on the market. However, the "Tantalum" withstands both the din and the vibration of the machine, which is certainly an exceptional proof of its extraordinary strength.



TANTALUM LAMPS
The Strongest Metal Filament Lamps on the market.
Undergoing severe vibration test since November, 1908, on MERRY-GO-ROUND at ST. KILDA BEACH, MELBOURNE.

VULCANITE
GUARANTEED QUALITY
PROMPT DELIVERY
F. CARSON & EVANS.
3A FENCHURCH BUILDGS. LONDON.E.C.
EBONITE

CONTRACTS WORTH WATCHING:—

Birkenhead.—Mr. W. Gibruth, H.M. Office of Works, Head Post Office, Liverpool. Sorting Office at Rock Ferry.

Bridgend and Cowbridge.—Mr. P. J. Thomas, architect, Bridgend. New Board Room and Offices for the Union.

Crewe.—Postmaster, Head Post Office, Crewe. Sorting Office at Station.

Deptford.—Messrs. Castle & Warren, architects, Talbot House, Arundel-street, London. Branch Library.

Edinburgh.—Mr. T. Hunter, Town Clerk. A competition is to be held shortly for designs for a new hall in Lothian-road.

Glasgow.—Mr. R. A. M'Corvert, 5, Brisbane-street, Longside. Six tenement houses in Falkland-street.

Ilford.—Mr. H. Shaw, engineer, Town Hall. Erection of block of office at the Electricity Works.

Leytonstone.—Mr. R. Dempsey, Clerk to District Education Sub-Committee. High School for 300 girls.

Southampton.—Mr. W. J. Taylor, County Surveyor, The Castle, Winchester. Council School for 140 children at Cove.

West Ham.—Mr. J. S. Morley, Borough Engineer, Town Hall. Alterations and additions to Little Heath House, Goodmayes Asylum.

Whitby.—Mr. E. H. Smales, architect, 64, Baxtergate, Whitby. Drill Hall.

Wigan.—Messrs. Heaton, Ralph & Heaton, King-street, Wigan. People's Palace and Opera House.

Woolwich.—Mr. J. R. Dixon, Borough Engineer. Additions and alterations to convert hall into a branch library.

ELECTRICAL ENGINEERS TERRITORIALS (London Division).—Orders for week ending April 30: Monday, April 25, "A" Co., Recruits' Infantry Drill, 6 to 6.45 p.m., Company Drill, 7 to 9.30 p.m.; Tuesday, April 26, "B" Company, Infantry Drill, 7 to 8 p.m., Technical Drill, 8 to 10 p.m.; Wednesday, April 27, Gymnasium, 6 to 9.30 p.m.; Thursday, April 28, "C" Company, Recruits' Infantry Drill, 6 to 6.45 p.m., Company Drill, 7 to 8 p.m., Technical Drill, 8 to 9.30 p.m.; Friday, April 29th, "D" Company Drill, 7.15 to 8.30 p.m., Technical Drill, 8.45 to 9.45 p.m.; Saturday, April 30, "C" Company Drill, 3 to 4.30 p.m., "A" Company Drill, 3.30 to 5 p.m.—(Signed) P. H. Campbell, Capt. R.E., Adjutant.

EXERCISES IN ELECTRICAL ENGINEERING.
By Magnus Maclean, M.A., D.Sc., F.R.S.E.
Price 1s. 6d.
ELECTRICAL ENGINEER, 149, Fleet-street, London, E.C.

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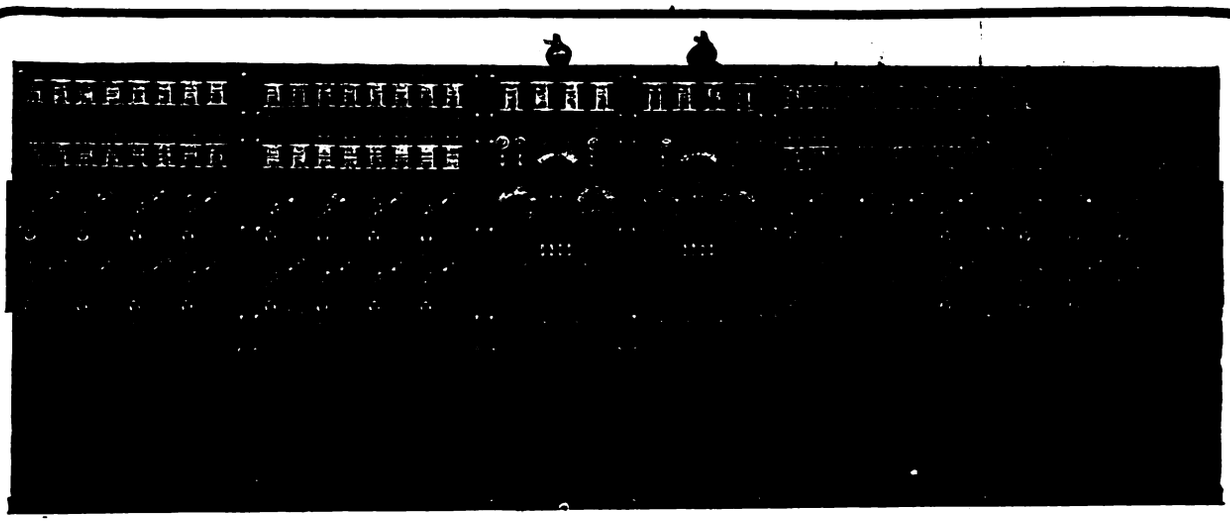

SWITCHBOARD supplied for the "ORSOVA" by Ferranti, Ltd.

L.T. PORCELAIN HANDLE FUSE.

SWITCHBOARDS.

We also supplied the switchboard for the "Mauretania" and switch-gear for the "Lusitania." . . .

FUSES.

INSTRUMENTS.

ALL CLASS of SWITCHES

From 25 to 15,000 Amperes.

MOTOR STARTERS.

FERRANTI LTD.

HOLLINWOOD. LANCASHIRE.

(No. 185.)

FREE TRADE v. PROTECTION.

The Secretary of the National Electrical Manufacturers' Association (Incorporated) announces that a meeting has been convened to be held at the Caxton Hall, Westminster, on Monday, May 23, 1910, at 8 p.m., precisely, to discuss the effect of Free Trade or Protection upon the Electrical Industry.

The following are a few of the more interesting points regarding this meeting which have been settled up to the present:—

The discussion will be opened by Mr. Hugo Hirst (from the Protection point of view) and Mr. J. E. Kingsbury (from the Free Trade point of view).

The chair will be taken by Mr. H. W. Butler, of the Electrical Power Storage Co., the chairman of this association.

No resolution will be placed before the meeting, nor vote taken.

Only those who are directly connected with the electrical industry will be allowed to take part in the discussion.

Any person desiring to take part in the discussion is requested to kindly send his name to the Secretary before May 21 next.

This Association will, as such, be in no way responsible for the views held by neither of the openers of the discussion, or the opinions expressed by its members individually or by others at the meeting.

This meeting has been convened by the Association at the request of several of its members. The Secretary (Mr. F. B. O. Hawes) will be glad to furnish any further particulars to our readers.

DIARY.

FRIDAY, APRIL 22.

ROYAL INSTITUTION OF GREAT BRITAIN, Albemarle-street, W.—At 9 p.m., Mr. T. Thorne Baker on "The Telegraphy of Photographs, Wireless and by Wire."

SATURDAY, APRIL 23.

ASSOCIATION OF ENGINEERS-IN-CHARGE, Bride-lane, E.C.—Bohemian concert.

MONDAY, APRIL 25.

INSTITUTION OF ELECTRICAL ENGINEERS (Newcastle Section).—At the Armstrong College, at 8 p.m., Mr. W. W. Wood on "Earthed *v.* Insulated Neutrals in Colliery Installations."

TUESDAY, APRIL 26.

FARADAY SOCIETY.—In the Library of the Institution of Electrical Engineers, at 8 p.m., Professor P. Walden on "Is Water an Electrolyte?"

WEDNESDAY, APRIL 27.

INSTITUTION OF ELECTRICAL ENGINEERS (Students' Section).—At 7.45 p.m., at 92, Victoria-street, S.W., Mr. J. C. Connan on "Some Notes on Current Central Station Design in Germany."

THURSDAY, APRIL 28.

INSTITUTION OF ELECTRICAL ENGINEERS.—At the Institution of Civil Engineers, at 8 p.m., Mr. W. W. Wood on "Earthed *v.* Insulated Neutrals in Colliery Installations."

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Electrical Progress at Home & Abroad.

A Review by our Special Correspondents.

TYNESIDE.

NEWCASTLE-ON-TYNE.

In accordance with the policy of the Newcastle branch of the Institution of Mining Electrical Engineers, directed towards keeping the members in close touch during the summer months, a very interesting visit was paid on Saturday last to the Harton Colliery, which is perhaps one of the finest examples of up-to-date colliery electrical equipment in Great Britain. Upwards of 60 members were present, including the local secretary, Mr. Fisher; one of the vice-presidents, Mr. W. C. Mountain; and members belonging both to the mining and electrical sections of the Institution. After the electric winding plant, which has been previously described in THE ELECTRICAL ENGINEER, had been inspected, the sub-station equipment and the auxiliary machinery were visited, and such members as cared to go underground were shown the methods of electrical distribution adjacent to the shaft bottom. As the afternoon was a "pay" week-end, the men were not working, so that the party had an excellent opportunity of close examination of the plant. In pursuance of the same policy, a second visit will be paid on May 14 to the Carville power station of the Newcastle-upon-Tyne Electric Supply Co., Ltd.; while on June 11 an excursion, to which the ladies are also invited, will take place to Fountain's Abbey.

Signalling Gear for Mines.

As colliery engineers are becoming more used to electricity in mines, some dissatisfaction is felt at the old-time method of signalling the shaft-cages by striking a bell by means of a knocker actuated by wires running down to the various seams. Messrs. Gent & Co., Ltd., are introducing to the attention of colliery owners in this area an exceedingly ingenious and inexpensive electrical arrangement for the purpose. In the winding engine house is placed a dial on a projector frame, having upon it a series of shutters corresponding to the signalling points in the pit. There is also a scale having on it a pointer moving over a number of divisions by successive electrical impulses. Duplicates of this are installed at the signalling points. Bell signals work in conjunction with the device, and the position of the pointer corresponds with the number of times the bell is rung for any signal. When a signal is given and understood, the pointer is restored to zero by a foot press under the winder's chair. Arrangements are also provided to prevent signals being transmitted from any other station while one point is in communication. The system possesses the merits of simplicity and mechanical and electrical strength.

Extensions at the Newcastle General Post Office.

For some little time extensive building operations have been carried on in connection with an extension to the Newcastle-upon-Tyne General Post Office in Westgate-road, rendered necessary by the need for increased accommodation in the postal departments. In connection with this work, electricity is being utilised in the equipment of four electrically operated lifts, capable of raising loads of from 5 cwt. to 1 ton. Two of these lifts are to be operated at the high speed of 180 ft. per min. Three of them are to be controlled by means of the push-button method, while one is to be moved by means of switch mechanism in the car. The voltage of supply to the motors is 480 volts, while the pressure to be applied to the control is 240 volts. The lifts are to be used both for passenger and goods service, and are to be supplied by Messrs. A. & P. Steven, Ltd., of Glasgow, whose local agents are Messrs. F. O. Hunt & Co.

General Industrial Progress.

An influx of work has definitely set in which will have a good influence, among other things, upon the electrical industry. On Monday morning, the 18th inst., the British cruiser *Newcastle* left the Elswick yard prior to going upon her steam trails. She is 430 ft. long, 47 ft. broad, and has 4,800 tons displacement. Electricity has its uses on board. It is also reported that Messrs. Armstrong Whitworth are making rapid progress in the construction of the British battleship *Monarch*, which is probably to be launched at the end of the year. The British cruiser *Weymouth* is also under construction, together with the Brazilian battleship *Rio de Janeiro*, while the Brazilian scout *Bahia* left the Tyne on the 18th on her way to South America. As these boats pass out, there are indications that other work will follow this up. Messrs. Swan, Hunter & Wigham Richardson, Ltd., are building the Cunarder *Franconia* at their Wallsend yards, together with other boats, while in the annual report of Messrs. Armstrong Whitworth & Co., Ltd., it is mentioned that there are eight ships, of a total tonnage of 29,500, in hand at the Walker yard alone. There is, therefore, a brisker tone among electrical manufacturers and contractors in this area who are laying themselves out for marine requirements.

THE MIDLANDS.

BIRMINGHAM.

The new motors put down in connection with the pumping station of the Birmingham, Tame, and Rea District Drainage Board, at Bromford, and supplied by Crompton & Co., form an important addition to the plant, and are intended for dealing with storm water. There are two of them, and provision has been made for a third of the same size. When this is put in the pumping station will be the largest existing in connection with any sewage works, the total ultimate capacity being 100,000,000 gallons per day. The two large Crompton motors are each of 225 h.p., three-phase, 50 cycle, squirrel-cage, with a speed of 194 r.p.m. Each drives a directly coupled centrifugal pump, having a rated capacity of 15,000 gallons per min., and an actual capacity of 20,000 gallons. The pumps have been supplied by W. H. Allen, Son & Co., of Bedford, and are of the Conqueror type. The pumping station which was erected about four years ago, has also two Johnson & Phillips' motors, each directly coupled to an Allen's centrifugal pump. These are much smaller than the new motors, working at 2,000 volts and having each 55 brake h.p. Each of these pumps (which are used to deliver sewage to the filter-beds) will deliver 5,000 gallons per min. There is also a Johnson & Phillips' motor of 10 b.h.p., 720 r.p.m., working a small supplementary pump for clearing the well. There are, on different parts of the sewage farm, other motors, for the most part driving pumps, and representing an additional power of something like 300 h.p. As the sewage purification is now carried on entirely by spraying on to bacterial beds, and these are constantly in course of extension, it will be seen that the Drainage Board is one of the most important users of electrical power in the district. The current at the new pumping station is obtained chiefly from the Aston Corporation, but there is a considerable supply generated at the refuse destructor, which forms part of the equipment of the sewage works. The generators here are two British Thompson-Houston dynamos, each 115 kw., 2,200 volts, 3-phase, 50 cycle, 175 b.h.p. They are driven by Belliss & Morcom engines, and there are three Lancashire boilers heated, two by flues from the destructor, and one by coal. The station also contains a 225 volt, D.C. exciting set, driven by 9 h.p. engine.

Electrical Time Keeping.

The important part played by electricity in enabling the world's trains to keep time was dealt with in a lecture delivered by Mr. W. H. Whitehouse, M.I.E.E., on the 13th inst., at the Midland Institute. The subject of the lecture was "Standard or Railway Time throughout the World." The lecturer stated that in 1840, on the opening of the London and Birmingham Railway, the clocks at the various stations were set differently, so as to allow for the slight differences in the longitude, the maximum difference between Camden and Birmingham being 7 min. 15 sec. With the development of railways a uniform

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system of time became imperative throughout the country, and one based upon the longitude of Greenwich was adopted. For a small country like ours, whose greatest breadth from East to West is only about 7° of longitude (equal to 28 min. of time), this arrangement was quite satisfactory, but with a vast trans-Continental system of America and Canada, one universal time could not be used. When the Canadian Pacific Railway was constructed there were 75 different local times in use on the line. Mr. Sanford Fleming, the engineer of the line, proposed at the Geographical Congress of 1881 that the world should be divided into 24 time zones, each of 15° of longitude, and this was adopted, as far as America was concerned, in 1883. The North American continent is thus divided into five time zones, each differing by 1 hour, and the railway time tables are arranged accordingly. On the European railways before 1891 there were 24 different standards of time. These have now been reduced to three, while Australia, in 1895, adopted a time system based upon the meridian of Greenwich, and divided not into 15° of zones, but following approximately the territorial divisions.

Synchronising.

This standardisation of railway time necessitated synchronisation of clocks, which was only rendered possible by means of electricity. Mr. Whitehouse, in conclusion, described how the clocks of the United Kingdom are synchronised with the standard clock at Greenwich Observatory. This clock closes an electric circuit to the telegraph office in London every hour, thus enabling time signals to be sent to any office in the Metropolitan district at any hour of the day. For all the provincial offices the 10 a.m. signal is employed. At London, the wire from Greenwich is connected to a polarised relay. The tongue of this relay is normally in contact with the contact stud joined to the zinc end of the battery, the positive pole of the battery being connected to the opposite contact stud of the relay, and its centre connected to earth. There is also a time switch controlled by a clock, which at 9.58 moves the line wires leading to the provincial office from its ordinary instrument on to the relay on the Observatory circuit. This puts a negative current on to the line. At the down station a double bar switch is provided to put the "renters'" wire and the London office through from the test box to the time relay. When the switch is in the second position, the London wire only is put through the town relay, and on the receipt of the preliminary or negative current the switch is turned to its third position, putting the "renters'" wire in communication with the tongue of the relay and local battery, by which the signal is repeated to the "renter." As soon as the "renters'" current has gone out, the switch powers and the rest of the apparatus are turned back to their normal positions. Mr. Whitehouse also mentioned two very interesting installations of electrically-controlled clocks put in recently by the Synchronome Co., one at the new Birmingham University buildings at Bournbook and one at Messrs. Nettlefold's Works, Smethwick.

LANCASHIRE.

MANCHESTER.

There are indications of a considerable electrical development taking place in this area shortly. Manchester alone has recently decided to spend £40,000 on electrical plant, £10,000 being for motors for hiring out. This is necessary to meet the growing demand for power. Already there are some 6,000 kw. of motors in various branches of the textile industries on the mains, and almost every month sees some fresh large firm added. The supply to most of the large consumers is given at 6,600 volts, 50 cycles, three-phase, and is transformed down in sub-stations on the consumer's premises to L.T., D.C., or A.C., according to requirements. The same development is taking place in the small towns, a few of which, as Littleboro', are already advertising for tenders.

Growth at Ashton.

A Local Government Board inquiry has just been held here to consider the Corporation's application for sanction to borrow £48,400 for extensions to the borough electricity works.

As affording evidence of the rapid advance electric power is making in Lancashire, it is interesting to note that the application was made because of the fact that during the past two or three years applications for power, amounting to several thousand horse-power, had been made by local manufacturers, which the Corporation were unable to supply, owing to their plant not being large enough. Also in view of the monopoly held by the Corporation, and of the recent inquiry held in connection with another town in the district (brought about by a local company desiring to provide the necessary electric power—which it was alleged the Corporation there could not supply itself), the Corporation of Ashton now think it is highly desirable that their monopoly should not be jeopardised, and that their station should be enlarged so as to meet all the requirements of intending consumers. If other towns have, under the wise guidance of their grocer and baker councillors, been allowing loads amounting to several thousand kilowatts to go away refused, it is to be hoped they also will be frightened into action by the fear of some "grasping company" taking their monopoly from them. It looks as though a little less local monopoly and more company competition in the supply of electricity for power and other purposes might make a very great improvement in the home business of electrical manufacturers.

The Rochdale Report.

The year's working on the tramways has resulted in a loss of £367, as against last year's loss of £169. The results of the electricity department are extremely good, a profit of £5,178 having been made, as against £4,830 last year and £4,135 in 1908. Of this year's profits, £4,000 are being given to the rates; this makes over £16,000 thus turned over since the department started. The receipts were £22,116, or £1,789 more than last year, while the working expenses at £9,000 were about £60 less than last year. The capital expenditure was increased during the year by £1,470, and now stands at nearly £98,000.

SCOTLAND.

GLASGOW.

Outside of the large municipal undertakings supplying light and power, the two main lines of future development in connection with the electrical industry would seem to be (1) the formation of private supply companies obtaining a provisional order for a given area, putting down one or more central stations to generate electrical energy at high tension, and distributing the same to transforming sub-stations dotted at intervals over the area; (2) the other main direction of growth is the utilisation of water power or steam plant by private concerns for the lighting of their own works and the residences in connection therewith. In a Fife village, for instance, a firm of flax spinners have some half a dozen large mills abutting upon the river Leven. The firm also own the whole of the workpeople's houses in that end of the village in which their mills are situated. There is a considerable mansion with policies attached, and a series of cottages for the management. By putting down a water turbine of some 400 h.p., they are generating continuous current at 210 volts, with three dynamos, by Holmes & Co., of Newcastle. There is an accumulator of 55 amp. hours capacity, and the lamps are of Tantalum and Ediswan type, the c.p. being 10, 25, 30, and 50, according to the situation of the lamps. Besides the mills, the firm have lit about half a mile of street, and the mansion house and residences of the management referred to. So far, none of the energy is being used for power purposes, but it is expected that this will come in time. The whole work was carried out by a well-known firm of electrical contractors in Dundee.

In the same village there are three large paper mills, one of them among the largest in Scotland; it has been lit throughout with electricity for a number of years, and no doubt the other mills will follow suit. Altogether, Fifeshire, with its large coal field and the paper-making and linen manufacturing industries just referred to, should offer a promising field for the energetic electrical contractor for a considerable time to come.

Coming Exhibitions.

Preparations are now rapidly going forward for two exhibitions, both electrically of the first importance, but otherwise very dissimilar in scope and general significance. The one is the outcome of the agitation against the

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smoke problem a month or two ago, and is to be an exhibition of appliances for lighting, heating, and cooking purposes, the devices to be shown utilising all the known means of smokeless heat. This exhibition will be under the ægis of the Glasgow Corporation, and will last for one month from about the middle of September. Glasgow is wanting in suitable premises for such a show as this, but it has been decided to rent a Roller Skating Rink in Victoria Road, South Side, Glasgow, which has an area of 34,000 sq. ft., for the sum of £100 per week. The other exhibition is the Scottish Exhibition of National History, Art, and Industry of 1911, and is, of course, a very much more ambitious affair. It will take in a larger ground area than the Edinburgh Exhibition of two years ago, and will include a large variety of both electrical and mechanical exhibits. The ceremony of "cutting the first sod" is to be performed by the Most Hon. the Marquis of Tullibardine, on April 22. This exhibition will, of course, run during the whole of the summer months of 1911. One is glad to hear that it is to contain a minimum of stalls of the Oriental bazaar order, for the sale of tinsel and useless trinkets!

Britain and Foreign Competition.

In these pessimistic days, when so much is heard of Britain going to the dogs, so far as her place in the world markets is concerned, it is, indeed, refreshing to find a prominent Scotch electrical engineer speaking hopefully, not only of the future, but of the present, with regard to the possibilities and prospects of the British electrical industry. Mr. H. A. Mavor, of the firm of Messrs. Mavor & Coulson, Ltd., Glasgow (who have done so much splendid pioneering work in connection with electrical development), contributes a most encouraging review of the electrical industry to the columns of the *Glasgow Herald* of April 12. In the early days, he says, owing to the combined effects of restrictive legislation and the detrimental influence of municipal authority on enterprise, the British manufacturer had to laggardly follow in the footsteps of the foreigner, but in recent years, notwithstanding the general depression in trade, the home business has shown a tendency to put the British manufacturer once more in a position to deal in the world's markets. Thanks to the cheap supply of electricity available in the principal industrial centres, the British manufacturer is now able to deal with our native requirements, and to roll back the tide of foreign invasion not only at home, but also in the Colonies. The steam turbine has contributed largely to this more satisfactory condition. "There is now no need to go abroad as Glasgow did for its tramways steam equipment. The American plant which played so conspicuous a part in the original equipment is now obsolete, and the new work is all home-made. A few steam turbines are still being imported from Germany, but the day of the German electrical engineer in Britain is nearly closed for the present, and there is now practically no importation of American electrical plant. . . . There is no question of the superiority of the British manufacture, and no difficulty in getting a preference for it when the buyer has a free hand." Recent experience in various parts of Scotland echoes an emphatic confirmation of these concluding words!

The Smaller Corporations.

At least four of the smaller local authorities in Scotland are at present contemplating considerable extensions to their plant and mains, chiefly with a view to meeting increased demands for power supplies to industrial users. Details will come to hand in due course, but, meantime, it is interesting to note that private firms are generally coming to the conclusion that it is more economical to take supply from the local central station than to generate with their own plant.

Town Council Vagaries.

As announced in these columns at the time, the Glasgow Corporation decided about the end of last year that in future all Committees placing contracts should give a preference to British goods. A little later it was also decided that the Corporation's fair wages clause should apply to Continental labour in the event of an order being placed abroad. The latter resolution stands, but last week the decision with regard to the preferential treatment of the British manufacturer was rescinded. After all, where is the need for such a resolution at all: if the Glasgow Corporation invite tenders, and offers come in from foreign makers, they needn't place the orders abroad if they do not want to.

GERMANY.

BERLIN.

Quite recently the large wireless station at Nauen, near Berlin, has maintained communication with a steamer of the Woermann Line during the whole of its journey from Hamburg to West Africa, and to continue to exchange messages with it after it had come to anchor at the Cameroons. From thence to Nauen the wireless distance is roughly 4,000 miles, and the waves had to negotiate such obstacles as the Alps, the Algerian tableland, and the mountains of Adamana. This is by far the best over-sea and land record yet made.

Electric Membrane Sirens.

These sirens serve as substitutes for continuous current alarms, and render most useful service in private dwellings, business offices, hotels, hospitals, etc., in fact, wherever the clatter of ordinary electric bells is undesirable for any reason, or when an identifying sound is required. The new siren is put on the market by the C. Lorenz A.G., of Berlin. All parts are enclosed in a cast-iron case in which the membrane is stretched horizontally. A pointer bearing on the membrane puts it into communication with an electromagnetic apparatus, provided with the usual adjustable interrupters with platinum contacts. When the armature is attracted a contact spring is set in action, which in a state of rest forms the circuit, so that the attraction causes the membrane to vibrate at a rate proportional to the frequency of interruption. The sound produced is carried into the air through a horn attached to the case. Means are provided whereby the apparatus can be connected with the usual wall-studs for connecting up electric lamps.

Company Notices.

The ninth annual report of the Felten & Guilleaume Aktien Gesellschaft congratulates the shareholders on the fact that the turnover was not less than for the previous year, but although the gross profit rose from 3,316,214k to 3,669,031k, the net profit fell from 2,283,405k to 2,257,431k. The dividend will, however, be maintained at 15%. The prospects for the current year are rather uncertain, especially as regards Government contracts, but there is no reason for any anxiety.

The Aktiengesselschaft Elektrizitatswerk Lebring proposes to increase its capital by six million kronen (say, £275,000) in 4½% shares. The directors wish to purchase the Elektrizitatswerk Peggau, at present the property of Albert Buss & Co., of Basel & Graz. It is proposed to re-name the combination Vereinigte Elektrizitatswerke A.G. The new undertaking, if completed, will be one of the largest concerns in the Alpine district for supplying both light and power. It will have 100,000 h.p. at its disposal, derived solely from water.

The Elektrochemische Werke G.m.b.H., Berlin and Bitterfeld, is paying a 10% dividend for 1909-10, as against 9% for the year before. The net profit was 1,232,464 marks.

According to the Deutsche Export Revue, the platinum firms in the Ural have combined with the French firm Bonardelle to form a company to exploit the Tagilsk mines. The capital is to be 600,000 rubles, and the price of the metal is to be fixed at 28,000 rubles per pood. We also hear that at a congress of gold-traders recently held at Ekaterinburg, the question of platinum monopoly was again raised.

UNITED STATES.

NEW YORK.

An extremely valuable paper on the diseases of boilers, which was read recently at a meeting of the New England Association of Electric Lighting Engineers, by Mr. F. S. Allen, is the subject of warm encomiums in the technical journals. The *Engineering Record* declares it to be probably the most authoritative statement that has yet appeared on this subject, and this verdict would seem to be general. Mr. Allen's text is that boilers are heirs to nearly as many diseases as the human family, and he analyses their common

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defects and discusses the remedies. One fertile source of trouble of late years is defective bolts, which, though apparently of good quality, are often found to be so lacking in ductility that though in some cases an inch in diameter, a blow from a boiler inspector's light hammer was found sufficient to snap them off. Here the remedy, of course, is to use only bolts that are forged from the best quality of Swedish iron, which are not subject to intermittent variations of stress. But defects arise from such a variety of causes it is not easy to tabulate them. In earlier days, when all boilers were made from iron plate, there were far fewer failures, and this was due in the first place to the fact that it was impossible to use large plates, and secondly to the circumstance that iron is less susceptible than steel to lap-joint crack. A defect in riveted joints can easily be produced by neglect in adapting the hydraulic pressure in riveting to the nature of the joint. Then again, fatigue of metal, under the influence of stress and temperature, is a source of failure, and there is often found evidence of profound alteration in the structure of the material in boiler tubes, due to the fact that the skelp from which the tubes were made was of inferior quality.

Incrustation, Scale, and Temperature.

Mr. Allen urges that another cause of rapid deterioration and loss of efficiency in boilers is the formation of incrustation and scale, to which water-tube boilers are peculiarly sensitive, as their tubes are liable to become overheated, and the thin material of which they are made then becomes subject to distortion, where the relatively heavy plates of a boiler shell would remain comparatively unaffected. He cites a case where several tubes ruptured in one of the largest and best-equipped electric plants in the United States, and overheating of the lower tubes was noted in all the boilers. Tests showed the rapid deterioration to be due to the feed water and when a change was made in the water supply there was no further trouble. In this connection Mr. Allen notes the curious fact that structural changes never take place at the bottom of the tube, but always " at about eight o'clock in the circle of the tube." Then again, the increase of temperature attendant upon the use of higher pressures has brought about new developments in connection with the formation of scale, and this is especially true in the fire-box type of upright boilers. There is little space, in these boilers, for the deposit of scale upon the tube sheets directly over the fire, and in view of the large amount of heating surface and the normal evaporation, the formation of scale must be very rapid upon the tube sheet, especially when the feed water is at all brackish. Mr. Allen gives two very remarkable instances of this. In both cases the boilers were nearly new, and were of good construction, and working under proper factors of safety. In one of the cases the trouble occurred in a battery of very large boilers of this upright type, operating at a pressure of 170 pounds per square inch; the owners in this case, having a large number of boilers of the same type operating at 125 pounds. There had never been trouble from scale, although in the older boilers, operated at 125 pounds, there was a considerable deposit of mud, which was readily removed by periodical washings. No trouble from leakage had been experienced from this sediment at any time, in any of the boilers of this plant, until the new high-pressure boilers were installed for electric power; and the plant was thoroughly modern and up-to-date, and everything of the best construction. An examination of the high-pressure boilers, after the leakage around the tube ends had developed, showed a thin, hard coating of sulphate of lime over the whole tube sheet. The second case was similar, but the plant was many miles away, and used an entirely different water. Nevertheless, the same kind of action took place in the boilers that were operated at 160 pounds, although boilers in the same room had been operated on the same water, with entire success, for twelve years, at 125 pounds. The explanation is that the difference between the temperature, due to 125 pounds pressure, and that due to 160 pounds, was sufficient to cause the precipitation, in each case, of a small quantity of sulphate of lime, which, at the lower temperature, had remained either in solution, or in suspension with the mud that had been washed out so readily.

Oil Troubles and Corrosion.

Lubricating oil is another frequent source of injury where the water of condensation is recovered from the exhaust steam, and used over again in the boilers. Separators are put in, having a nominal capacity based upon the area of the exhaust pipes, without reference to the volume of steam that these exhaust pipes are to carry. This, says Mr. Allen, is a grave error, in many cases. Separators have capacity, as well as other machinery; and in installing an oil separator, care should be taken to ensure for it a capacity sufficient to handle the full volume of steam passing through it. There also seems to be much difficulty experienced in removing oil from boilers, when it has once effected an entrance. This can be done readily, in some types of boilers, by swabbing the sheets and tubes with a mop dipped in kerosene oil; but where the boilers are inaccessible for mopping, they can be boiled out with a strong solution of soda ash (or caustic soda, if the soda ash does not prove effective), with a generous addition of kerosene oil, the pressure being maintained at half or two-thirds of the regular working pressure for from 12 to to 20 hours. After this treatment the oil can usually be washed out in the form of a curd. Corrosion, another boiler disease, is not so common to-day as formerly, but it still is an active enemy of steam boilers. Where the water is pure and the boilers are operated intermittently, corrosion is frequently found in the form of pitting. This action takes place very often in pumping stations, and in power plants and electric stations where the fires are kept banked for long periods, with the water in the boilers quiescent, and far less often in boilers that are always in active service. Boilers that are used exclusively for heating purposes suffer more than any others from pitting. Once started, corrosion is likely to go on until the material of the boiler is destroyed, unless measures are taken to check it. When corrosion is observed in connection with the use of a pure water, one of the best methods of treatment is to keep the water alkaline with soda ash, for this tends to check the corrosive action, and the soda does not injure the boiler. Nitrates in the water should be especially avoided, as they are especially troublesome and dangerous. The presence of nitrates commonly results in the formation of a light scale coating, under which an active destruction of the material of the boiler goes on, the plates and tubes becoming wasted away, and the braces and rivet heads cut off.

The Deceptive Staybolt.

In certain types of boilers the breakage of staybolts is a frequent and annoying, as well as expensive occurrence. Such bolts are often drilled with a three-sixteenths-inch hole, which either passes through the entire length of the bolt, or at least goes in deeper than the thickness of the outside sheet; and such holes are supposed to give absolute safety, so far as the detection of broken bolts is concerned, the theory being that steam will escape from the end of the bolt as soon as fracture has occurred, and thereby call attention to the trouble. The drilled hole is not to be relied upon, however, because, in the process by which the staybolt fails, the fracture will creep into the bolt slowly, and when it first encounters the hole, moisture from the boiler will leak out through it in very slight quantities, and evaporate without attracting any attention. In evaporating, however, the moisture leaves behind it a certain amount of solid matter, and this accumulates until it forms a hard, baked residue, completely choking the opening in the centre of the bolt, so that the apparent absence of leakage leads to a sense of security which is far from corresponding to the actual facts.

Careless Operation and Superheated Steam.

Numerous minor diseases of boilers, Mr. Allen points out, such as rapid losses of ductility and development of incipient fractures, may be due to the varying level of the water, to the introduction of cold feed water, or to blowing down the boiler under high pressure and leaving the drafts on, so that cold air may be drawn through and give rise to unequal contraction, or to pushing the fires too hard in raising steam from cold water. Strains are also frequently caused by the burning out of the fire under one boiler of a battery, while this boiler is left connected with the rest of the battery, and with the draft full on. Referring to the action of superheated steam, Mr. Allen observes that when superheating is done in connection with steam generators, the elasticity and strength of the

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material are affected if a high temperature is produced, and he gives it as the result of his own experience that cast-iron is an unsuitable material to use for exposure to superheated steam of high temperature. He instances the case of some extra heavy valves of the best make, with cast-iron bodies, which, when exposed to superheated steam at high temperature, became badly checked and marked, so that the whole body of the casting had an appearance suggestive of the crazy cracking observed on imperfect crockery. These valves were replaced by others in which soft steel castings of the best quality were used in the place of the cast-iron, and the new ones have thus far shown no defects. Fittings or manifolds of cast-iron, connecting superheaters with the generator, should not be endorsed or approved for superheating to 100° or over. In fact, cast-iron for such purposes has already been abandoned in the best practice, forged or wrought iron being substituted for it.

Phenomena of Commutation.

To the history of the complex phenomena of commutation, Mr. F. W. Carter makes a striking contribution in the form of a paper published in the current issue of the *Electrical World*. He points out that one of the difficulties in the scientific discussion of this subject arises from the uncertain nature of the contact between the brush and the commutator. Oscillograph records of the difference of potential between these show it to be continually varying. This is doubtless due to the agitation of the brush, and it is probable that a thin layer of air is continually present between the brush and the commutator, dragged in by the movement of the commutator, so that the current passes between them as by a very short arc. This view, he says, is confirmed by the ordinary measurements of contact resistance which really give the mean value of a very variable quantity. The impossibility of keeping the agitation quite uniform accounts for the wide discrepancy of results obtained under apparently similar conditions, but the general nature of the variation of contact resistance with current density is consistent with this supposition, and he assumes therefore that the difference of potential between brush aud commutator at any instant is a linear function of the current density—*i.e.*, made up of a constant term depending on the direction of the current and a term proportional to the current density. His conclusion is that the durtiona of the short-circuit of each coil under the brush must exceed the effective time constant of the coil, namely, the ratio of the inductance of the coil to the effective resistance of the brush contact with the separating segment. If the time of commutation is less than this time constant, the current density tends to rise indefinitely in the tip of the brush, with a spark, at rupture, as the result. If the time of commutation is greater than this time constant, the current density in the tip will have a chance to drop to zero.

A Plea for Vacuum Cleaners.

In the course of an interesting article on modern electrical developments, the *Electrical Review* of Chicago observes that the introduction of vacuum cleaning within the lasts few year is bringing about a most desirable sanitary reform in domestic economy, to which the attention of electrical men in general and of the central-station managers in particular might well be directed in view of the approach of spring house-cleaning time. Electricity is now making the vacuum cleaner a household necessity just as it has recently made the electric flat-iron indispensable. The electric vacuum cleaner has even more points in its favour than the electric flat-iron, for it not only adds to the comfort of housework, but it greatly diminishes its cost as well as the wear and tear on the furnishings, while above all it promotes the health of the entire household. The last point alone should be regarded as so important as to induce the general use of vacuum cleaners in even the most moderate homes and the ability to use them should be an added reason for having every home wired and connected for electric service. To aid in the more rapid introduction of vacuum cleaners in our homes, central stations can adopt plans similar to those that proved so effective in the introduction of the electric flat-iron. The payments for the outfit itself can be extended over one or even two years and added to the monthly bills, as is done so successfully by gas companies in selling gas stoves and ranges. To reduce the initial cost still further a number of neighbours can club together to purchase a vacuum cleaner in common that can be used on stated days in each home. A central-station company can even do a good business by loaning its vacuum cleaners to its patrons at a moderate sum per day. The owner of an apartment building can well afford to have a vacuum cleaner to lend to his tenants on different days under the guidance of his janitor. As a matter of fact this is now an admitted feature of several new apartments in Chicago.

The Edison Storage Battery.

The trials of the Edison-Beach storage battery car in this city have proved so successful that sixteen new cars have been ordered and will be put on the cross-town section as soon as they can be completed. There has been a good deal of alleged humour expended over Mr. Edison and his storage battery during the last ten or twelve years, but the triumphant emergence of the Beach car from the tests to which it has been subjected by hard-headed business men is a very effective reply to the light-hearted critics. It is interesting to note, by the way, in this connection, that the promoters of the proposed Springfield & Carthage Electric Railway are investigating the Edison storage battery car in view of installing this class of cars on the line from Carthage to Springfield. When completed this line will be as long as any inter-urban line in Missouri and will touch the richest farming and mining land in the state. At present Carthage is connected by an electric railway with Girard and Pittsburg, Kansas, a distance of 75 miles, and when the new line is completed it will connect Springfield with Girard, a distance of 125 miles. The construction work will begin as soon as the weather will permit.

CATALOGUES AND PRICE LISTS.

The British Aluminium Co., Ltd., have issued an illustrated four-paged leaflet dealing with "Methods of Jointing Aluminium Busbars, Machine and Feeder Connections." A table of standard busbar sections is also given.

A well-printed circular, giving details of the 100 c.p. "Onewatt" lamp for D.C. and A.C., has been printed, and Messrs. Siemens Bros. Dynamo Works are prepared to supply these with dealers names and addresses.

Messrs. Ernest F. Moy, Ltd. List No. 18 deals with switches of various designs.

Section VI. of the Wilson-Wolf Engineering Co., Ltd., Bradford, gives illustrations and particulars of the "Arctic" propellor ventilating fans for direct current.

Messrs. Venner & Co., send us an illustrated price list of their Time switches, for combined arc and incandescent street lighting, etc. Large diagrams enable the working of the appliances to be easily grasped.

A 16-paged pamphlet on Dry Cells, Dry Cell Batteries, Transport Cells, and Ignition coils has been issued by Messrs. Siemens Bros. & Co., Ltd.

"The Modern Method of Driving Machinery" (by "Eoa" electric motors) is a handsomely got-up pamphlet issued by the Electric & Ordnance Accessories Co., Ltd., of Birmingham.

FINANCIAL NOTES.

The directors of the Monte Video Telephone Co. have declared interim dividends for the half-year ended January 31 last at the rate of 5% per annum on the Preference shares, and 6% per annum on the Ordinary shares.

It is announced that the coupon falling due the 1st prox. on the 5% Prior Lien Bonds of the Underground Electric Railways Co. of London will be paid on and after the 2nd prox. in London at the London County and Westminster Bank.

An interim dividend of 4% is announced on the deferred Ordinary stock of the British Columbia Electric Railway Co., Ltd., for the half-year ended December 31 last.

The British Electric Traction announce that the receipts of all the associated companies for the week ended April 8, £28,926. Upon such of the lines as were working both last year and this year the receipts show a decrease of £3,060 upon the week.

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ELECTRIC DRIVE IN TEXTILE MILLS.*

By ALBERT MILMOW.

It is the purpose of this paper to deal especially with the employment of electric power, derived from hydro-electric systems of distribution, for the operation of textile mills. It is impossible in a paper of this kind to go very fully into detail, and no attempt will be made to discuss the forms of drives, kind of motors or, in fact, any other technical details, since any one of the more important ones would require a special paper to do it justice.

This paper aims to treat the subject from a broad, general viewpoint, with particular reference to its commercial aspects, and especially in comparison with the old forms of steam drive.

The general branches of the subject which will be taken up are first cost, cost of operation, production as affected by balancing and speed, and general remarks.

First Cost.

The references which follow will be to new mills especially equipped for electric drive, insofar as first cost is considered, and not to mills already equipped with steam power. The figures are based on a plant of 25,000 spindles on moderately fine work, which requires a power equipment of about 1,000 h.p. The figures which follow are for everything included in a mill that is chargeable to the power plant :

Electric Drive.

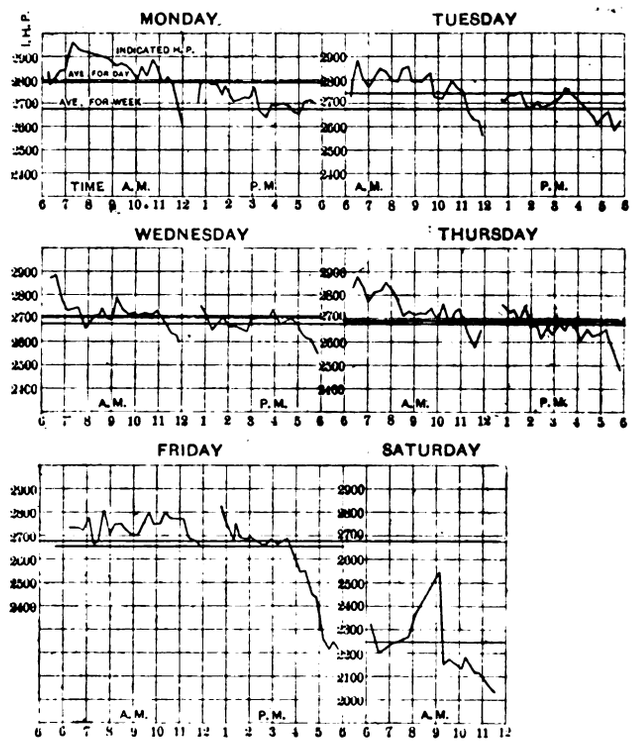
Group drive throughout, all 2,300 volt motors. Power delivered at 2,300 volts.	£
Transformer house and switchboard room ..	200
Belting	260
Motor support	80
Shafting	1,600
Boilers	240
Boiler setting	70
Boiler room	330
Reservoir	360
Piping	180
Motors	2,112
Transformers for low voltage motors, 2 to 5 kw.	252
Transformers for lighting, 1 to 50 kw. ..	766
Switches for motors	60
Switchboard	300
Wiring and installation, including lighting ..	800
Freight on electrical apparatus	66
	£7,636

Mechanical Drive.

	£
Boiler room, Engine room, Chimney	3,200
Engine, 24-rope wheel, compound	3,500
Engine foundation	400
Boilers	1,200
Boiler setting	360
Smoke breeching	152
Condenser, pumps and heaters	504
Reservoir and crib	1,300
Steam power piping	1,200
Ropeway and extra sprinklers	400
Shafting and structural steel work	2,410
Rope	120
Belting, main drive and counters	260
Lighting generator, belted, and switchboard	200
Marine engine generator, 10 kw., and switchboard	200
Lighting wiring, 2-wire system	400
Total	£15,806

From the table it will be seen that the total cost of the power plant for steam drive would be £15 16s. per h.p., while the cost for a similar electric equipment is £6 15s. 2d. per h.p., or a saving of £9 0s. 1d. per h.p. of plant capacity where the electric drive is used.

It is to be noted that all costs are included in these estimates, though it is quite usual for advocates of steam drive to take for its first cost only the costs of engines, boilers, piping, etc., neglecting such important items as building chimneys, belt-ways, condenser reservoirs and other items which are essential to steam drive, but which are not required where a mill is electrically driven. This difference in cost should enter into the cost of power, taking the interest and depreciation at 12%, the lowest possible figure. However, it is obvious that if this same amount of money were expended in producing textile machinery, the earnings would certainly exceed the 6% included in this figure as an interest charge.



Cost of Operation.

The cost of steam power in a textile mill is very difficult to determine. Fig. 1 shows a series of engine indications made for a period of one week, at 10 minute intervals. It will be noted that a very wide variation of power is shown, and only a very thorough and detailed set of indications, as shown here, will give a fair average of the amount of power.

It is customary with advocates of steam drive to make certain large deductions in a purely arbitrary manner from the total cost, for the values of steam used in processes of manufacture other than for power, such as dye-house operation, heating and slashing, and then to divide the remainder by a factor obtained by taking one or more engine indications.

It will be seen from Fig. 1 that it is obviously erroneous to take any value for the total horse power of a mill other than an average taken approximately as shown ; even this, to obtain perfectly accurate results, should extend over a long period, embracing all the seasons of the year, as there are many variable quantities involved, such as the temperature of the mill, which varies with the seasons, the humidity of the air, and even the nature of the cotton staple.

These factors cause an extreme variation of power during say, a year's period of as much as 20%, and this variation is very noticeable in a day's or a week's run, as will be seen by the variations of power as shown in Fig. 1 on that part of the curve corresponding to Monday.

On account of using the same boilers for power and for other purposes, it is difficult to obtain accurate figures on the cost of dye-house, heating, and slasher operation in a steam-driven mill. Where boilers are used for making tests, it is usual to use a large power boiler, which runs in an under-loaded condition and hence inefficiently, and the steam is often carried in long systems of piping before it is utilised. In electrically driven mills it has been possible to segregate these costs. The cost of heating a 10,000 spindle mill is, for the climate of the Piedmont region, about £50 per year,

* Abstract of paper presented at the Charlotte meeting of the American Institute of Electrical Engineers, April.

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and as this size mill will use about 500 h.p., the cost of heating may be taken to be 2s. per h.p. per year. This figure is for a boiler of just sufficient capacity for the work. Similarly, the cost of slashing is found to be 5s. 2d. per h.p. per year, or a total of 7s. 2d. per h.p. per year for heating and slashing. Of course, this figure varies with the class of work, but it applies to work using an average of about No. 30 yarn. The figure commonly taken in estimating steam horse power cost is about 16s. per h.p. per year, which is entirely too high. For these reasons it is very difficult to determine any accurate cost of the steam power on the horse power-year basis.

In dealing with about 70 mills electrically driven, many of which have been converted from steam to electric drive, it is found that no two present identical conditions, and even when a mill is changed to electric drive, the opportunity of improving speeds, etc., is usually taken advantage of, and the mill is generally reorganised to an extent that precludes the possibility of a direct comparison.

It has been found, however, that where the machinery in a converted mill has been kept intact and the speed kept constant, and where accurate records of engine indications prior to the change have been kept (which is rarely done) a saving in the power required is effected, though most mills when making this change take the opportunity afforded of improving production in one or more ways and thus increase the power required. The manner of operating a mill is also important in determining the amount of power required. Some mill men force production to the highest point, while others are content to run at moderate speeds and production.

The varying cost of fuel, the quantity and varying temperature of condenser water, and the difficulty of obtaining accurate data, make it impossible to arrive at any accurate conclusion regarding an average cost of steam-generated power in textile mills.

In electrically-driven mills the absolute horse-power-hours and the indicated power can be determined at any time. An opportunity is given to check wastes and correct them, and a considerable amount of non-productive power is saved by the elimination of useless shafting.

Assuming the price of electricity to be £5 per h.p. per year for 11 hours per day, 306 days per year, and assuming a saving at equal production of 15% in power, which I consider conservative, the cost at which steam power must be generated to equal the price of electric power will be £4 5s. From this must be deducted the fixed charges on the difference in first cost, which we may take at 12% on £9, or £1 0s. 4d. per h.p. per year, leaving £3 0s. 8½d., plus 7s. 2d., which will be required for the heating and slashing operations of the mill, or a total of £3 11s. as the figure at which steam power must be generated to be equal in cost to electric power at £5 per h.p.; and in this figure there must be included the cost of all oil, waste, labour, fuel, ash removal, coal handling, superintendence, and, most important of all, the item of repairs, which is frequently omitted entirely in making estimates of steam power cost. If it were possible to attain this figure with a steam drive, a power only very inferior to electric drive would then have been obtained.

Production.

Hydro-electric power offers many advantages in operation, due to the readiness with which parts of a mill may be run so that the maximum possible output may be obtained. By reference to Fig. 1 it will be noted that a wide variation of power is shown, due, among other things, to the fact that it is unnecessary to run all of the departments all of the time.

In a mill which has perfect balance, each piece of machinery used in each process will deliver to the next succeeding department just the right amount of material to keep both sets of machinery operating at full output all the time, and so on until the completed article of manufacture is produced. This is a condition difficult to realise, as in actual service it is found that market conditions in nearly every case make change of product necessary, and in a mill which can be designed for only a limited range of work, any variation from this affects all the preparatory departments by giving them more work for coarser product or less for finer product.

In mills which are used exclusively for spinning, and which do no weaving, a part of the product is in the form of twisted yarns and part of it in single yarns; hence the twister department, which uses a great deal of power, is often called upon to its full extent and again is often entirely idle.

In equipping a mill for electric drive it is usual and proper to provide one or more motors for each process of the work so that in case the demand on that department is increased, it is possible to work over time on that particular department, where, on account of the inefficiency of the engine at light loads and often because of the very small part of its capacity that is required, it would be impossible to run with a steam drive; or, if some department, such as the twisters, is not needed at all, the motor provided for it can be shut down entirely, saving all expense of its operation without affecting the operation of any other department or in any way affecting its speed.

These points are actually taken advantage of and practised to a very great extent. In mills using automatic looms they are frequently left in operation at the noon hour, when they will run until some threads break, when the loom automatically stops itself and remains stopped until the weaver returns. Many of them continue in operation without interruption. In some cases looms are left in operation after shutting down time until the loom stops itself, which often does not occur until all the filling yarn is exhausted. These hours in the aggregate sum up a very respectable total in the course of the year.

The textile industry in the south is at a growing stage and few if any mills are left complete as first installed, especially among the larger mills. It is almost the usual thing to see a mill with one of its ends boarded up instead of closed with brick, thus proclaiming to the world the intention of its owners to extend it as soon as they can. In the days before electric power was available this necessitated a steam plant entirely too large for the first installation, so a plan was resorted to of installing one-half of an engine and operating this as a simple engine, with the ultimate intention of adding a cylinder for compounding when the mill should be increased. This arrangement necessitated the investment of a great deal of money in a steam plant to begin with, which to-day can be put into the manufacture of cotton goods, and resulted in very high costs for power when using only a simple engine. These conditions have too often proved a handicap which has prevented the mill men from realising their hopes as soon as they might have done. With electric drive the system is perfectly flexible. Only the investment for the work actually installed is demanded at the outset, and the full output and efficiency are secured from the beginning.

An interesting application illustrating the flexibility of electric drive has recently been made and is being quite generally followed. In this case a mill was built with a capital of £20,000 and with an equipment of 5,000 spindles for the production of yarns. It was the intention to operate this mill day and night and the promotion of the mill was based on this idea. It was found, however, that for the spinning frames, which require women and girls to operate them, sufficiently satisfactory labour could not be obtained to operate during the night run, so that the management found itself in a position of being able to offer to its stockholders a production based only on the actual money employed, or £20,000. Through their own initiative they then took advantage of the opportunity offered by electric drive and added to their equipment an amount of spinning machinery equal to that already installed. This operated with the rest of the equipment during the day time, and all preparatory machinery, for which only men are employed, is operated day and night, thus giving material to the double number of spinning frames during the day. This resulted in a production equal to that of a mill of 10,000 spindles costing £40,000, while the total cost of the mill was only £24,000. The addition of the extra spinning machinery cost £4,000, and the original cost of the mill was £20,000. This arrangement has, simply by the proper use of electric power, saved the mill an additional burden of investment of £16,000, the interest and also the depreciation on which would more than eliminate the entire power bill.

The old idea of building a mill amounted essentially to first building a steam plant and then building the mill to

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conform to it, as its shape and the arrangement of the machinery had to conform to the most convenient ways of running shafting. In an electrically driven mill the matter of power is secondary. The machinery is placed in the most convenient way for operation as a textile plant and the motors are installed afterwards.

It has been found that in practically every mill that has been converted from mechanical to electric drive, an increase in production has been obtained. This is almost always the case and it is not usually taken account of by investigators of power costs. Among the uninformed there is a quite general opinion that the converted mill takes to operate it electrically as much as or more power than it previously did with steam. On account of the increased production with the electric drive this is true in a great many cases; but in many other cases it is uncertain, as no accurate records of steam indications have been taken or kept. The explanation of this increase in power is simply that the production has been increased. At the time the motors are installed the speeds of the mill are readjusted and nearly always increased, the power is applied more directly to the work with less chance of slippage of belts and, above all, the speed with motor drive is much more constant.

In the territory of the larger hydro-electric systems the total number of mills operated consume a large amount of power. Each mill comprised in the group uses a relatively small proportion of the power furnished by the system. It is, therefore, possible to throw off or on many motors, or, indeed, many of the entire mills without disturbing the speed of the system. This is not the case in a mechanically driven mill, where even a small part of the machinery represents a good percentage of the total load of the engine.

In a converted mill, driven from a hydro-electric station, one of two results are always brought about. If the original production is maintained the amount of power necessary is reduced. This should not in all cases be regarded as of paramount importance, the most vital advantage being an increased product from the mill, which it has been shown can be obtained through electric drive. This has actually been obtained in nearly every case that has come under my observation.

In mills only very roughly converted, where surplus power is taken, and where the old uneconomical arrangement is left intact so that the steam drive may be used when the electric power is temporarily shut off, all carefully kept records show that an increase of production of from 2 to 10% is obtained. In new mills especially constructed for electric drive the higher of these figures should obtain. This increase is brought about by two things. First, proper balancing of the work, and next, the application of motive power directly to the work it is to drive, and the fact that this motive power has a constant speed value, both instantaneously and continuously.

The importance of production may be shown in a broad, general way as follows: The value of a mill's product per annum is about equal to its capital stock. The cost of manufacture, with many variations for the class of work, may be taken proportionately about as follows:

Cotton, 60%; power, 4%; all other costs, 36%, and the power cost, as a total is from 3 to 6% of the total market value of the product. Thus, assuming the cost of a 5,000 spindle mill as £20,000, its product in a year will be worth, roughly, £20,000, and its power bills say £1,000. If the product of this mill could be increased 10% the gross value of this increase of product would be £2,000, of which the only cost would be cotton and power and some labour. The most costly operations of labour are paid by the day and effect no increase.

Allowing, however, for some increased labour cost we have as the total cost of this extra production:

Cotton, 60%; power, 4%; and labour, 3%, or a total of 67% and a net profit of £660 per year, or two-thirds of the total cost of the power, thus nearly eliminating the power bill. On account of the steadiness of the speed of the electric drive the machinery will suffer less deterioration than if run at even lower speeds with the steam drive.

It is very proper and very necessary to take all of these points into account as having a direct bearing on the cost of steam power.

General Remarks.

In hydro-electric systems of distribution to cotton mills it is found to be impracticable to place a sub-station for each consumer, especially to meet the conditions which we have in Piedmont Carolina, where several mills of small or moderate size are installed in one town. This is on account of the large first cost of a sub-station reducing from 100,000 volts, and also on account of the difficulty of running the high-tension mains through cities and towns. On account of the high cost of transmitting low secondary voltage any distance, both as to initial investment and in power loss, it was found necessary to adopt 2,200 volt motors in mills where the general practice had been to use motors of 550, 400 and even as low as 220 volts.

At first considerable prejudice existed among the mill owners and the underwriters against the use of high voltage motors, but some years of experience have demonstrated their superiority in every way. The first cost is about equal to that of the lower voltage motors. Their efficiency is equal and the slip is also equal or somewhat less. With an equipment of 2,200 volt motors power can be transmitted with an economical loss and reasonable first cost to a distance of approximately one and one-half miles from the central sub-station.

In many of the older low voltage installations, for the sake of economy, open wire is run in the mill. The cost of installing it in conduit would be excessive on account of its size. And also on account of the size of the wires, and the very extensive system of feeders, it is only a matter of time until open wiring becomes disarranged, due to its being swept to remove the lint and dirt which it accumulates. Another serious feature of this system is the frequent and necessary employment of fuses to protect smaller branches.

Probably 90% of the motors burned out in the mills under my charge have been burned out by the failure of one of the three fuses of the three-phase circuit, leaving the motor operating on a single-phase, which eventually destroys it. On account of increases to the mill equipment, or bad initial calculations, the wiring loss in the mill often runs up to very high figures with the lower voltages. In one mill in my experience, with a 220 volt distribution about 500 ft. long, the total wiring loss reaches 15%, and this after the mill management had at a considerable cost added feeders from time to time as the mill has been enlarged.

In mills using 2,200 volt motors, the wiring is run in iron or steel conduit and consists of three-wire insulated cable with lead sheaths. The loss in this system is reduced to practically nothing, the cost is low, and complete protection is afforded by means of automatic oil switches. The size of the wires is very small, and the whole system takes up less space in a mill and is no more conspicuous than water and sprinkler pipes. On account of grounding the conduit, the liability to accident is practically eliminated.

The manufacturers of standard motors now build 2,200 volt motors in sizes of as low as 15 h.p., and where motors smaller than this are required, 2,200 to 550 volt transformers are installed on the mill wall close to the motors and the secondary wire is run directly to the motors from them.

PUBLICATIONS.

"Transactions of the Glasgow Technical College Engineering Society." Vol. VI. Part I.

Contains Professor Magnus Maclean's paper on "Motor Cars—Electric Ignition," and discussion thereon.

"Optical Instruments Simply Explained." Illustrated. (London: Percival Marshall & Co. Price 6d. net).

Deals with the nature of light, lenses and the eye, binoculars and telescopes, photographic lenses, and miscellaneous applications. Concise elementary treatise, well done.

"The National Physical Laboratory." Report for the year 1909.

This report contains information about the original and test work carried out in the various departments. Much useful work has been done in the electricity and electrotechnics departments. A list of papers read before different learned societies gives a good idea of the scope and invaluable character of the research work undertaken at Bushey Park.

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THE 220 VOLT PROBLEM.*

By GEORGE D. SHEPARDSON.

Engineers have recognised the desirability of using high voltage for the transmission and distribution of electrical energy. On transmission lines, the upper limit of voltage is determined by the increasing cost of transformers, poles and insulators and the greater loss by leakage and static discharge. On distribution lines, the upper limit of voltage is practically determined by consideration of public safety, as in the case of primary lines which are frequently limited by ordinance or by insurance requirements to 6,600 volts and more commonly to 2,500 volts. For general distribution and for use inside buildings, the highest practicable voltage is determined by the limitations of the receiving apparatus, such as incandescent lamps and other heating devices, and also by the requirements of the insurance rules. Both of these limitations are gradually rising, as a result of improvements in the manufacture and installation of wiring and of appliances. For use inside buildings, the National Electrical Code now allows as high as 550 volts for motors and some kinds of lighting, and as high as 300 volts for all kinds of lighting and other uses of electricity. Incandescent lamps, flat-irons, cooking and similar heating utensils are available for as high as 250 volts.

Statistics of a recent issue of the McGraw Central Station Directory, revised in some cases by other information, show that in 1909 there were 166 central stations in Minnesota, in which an aggregate capacity of 51,500 kw. is available for the 700,000 incandescent lamps connected. Of these 35 plants aggregating 25,000 kw. capacity and 179,000 connected lamps seem to be using three-wire secondary systems; 17 plants aggregating 10,000 kw. capacity and 225,000 lamps use direct current three-wire systems; a total of approximately 52 plants aggregating 35,000 kw. capacity with 404,000 connected lamps are using some sort of three-wire system (not necessarily including alternating current three-phase systems). Fifty stations aggregate about 11,000 kw.-capacity supply about 200,000 lamps with approximately 110 volts over two-wire circuits. Sixty-three stations aggregating 5,600 kw. capacity supply approximately 102,000 lamps at 220 volts over two-wire circuits. One small station apparently supplies 500 lamps connected to a 250-250 volt three-wire system. This 38% of the Minnesota central stations with 11% of the total incandescent lamp capacity supply about 15% of all the incandescent lamps lighted from central stations. The three-wire plants vary in size from 25 to 11,400 kw. capacity; the plants supplying current at 110 volts over two-wire lines vary in size from 17 to 1,000 kw. capacity; those supplying lamps at 220 volts vary from 15 to 400 kw. capacity. These comparative figures, which are approximately reliable, indicate that the special field for the 220 volt systems is in the small towns where the demand is limited and also scattered.

While the use of high voltages is generally desirable from the standpoint of the line, the consuming devices generally favour lower voltages. Generally speaking, motors, lamps, cooking and other heating utensils cost more as the voltage rises. The efficiency of the various loads is apt to be practically constant, except that for very low voltages the large conductors are likely to involve increased loss of heat through the leading-in wires. The 220 volt incandescent lamp has always been inferior to the 110 volt lamp and is likely to continue under the double handicap of higher first cost and of lower efficiency in operation. In order to take the same energy at double the voltage, the current taken by the 220 volt lamp must be one-half that taken by the 110 volt lamp of equal rating; to take half the current at twice the voltage, means that the resistance of the 220 volt lamp must be four times that of the corresponding 110 volt lamp; this involves the use of a filament of half the area and twice the length. As the filament gets longer and of smaller area it becomes mechanically weaker and it cannot be operated safely at so high a temperature; it should be supported at more frequent points than required by the larger filaments. On account of the necessity for high resistance, the carbon filament lamp has not been developed so far as has the 110 volt lamp. The 220 volt carbon-filament lamp still uses a filament which is neither flashed nor metalised. For many years the filaments of 110 volt lamps have consisted of a central core of carbonised cellulose upon which a coating of graphite has been "flashed" by heating the base filament to incandescence in an atmosphere of some hydrocarbon such as gasoline or turpentine vapour, the heat causing the vapour to dissociate and to deposit pure graphite carbon on the heated filament.

After the development of the tantalum lamp which made 2·0 watts per candle commercially possible for the 110 volt lamp, a special 220 volt tantalum lamp was developed, having two-volt filaments connected in series. This required a much longer globe and was feasible only for lamps of 25 or more c.p. The development of the tungsten lamp with an efficiency of 1·25 watts per candle for 110 volt lamps, was soon followed by the "Mazda" lamp having efficiencies varying from 1·15 watts per candle for 250 watt lamps to 1·33 watts per candle for 25 watt lamps.

While the 220 volt lamp costs more to buy and more to operate than does the 110 volt lamp, and while the arc lamp problem is much more troublesome, yet there are certain redeeming features which make the 220 volt system give satisfactory service and earn satisfactory dividends. The simplicity and the lack of difficulties from low power factor and from induction troubles enable an engineer of ordinary ability to handle a 220 volt direct current system with less trouble and uncertainty than he could handle an alternating current system. The lower voltage and the absence of transformers and their exciting current, should bring about higher efficiency of the distributing system, so that the ratio of the total watt hours sold, to the total watt hours generated at the station should be considerably higher for the 220 volt direct current system than for the alternating current system. On the other hand, the direct current watt hour meter is apt to be more expensive and more likely to run slow with age than is the lighter induction meter used for alternating currents. Another item that lessens the relative disadvantage of the 220 volt system is the fact that the smallest size wire allowable on pole lines is governed not by minimum allowable electrical conductivity, but by its mechanical strength. In general, the 220 volt lamp is advantageous even to the ultimate consumer. For with him, it is likely to be a question as to whether he can have any electric light at all if he is not supplied at 220 volts, for in many small and scattered towns a 220 volt system is the only electric system that would pay. He therefore has the choice not between 110 volt and 220 volt lamps, but between electric 220 volt lamps and "electric" oil lamps. It may therefore be concluded that the 220 volt system is desirable in many cases where the loads are small and are scattered and where the total load is comparatively small.

* Abstract of a paper read at the Minneapolis convention of the Minnesota Electrical Association, March 30.

REVIEWS.

"Energy." By Sidney A. Reeve. (McGraw-Hill Book Co. and Hill Publishing Co.)

The author has set himself the laudable and by no means simple task of writing a comprehensive and plain treatise on the nature of energy, work and heat. He deals with the subjects from the point of view of the engineer, who, from the nature of his training, thinks in terms of the *concrete* rather than the abstract. In his preliminary reasoning the writer points out that many of the so-called fundamental formulæ used by engineers are merely approximations and that by studying only such approximations the average man is liable to error. Thus, it is not always realised that no single body can possess energy, and that the formula for kinetic energy, $\frac{1}{2}$ m v^2, is an approximation which is only near the truth, because the mass of any body with which the engineer has to deal is very small when compared with the mass of the earth. As so great a portion of the efforts of the engineer are directed towards the harnessing of the forces of nature, it is very desirable that he should have an exact conception of the laws of nature. The author deals with the Newtonian laws, frees them from the nebulous mist of the average text-book on mechanics, and among other things shows their bearing upon the theory that heat is a mode of motion. A word of praise is due to the author for the way in which he has expressed his arguments.

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Business Notes and News.

LIGHTING AND GENERAL—Home.

BRAUNTON.—A post-card poll is to be taken on the suggested contract to be entered into with a company for lighting by electricity.

CHICHESTER.—The Town Council have accepted the tender of the local Electric Light Co. to light the city for five years, at £3 5s. per lamp. It is expected that as the result of this contract, the price per unit to private consumers is likely to be reduced to 4½d. per unit.

DERBY.—Mr. H. R. Hooper, Local Government Board Inspector, investigated an application for the sum of £5,203 for the extension of the electrical undertaking. It was stated that £4,076 was required for generators, £1,037 for conversion of plant, and £100 for provision. The inspector was also told that in 1908-9 there was an increase of 600,000 units in the demand, and it was estimated that a similar increase would be experienced this year.

DEVONPORT.—Electric lighting mains are to be extended to the Pennycomequick district.

DUBLIN.—The Electricity Department's estimates for the year showed a deficit of about £14,000 ; £10,000 has now been struck off the estimate.

DUNDEE.—It appears that the building and equipment of the new electricity station at Carolina Port and sub-stations (described in our pages of April 8), were estimated to cost £100,000, and this estimate has been exceeded by only £3,000.

DUNFERMLINE.—The United Free Church is to be lighted by electricity, a legacy of £100 being utilised for the purpose.

EDINBURGH.—The Town Council have decided to delay the erection of three cooling towers at Dewar-place Electric Light station, and the provision of exhaust steam turbines at a probable cost of £45,000.

GILLINGHAM.—The Local Government Board inquiry into the application to borrow £3,000 for purposes of the electrical undertaking has been postponed pending readjustment of accounts, the Inspector holding that capital had been debited with items that belong to working expenses.

GLASGOW.—New rules under the Cinematograph Act have, after consultation with theatre and music hall managers, been adopted.

HAMPSTEAD.—The " telephone " method of charging has been adopted by the Borough electricity department. A further 317 street lamps are to be converted from gas to electricity, at a cost of £2,006, two 32 watt lamps being used on each standard. As the result of a contractor having withdrawn an accepted tender for coal, the Council have decided that in future tenders shall contain a clause preventing such withdrawals.

LONDON.—The County Council have sanctioned conditionally the laying of cables by the following boroughs and companies : Charing Cross, West End, and City Electricity Supply Co. along a portion of Charing-cross-road, in Manette-street, Greek-street, and along the Shaftesbury-avenue subway ; the London Electric Supply Corporation : in Commercial-road, Cornwall-road, Waterloo-road, York-road, Slacke-street, Aquinas-street, Brad-street, Coin-street, Eaton-street, Ethelin-street, Exeter-street, Heed-street, Whittesley-street, Wooter-street, in Raymouth-road, Southwark-park-road, Galleywood-road, Lynton-road, Rotherhithe New-road, Cranham-road, Parfitt-road, Anchor-street, Ambrose-street, and Rosebery-street, and to construct inspection boxes ; the Metropolitan Electric Supply Co. in Conduit-mews ; St. Pancras Borough in Ascham-street, and Gloucester-crescent ; County of London Electric Supply Co., in Bond-street ; South Metropolitan Electric Light and Power Co., in Peak-hill. Notices have also been served of the intention to lay cables in the following streets by the various bodies, for which, however, the sanction of the County Council is not required : Battersea Borough Council, in Macduff-road and Lurline-gardens ; Hackney Borough Council, in Bentley-road and Kingsland-road ; Hammersmith Borough Council, in Wood-lane ; Hampstead Borough Council, in Finchley-road, Cannon-hill, West-end-lane, Lyncroft-gardens, Parsifal-road, Ingham-road, Weech-road, Fortune-green-road, Aldred-road, Hillfield-road, Achilles-road, Ulysses-road, Agamemnon-road, Ajax-road, and Gondar-gardens; Marylebone Metropolitan Borough Council, in certain streets indicated on plan No. M. 547, sheets Nos. 1, 2, and 3 ; Shoreditch Borough Council, in Weymouth-terrace ; Stepney Borough Council, in Oley-place, Redmans-road, and Pole-street ; and Woolwich Borough Council, in Nile-street.

MANCHESTER.—Application is to be made to the Local Government Board for permission to borrow £40,000 for an extension of the electricity undertaking.

OSWALDTWISTLE.—The District Council are applying to the Board of Trade for a Provisional Order to generate and supply electricity for lighting and power.

PENZANCE.—The Town Clerk reported the receipt of a letter from Mr. W. T. Pressland, electrical engineer, Westminster, as to the Penzance Electric Lighting Order, who wrote that he had at last been able to get the Cornwall Electric Power Co. to look into the matter. One of their directors had been to Hayle and Penzance, and he could state that he would advise the Board to proceed with the supply of current to Penzance. After the meeting he should be able to place a proposition before the Council and the Board of Trade which would satisfy them that a definite date would be given for the supply to Penzance of electric current.—The letter was referred to the Electric Lighting Committee.

RHYL.—The new steam set at the Corporation's electricity works is now in good order. During the past month the output was 13,101 units, as against 14,019 units at the same time last year, but the works costs have been reduced from £87 7s. 10d. to £83 14s. 7d.

RUNCORN.—The Board of Trade are about to issue Electric Lighting Orders for the urban and rural districts to the Salt Union. It is provided that, if after the expiration of three years substantial progress is not made in the rural district, that part of the Order may be revoked.

STOCKTON HEATH.—The Parish Council are taking active steps to oppose the Warrington Corporation Bill, objection being taken to clause 24 relating to electricity.

WHITEHAVEN.—An application is to be made to the Local Government Board for powers to borrow £2,500 in order to cover the cost of new plant at the electricity works, estimated at £2,340.

WIGAN.—To the Electric Light Committee the Town Clerk reported that, since the local inquiry into the Corporation's application for borrowing powers, he had seen Mr. Hooper, the Local Government Board Inspector, in regard to the item of £4,472 3s. 1d., referred to at the inquiry, which represented the debit balance on the Pemberton Electric Light Revenue Account when the Pemberton station was taken over, which amount had been continually suspended, and appeared as a debit on the Electric Light Capital Account. The Inspector stated that he did not think the Local Government Board would give their sanction to further borrowing powers, until the amount had been wiped out of capital account. It was resolved that the Electrical Accountant be instructed to immediately transfer the item of £4,472 3s. 1d., at present charged against Electric Light Capital Account to Profit and Loss Account, so that the same can be liquidated during the current year.

LIGHTING AND GENERAL—Overseas.

JHANSI.—A scheme has been sanctioned for the provision of a power house and the general electrification of the locomotive and carriage and wagon workshops of the Indian Midland Railway at Jhansi, the headquarters.

LAHORE.—Two hundred additional electric fans which have been provided for the General Offices of the North-Western State Railway at Lahore have been purchased in India. They will be operated by power supplied from the power house of the Lahore locomotive workshops.

MEXICO.—A contract has been entered into between the Government and Señor Don Francisco Martinez Arauna, whereby the latter is empowered to utilise the waters of the river Tepeji, in the State of Hidalgo, to an extent not exceeding 1,500 litres per second, for the generation of electrical energy. The concession is for a period of 20 years. The concessionaire engages to begin operations within 24 months, and to complete the work within 7 years, from the date of promulgation of the contract. He is granted the right to import free of duty, once only, all the machinery necessary for the work, and is further authorised to construct any bridges, electric power conductors, and telegraph and telephone lines that may be required.

SANTA CRUZ.—The Argentine Republic has granted Mr. Edward Richards a 30 years' concession for the establishment and working of a telephone system, to extend from Ultima Esperanza (Province of Santa Cruz) to the 30th section in the southern zone of Santa Cruz, with a branch to the Gallegos—Punta Arenas telephone line.

VALPARAISO.—Francisco Huneus, of Santiago, has obtained permission to make use of water from the river Cachapoal to the extent of 40,000 litres per second for the generation of power for industrial purposes.

TRACTION—Home.

LONDON.—In connection with the laying of ducts between the Greenwich electricity generating station and the Woolwich sub-station, to be used for the working of the tramways from Woolwich to Eltham, etc., the London County Council have made arrangements with the War Department for the temporary laying of two high-tension cables and a telephone cable within the wall of the Woolwich Dockyard, pending the building of the new

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dockyard wall and the widening of the adjoining roadway. The expenditure to be incurred is provided for in the estimate of £29,750, in respect of the construction of the Woolwich to Eltham tramways.

TRACTION—Overseas.

MENDOZA, ARGENTINE.—The first section of the electric tramway is expected to be ready by the end of the year.

COMPANIES' MEETINGS AND REPORTS.

DIRECT UNITED STATES CABLE.

The board of directors have resolved upon the payment of an interim dividend of 4s. per share, free of income-tax, being at the rate of 4% per annum for the quarter ended March 31, 1910, payable on and after the 25th inst.

CORK ELECTRIC TRAMWAYS AND LIGHTING.

At the 13th ordinary general meeting, Mr. A. R. Monks, who presided, moved the adoption of the report. He said that in spite of the strike in May last, the accounts showed profits considerably in excess of those for the year 1908. For a considerable time the company had kept a special staff to advise consumers, and also to inspect installations during erection, with the result that all the advantages and freedom from fire which electric light possessed had been realised. The motion was seconded and adopted.

CUBA SUBMARINE TELEGRAPH.

The report states that the total receipts of the six months to December 31 were £16,376, while the expenses amounted to £6,415, leaving a balance of £9,961, to which has to be added £7,059 brought forward, giving a total of £17,021 to be dealt with. The sum of £2,000 has been added to the reserve fund, which now stands at £116,000. The dividend on the Preference shares will absorb £3,000 and leave £12,021, out of which the directors recommend the payment of a dividend at the rate of 6% per annum on the Ordinary shares, free of income tax, the balance, £7,221, being carried forward.

NORTH METROPOLITAN ELECTRIC POWER.

Mr. E. Garcke, presiding at the meeting of the North Metropolitan Electric Power Supply Co., said that the amount of energy sold during the year was 16,402,447 Board of Trade units, which was an increase of 16·5%. The value of this supply was £87,833, which was an increased revenue from the sale of energy alone of £12,239, equivalent to over 16%. The North Metropolitan Electric Power Supply Act, 1909, authorised the increase of the capital of the company by £250,000 to £750,000. The business of the company was developing very satisfactorily. They were this year paying a dividend of 6% on the Ordinary shares.

METROPOLITAN ELECTRIC TRAMS.

Presiding at the meeting of the Metropolitan Electric Tramways (Ltd.), Mr. E. Garcke said that their position was satisfactory, and their prospects were good. The primary reason for this good position was to be found in the arrangements which they had been able to make with the local authorities, which made the desires and objects of those local authorities identical with those of the company. During the past year they had practically completed their system of tramways and light railways in the North Metropolitan area. It had been a very difficult business to bring the enterprise to its present satisfactory state, and it was a source of great satisfaction that it had been accomplished.

LISBON ELECTRIC TRAMWAYS.

After paying 5% per annum for four years in succession on the Ordinary shares, the directors have increased the distribution for 1909 to 5½%, while £5,000 has been transferred to a staff pension fund. The sum of £35,000 is written off against depreciation, the same as for 1908, while £5,000 is again transferred to exchange reserve. It will, therefore, be seen that the results obtained during the past year have been satisfactory, and an analysis of the accounts shows that, after allowing for the service of the 5% Debentures, there is a net balance of £103,800, an improvement of £13,900. The rate of exchange, which fell severely in 1908, has remained practically stationary during the past year, so that no further loss has been experienced in this connection. The traffic receipts of the company continue satisfactory, and there is every reason to regard the outlook for the current year with confidence.

PRIMITIVA GAS AND ELECTRIC LIGHTING OF BUENOS AIRES.

The report for the year 1909 states that the balance of revenue account for 1909 and the interest received from the German Transatlantic Electricity Co. amount to £129,700, to which must be added transfer fees £72 and the balance brought forward from the previous year of £26,903, making together £156,675. The directors recommend a final dividend of 4s. 6d. per share (free of income-tax), making a total distribution of 7% for the year on the Ordinary shares, leaving £57,323 to be carried forward. The amalgamation with the River Plate Gas Co. and the Buenos Ayres (New) Gas Co. only taking effect from January 1 last, their accounts for 1909 are not included in the balance-sheet now submitted. The demand for cooking stoves and heating apparatus continues to show a steady increase. The efficiency and extent of the company's distributing system, mains, services, etc., has been very considerably augmented during the year under review. It is proposed to take advantage of the present occasion to alter the company's name to "Primitiva Gas Co. of Buenos Aires, Ltd.," in view of the fact that the company relinquished some time ago the electrical section of its business to the German Transatlantic Electricity Co.

INDIAN ELECTRIC SUPPLY AND TRACTION.

Mr. J. G. B. Stone presiding at the general meeting, congratulated the shareholders upon the fact that the loss which had previously resulted from the working of the tramway portion of their business had now been entirely eliminated, and, speaking generally, the results from that (which was the least satisfactory part of their business) were showing gradual improvement. In the current year to March 12, on a slightly-reduced mileage, they had succeeded in carrying 58% more passengers, while the increase in the receipts had been 7½%. As to the supply of electric current for lighting and power for fans and other purposes the Chairman said that there had been an encouraging advance in the number of connections made. To the end of January the revenue returns had shown a surplus of 4,000 rupees, which was the largest in the history of the company. Ever since they commenced operations the United Provinces, of which Cawnpore was the commercial capital, had suffered severely from dearth, amounting almost to a condition of famine, and also from pestilence. He was glad to say that that state of things was now nearly at an end. The food crops in the North-West Provinces promised to be extremely good, and "bumper" yields were looked for with regard to cotton and oil seeds. That state of things would have a direct bearing on the spending power of the native population. In order to provide for the capital requirements of the business and to pay off creditors it was proposed to make an issue of £50,000 of 6% Debenture stock repayable in 1912, by which time the earning power of the company would have more largely developed. The report was adopted.

BABCOCK & WILCOX.

The tenth annual report for the year ending December 31, 1909, shows that the net profit during the year amounts to £360,003 15s.; to this has to be added the balance brought forward from last account, £43,278 19s. 9d., making a balance of £403,282 14s. 9d., less interim dividends paid October 11, 1909, of 3% on the Preference shares, and of 8% on the Ordinary shares, amounting to £69,400; leaving a balance of £333,882 14s. 9d. From this the directors recommend that the following dividends be paid for the half-year ending December 31, 1909: Dividend of 3% on the Preference shares (from which income-tax is

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to be deducted), £3,000; dividend of 8% on the Ordinary shares (free of income-tax), £66,400; bonus of 8% on the Ordinary shares (free of income-tax), £66,400—£135,800; leaving a balance of £198,082 14s. 9d.; placing to the reserve fund, £100,000 (which will bring this fund up to £600,000); placing to the dividend equalisation fund £25,000 (which will bring this fund up to £220,000); placing to a staff pension fund, £10,000—£135,000; and leaving a balance to be carried forward of £63,082 14s. 9d. Although the sales during 1909 did not show much improvement compared with the previous year, the year's trading was beneficially affected by some older large contracts which during 1909 came into the accounts. The companies with which we are connected gave us increased returns. The cost of production of certain of our manufactures was also reduced during the year by improvements in machinery and organisation. These factors having increased the profit as compared with last year, your directors consider that they are justified in suggesting the distribution out of the profits of 1909 of a somewhat larger bonus. The business in our boilers for marine purposes, both naval and mercantile, is progressing.

CANADIAN GENERAL ELECTRIC CO.

The directors, in their report for the year ended December 31 last, submitted at the annual general meeting in Toronto, on March 28 last, state that the profit and loss statement, while showing that the dividend for the year has been earned, does not reflect the actual measure of the prosperity of the company at the end of the year. Owing to the financial and industrial depression existing in 1908 and extending well into 1909, the first half of the financial year showed discouraging results, because of insufficient manufacturing orders to keep the various departments of the works operating on an economical basis. The latter part of the year, however, showed decided improvement, and since the close of the year the marked improvement in volume of orders received has been maintained. The company, it is stated, has secured some of the most important contracts for electrical apparatus ever awarded in any country, totalling nearly 200,000 h.p. These include three generators of 15,000 h.p. each, three generators of 12,500 h.p. each, and two of 11,000 h.p. each. The company's subsidiary—the Canada Foundry Co.—has just satisfactorily completed for the Canadian Government, at St. Andrew's Rapids, near Winnipeg, a movable dam of steel construction that is one of the most important engineering propositions yet undertaken in Canada, and have recently entered into a contract with the Dominion Iron and Steel Co. for the construction of their new blast furnace plant. All departments of the Canada Foundry Co. are now back to normal production, the structural steel department being overtaxed. The great development of the Canadian North-West made it increasingly difficult to handle the business of that district from either the Vancouver or Winnipeg branches, and the directors arranged to open a new branch office in Calgary, Alberta, which is now in operation. The profit for the year, after providing $91,093 for depreciation, $51,660 interest on borrowed capital, and $469,000 dividends paid, amounted to $14,236, which, with the undivided profits from 1908 of $145,231, give a balance at credit of profit and loss account of $159,468.

COMPANIES REGISTERED.

BRITISH ARC WELDING CO.—Capital, £15,000, in £10 shares. Objects: To carry on the business of welders, marine, electrical, civil and mechanical engineers, electricians, founders, etc. Private company. The first directors (to number not less than two nor more than six) are: R. S. Kennedy and J. Kennedy. Qualification, £200. Remuneration, as fixed by the company. Registered office, Suffolk House, Laurence Pountney-hill, Cannon-street, E.C.

CHALLENGE REINFORCED TUBE CO.—£110,000 (£1) (55,000 6% Preference). To take over the business of manufacturers and sellers of Challenge reinforced inner tubes for motors and the patent under which the same are manufactured and sold, and to adopt agreements (1) with the Challenge Rubber Mills, Ltd., and F. B. Smart, and (2) with the Reinforced Inner Tube Co., Ltd., and F. B. Smart. Minimum cash subscription, 10% of the shares offered to the public. First directors (not less than two nor more than seven): H. Edmunds, H. H. Frost, and W. G. Yarworth-Jones. £250. £150 each per annum (chairman, £250).

OBITUARY.

We regret to announce the death of Mr. Augustin Gifford Palgrave, M.A., electrical engineer, of Newcastle-under-Lyme.

PATENTS.

Electro Fuses.

25445.—1909. O. NORDENTOFT, Frederiksberg. The fuse consists of a member of insulating material, a number of metallic terminals cemented to the member by means of a mixture of magnesium oxide, and a solution of chloride of magnesium, and one or more metal wires connecting the terminals. The cement expands as it hardens, and forms a tenacious mass, which makes it difficult to remove the terminals when once they are placed in position.

Electrically Heating Sterilising Apparatus.

27909.—1909. C. E. HEARSON, Camberwell, S.E. The apparatus is heated by the passage of electricity through resistance wiring coiled around the exterior of the chamber containing the material to be heated. The passage of electricity is controlled by a thermostat mounted outside the chamber.

Electric Burglar Alarms.

28638.—1909. B. TRAUTMANN, Dresden. Oscillating contacts are suspended from a curtain so that when the curtain is disturbed these contacts are displaced, and are either brought into or out of touch with fixed contacts which causes a signal to be given.

Rotary Converter Dynamo Electric Machines.

29088.—1909. SIEMENS SCHUCKERTWERKE, G.m.b.H., Berlin. The armature of an auxiliary direct current dynamo-electric machine is coupled electrically or mechanically to the armature of the rotary converter. The armature windings of both machines are connected in series through a field winding placed on the field system of the converter. By these means undesirable variations in the speed and frequency of the converter are obviated.

Plug and Socket Connections.

29582.—1909. LUNDBERG BROS., Islington. In plug and socket connections used in electric light and power installations the plug part is provided with a laterally projecting pin and the socket part is provided with a hinged flap, having a hole in which the pin on the plug may engage in order to hold the plug against accidental displacement.

Revolving Magnets for Dynamo Electric Machines.

30176.—1909. ALLMANNA SVENSKA ELEKTRISKA AKTIEBOLAGET, Westeras. The rotor of the machine has projecting pole pieces with windings. The axial parts of the windings are curved to the shape of a chain line in order to ensure proper ventilation of the rotor and stator winding.

Working Arc Lamps in Series with Incandescent Lamps.

748.—1910. A. HEIMANN & W. SCHAFFER, Berlin. Groups of incandescent lamps and groups of arc lamps are connected with the economical transformer by substituting the series resistance of the group of arc lamps by the group of incandescent lamps, both groups being connected in series to the terminals of the transformer. From one point of the economical transformer, however, which sub-divides the total tension in the ratio of the tensions at the terminals of the groups of incandescent lamps and arc lamps, a branch line is led to a point of the line connecting the group of incandescent lamps with the group of arc lamps.

Cooling the Windings of Rotors of Dynamo Electric Machinery.

1404.—1910. SIEMENS SCHUCKERTWERKE, G.m.b.H., Berlin. This is a cooling arrangement for the end connections of dynamo-electric machinery in which the cooling plates have lateral projections and radial bent parts so arranged that they offer little resistance to the passage of the cooling air.

Telephone Transmitters.

1707.—1910. B. C. MAXWELL, Canton, U.S.A. A supplemental mouthpiece, with a detachable paper centre, fits into the permanent mouthpiece, but is out of contact with it. The extra mouthpiece has its outer edge rolled backwards, so that the outgoing currents are deflected away from the person using the telephone. The paper centre should be renewed each time the telephone is used.

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Alternating Current Dynamo Electric Apparatus.

694.—1909. British Thomson-Houston Co., Ltd., London, E.C. This is an improved method of suppressing the superfields generated by both windings independently of the main field in alternating current commutator machines. Windings are arranged in the rotor and stator having the same pitch. The windings are connected with the regulating transformer so as to retain the necessary phase relationship while the superfields generated by the stator and rotor respectively oppose each other.

Electric Motor Converters.

6069.—1909. O. S. Bragstad & J. L. La Cour, Karlsruhe. The improvement consists in providing the pole shoes of motor converters with compensating windings through which the whole or a proportion of the armature current flows. The windings are unequally and unsymmetrically distributed over the pole arc and, in order to obtain a compounding effect, are displaced relatively to the neutral zone in the direction in which the armature rotates, or in the reverse direction, as the case may be.

Electric Power Transmission Systems.

6177.—1909. C. A. Parsons, Newcastle. A generator and a motor are interwound in such a manner that a portion of the winding of the motor alternates with a portion of the winding of the generator. By these means one or more motors at different speeds can be driven by one or more generators, while at the same time the potential at no part of the winding is greatly different from that of the earth.

Automatic Electric Switches.

6405.—1909. E. R. Grobe, Wimbledon. This switch for auto-transformers is operated by the internal energy of the circuit. When one consumer's switch is closed a small current is caused to flow through a high resistance coil on a starting electro-magnet having a pole piece designed to pull from a distance. The electro-magnet closes a switch which completes the transformer circuit and energises a low resistance coil on a separate hold-on magnet designed to hold the armature when between the pole pieces.

Electric Motor Control.

6564.—1909. British Thomson-Houston Co., Ltd., London. A pair of alternating current motors of the commutator type have their armatures normally connected in series. A control system is arranged to short circuit the armatures for low speed operations, and to open the short circuit and impress a voltage on the armatures for high speed operation, A switch is employed for cutting either motor out of circuit. Means are provided for preventing the establishment of high speed connections when the motor is cut out.

6565.—1909. British Thomson-Houston Co., Ltd., London, E.C. The meter casing and the U-shaped core for carrying the current winding are arranged to carry the potential flux which passes through the driving disc. An improved means of adjusting the angle of lag of the potential flux consists of a shading piece adjustably mounted in the leakage gap of the potential core, and moves across the axis of the potential core.

Electric Resistance Units.

6674.—1909. British Thomson-Houston Co., Ltd., London, E.C. The unit comprises a continuous zig-zag strip of resistance material having integral members across some of the sections to short circuit them.

Electric Furnaces.

6820.—1909. J. H. Reid, Newark, U.S.A. The furnace has a number of converging arc-producing electrodes and a number of resistance elements which extend into the arc produced thereby, and are adapted with the electrodes to form a support on which the charge may rest during treatment.

Electric Light Reflectors.

6836.—1909. G. F. Alton, London, W. The reflector is trough-shaped, and has tubular lamps fixed in the back of the trough. A screen is fitted parallel to the reflected rays which pass on both sides of it.

Hand Operated Magneto Electric Machine.

6877.—1909. Siemens Bros. & Co., Ltd., Westminster. A clutch connects the handle with the gear wheel that drives the armature shaft and comprises one or two pieces adapted to be moved outward so as to bear against the inner periphery of the wheel when the handle is turned in one direction, and to be drawn inwards when the handle is turned in the other direction.

Generation, Storage and Use of Electric Power.

6916.—1909. C. B. Walker, Solihull. The plant consists of an internal combustion engine, a dynamo and a storage battery having a number of regulating cells so coupled that the starting, stopping and voltage regulation are entirely automatic and consequent upon the falling or rising of the potential of the whole or part of the battery. Approximately, a pre-determined constant potential is always maintained at the discharge terminals.

Electric Motor Control.

7114.—1909. British Thomson-Houston Co., Ltd., London, E.C. This is an alternating current motor of the commutator type. The controller is arranged in one position to short circuit the motor armature, in another position to maintain the armature short circuited while varying the motor connection. In the third position it opens the short circuit, and keeps it open in passing through the second position.

Compact Electrical Apparatus.

7193.—1909. G. Bryant & C. H. Ivinson, London, N. The apparatus comprises a coil with a soft iron core and a primary wire, a switch, means for completing the circuit, and an adjustable resistance. The resistance consists of an insulating chamber with a metal plate at one end in connection with the circuit, and a metal plate at the other end in connection with the circuit. Means are provided for causing one of the plates to approach or recede from the other plate. Between the plate is a layer of plumbago. The apparatus can be used for medical purposes, massage, dumb-bells, etc.

Electric Motor Control.

7230.—1909. British Thomson-Houston Co., Ltd., London, E.C. In this system of electric motor control, in which the speed and direction of rotation of the motor are controlled by regulating the polarity and potential of the generator from which it receives current, means are provided for automatically preventing the potential of the generator from being increased or decreased so rapidly as to cause the current in the armature circuit to rise above a certain pre-determined value either during acceleration or deceleration of the motor.

Electric Capstan.

7408.—1909. Hydraulic Engineering Co., Ltd., Chester. The capstan comprises a capstan head, an electric motor, reducing gear through which the capstan head is driven, a clutch interposed between the motor and reducing gear which is adapted to remain inoperative at low speeds of the motor, a brake which is automatically applied between the clutch and the reducing gear to stop the capstan head immediately the motor circuit is broken, and electrically controlled means for operating the brake.

Electric Switches.

9456.—1909. G. W. Hawker, Birmingham. The object is to produce a switch which has a quick break, and therefore a minimum of sparking. An insulated block slides in a recess in a bed plate, the lower end of which is shod with a spring actuating piece of metal held in position on the block by means of a rod passing into the centre of the block. The plate is allowed a slight movement independent of the block owing to the spring coiled round the rod. The block has a pin on which are pivoted two slotted arms working in pins. These arms are pulled together by a spring rod, working in guides, having a slot at its lower end in which the pin in the block works which provides the means for switching on and off.

Electric Systems for Power Transmission.

11400.—1909. Allgemeine Elektricitas Gesellschaft, Berlin. The system comprises a starting generator and a working motor with field windings externally excited. An automatic regulating device influences the field of the starting generator and operates independently or in series with the main exciting source. The device generates a potential depending upon the speed of the starting generator in such a manner that the effect of this speed upon the speed of the working motor for all positions of the control switch is completely neutralised.

Third Rail for Electric Traction Systems.

12254.—1909. C. A. Bluhm, Michigan, U.S.A. This third rail device comprises in combination guard rails, conductor and supporting chairs. The chairs are slotted to receive the guard rails, and provided with projections which extend into the hollow portion of the guard rails. The centre portions of the chairs support the conductors.

Electrodes for Electrolytic Purposes.

12709.—1909. Electrolytic Alkali Co., Middlewich. The ends of the carbon pin are divided into two or more pieces, which can be slightly opened by a wedge. When the pin is inserted in the carbon block the wedge is placed in the division so that it pushes the pins outwardly against the sides of the hole. This method ensures a firm attachment.

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Clutches for Electric Automobiles.

13407.—1909. C. M. DE SAINTE CLAIRE, Nice. The clutch for conveying rotary motion has friction members which engage each other. One member is frictionally mounted on a shaft and made to engage with the other member in such a manner that the clutch will convey a friction drive in the first place, and afterwards a solid or definite drive.

Insulators for Supporting Electrical Conductors.

13612.—1909. R. W. KEMBLE, Brixton, S.W. The insulator consists of three main parts, the central bolt to which is attached the current rail, the porcelain non-conductor, and the iron hood into which the porcelain is fixed and by means of which it is attached to the lost rail of the system. The bolt has a flat portion and a shoulder which co-operates with corresponding portions in the inside of the insulating member to form a locking connection in a manner which shall prevent longitudinal movement in one direction, or rotary movement between these two parts. The porcelain non-conductor has an external shoulder which fits into corresponding portions on the inside of the hood to form a locking connection (as described above) between the two members.

Switchboards.

13655.—1909. BRITISH THOMSON-HOUSTON CO., LTD., London. This is an improvement in switchboards of the type used on high tension electric distribution systems, and consists in a new arrangement of the duplicate bus-bar connections whereby a bus-bar or a set of bus-bars may be completely isolated from a feeder circuit so as to allow of cleaning and repairs without danger to the attendants. The bus-bars are arranged in rows one above another, and the bus-bar in each row is connected to a switch terminal located above, while the bus-bar in the other row is connected to a terminal located below a feeder terminal which carries a throw-over switch, so that when the switch is in one position connecting the feeder to one bus-bar, an insulating barrier may be inserted between the feeder terminal and the other bus-bar terminal, thereby completely isolating the terminals.

Electric Systems for Power Transmission.

13798.—1909. ALLGEMEINE ELEKTRICITATS GESELLSCHAFT, Berlin. An additional exciting winding is provided for the generator, energised by current controlled by an automatic resistance regulator in dependence upon the current and speed of the starting generator so as to render the speed of the working motor independent of the speed of the generator.

Magneto Electro Sparking Machines.

13908.—1909. B. BRAUD, London, W.C This is an improvement in means for giving an initial impulse to magneto-electric sparking machines used in connection with internal combustion engines. According to the invention, the coupling connecting the magneto-electric machine with the engine comprises several parts, one of which is rigidly mounted on a shaft of the engine, whilst a second part is secured to the shaft or spindle of the magneto electric machine. When the engine is working these two parts are locked together, but when desired they may be unlocked for the purpose of effecting the initial sparking without the necessity for the employment of means for rotating the engine or of a secondary battery.

Arc Lamps.

14128.—1909. VOIGT & HAEFFNER, A.G., Frankfort a Main. This lamp is specially designed for use for photographic purposes. It has a shade with a shutter pivoted to its front portion, while the back portion of the shade is formed into a flat box to receive the arc lamp. A tube passing through the box enables the whole device to be mounted over the support rod. The lamp is fixed to the rod by means of a clamping collar.

Shoes for Electric Traction Systems.

15371.—1909. R. J. HOUGHTON, P. ALLMAN & W. GRAY, Liverpool. The shoes are pivoted to the arms of bell cranks. The other arms are articulated to a guided crosshead. The reciprocatory movement of the crosshead is effected by hand or power, whereby the shoes are caused to make or break contact with the conductors.

Generators for Wireless Telegraphy and Telephony.

15891.—1909. E. HUTH, Berlin. This is a means for generating electrical oscillations by means of an arc characterised by forming the arc gap by two diverging electrodes of an arc characterised by forming the arc gap by two diverging electrodes, so that the arch is intermittently elongated and broken by the co-operation of the air heated at the gap and emerging therefrom. An oscillation circuit, capacity and self-induction, is combined with the arc circuit for controlling the period of interruptions.

Wireless Signalling.

17450.—1909. R. A. FESSENDEN, Brant Roack, U.S.A. The ineffective portion of the charge imparted to the antenna is reduced to as small an amount as possible by means of an arrangement of sheets of magnetic material placed between the capacity, which is largely horizontal, and the ground. This arrangement is used either in combination with the wave chute or as a substitute for it.

Electric Incandescent Lamp with Metal Filament Loops.

17627.—1909. H. KUZEL, Baden. This is an improvement in the method of supporting metal filaments. The three sets of metal supports are provided with elastic portions at the bights in combination with intermediate non-extensible supporting arms in order to produce different strains on the individual parts of one and the same filament loop.

Magneto Electric Machines.

17664.—1909. T. M. MUELLER, Dalton, U.S.A. The special feature in this invention lies in the production of an electric generator which employs a simple armature or inductive element, and an adjustable element for varying the density of the magnetic flux through the induction element. The machine comprises a permanent field magnet, a magnetisable element having a core on which is located an inductor coil, an induction element for periodically varying the flow of the magnetic flux from the permanent magnet to the core element, and means for changing the density of the magnetic flux passing from the field magnet to the core element, whereby the wave form of the current and voltage generated in the induction coil may be changed.

Multiple Distributor for Electric Ignition Apparatus.

18534.—1909. R. BOSCH, Stuttgart. One source of current supply for the rotary part of the distributor is constituted by an insulated line passing through its shaft. A separate source is constituted by an axially disposed wiping contact on the end of the shaft.

Electrically Heating Water Bottles.

18940.—1909. H. W. CHRISTIAN, Detroit, U.S.A. A metallic casing extends through the body of the water-bottle. A core of insulating material, a heating coil on the core and a thermostatic switch are fitted within the casing. One element of the switch is electrically connected to parts of the coil, and the other element with the casing. Means are disposed at the head of the coil for electrically connecting the coil with a source of energy.

Current Distributors for Internal Combustion Engines.

20656.—1909. R. BOSCH, Stuttgart. This is a current distributor for multi cylinder internal combustion engines of the kind in which there is a rotary brush for distributing currents to the terminals and in which all the parts carrying current are embedded in an insulating casing fully protected from water and atmospheric influences. The lead plug is prevented from rotating by making both the socket that receives it and the part of the plug that fits the socket, of a section that is not circular.

Switch Stands.

22796.—1909. C. RAITER, Breckenbridge, U.S.A. The stand comprises a casing, a door, a lamp holder mounted on the top of the casing, with two openings, a target spindle with off sets mounted in the casing, targets secured to one end of the spindle, a lever loosely pivoted within the casing, one end of which is attached to one of the off sets in the spindle, a link connected to the opposite end of the lever, which link passes through the casing, a connector secured to the outer end of the link and the switch point, a locking lever, and a plate for locking the mechanism.

Electric Switches.

22897.—1909. LUNDBERG BROS., Islington. The switch has two contact carrying arms and knobs or actuating levers mounted in the same bridge piece, operable together or independently. The holes in the sides of each contact carrying arms are such that one side of the contact carrying arm is mounted upon the spring of the switch so as to permit of the ends of the spring being maintained in a more advantageous manner than hitherto possible.

Electric Switches.

25132.—1909. W. A. MORSE, Westport, U.S.A. This is an improvement in switches of the type in which a solenoid controlled lever is provided at its ends with contact members adapted to close one or the other of two circuits according to which position the lever is moved. Additional yieldable carbon contacts are provided at each end of the lever to make the circuits before the main contacts are closed and to break the circuits after the contacts are open. The carbon contacts are connected with the main contacts and bevelled at their upper ends. Correspondingly bevelled carbon contacts are mounted in sockets hinged to the lever.

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TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns per week.			Increase or decrease.		Miles of track open.		Accounts for past year.							Cost per car mile.
	Ending	1909-10.	1908-9.	Week.	Current year.	1909.	1908.	Ending	Total receipts.	Passengers carried.	Car miles run.	Receipts per Passenger.	Receipts per Car mile.	Receipts per Mile of track.	
		£	£	£	£				£						
Aberdeen Corporation	April 13	1,251	1,368	— 116	— 636	27½	27½	May 31	71,930	17,517,304	1,566,119	·98	11·02	4,040,	5·10
Ayr Corporation	Sept. 18	671	562	+ 108	—	8	8	—	—	—	—	—	—	—	—
Baker Street and Waterloo Ry.	Nov.	8,141	6,070	+2,071	—	4·25	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	April 3	1,204	1,137	+ 67	—	24·003	13·52	—	—	—	—	—	—	—	—
Birmingham Corporation	April 9	6,412	6,548	— 136	—	56·792	58·52	—	—	—	—	—	—	—	—
Blackburn Corporation	Oct. 6	1,100	1,293	— 173	—1,036	24·53	28·3	—	—	—	—	—	—	—	—
Blackpool Corporation	Aug. 26	2,152	2,050	+ 102	+ 732	—	—	—	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams	,, 8	2,304	2,309	— 24	—	—	—	—	—	—	—	—	—	—	—
Bolton Corporation	Oct. 10	2,416	2,337	+ 79	— 259	42	42	Mar. 31	117,799	25,492,902	2,492,147	1·1	11·34	2,804	6·50
Bournemouth Corporation	July 21	1,681	1,723	— 42	— 23	29½	29½	,, 31	86,225	13,991,328	1,766,068	1·47	11·71	2,912	7·22
Bradford Corporation	April 9	4,511	5,014	— 503	—1,064	98	54·81	,, 31	235,258	47,839,569	5,331,007	1·17	10·59	2,378	—
Brighton Corporation	April 17	834	1,011	— 177	— 585	9·5	—	—	—	—	—	—	—	—	—
Bristol Tramway Company	April 15	5,536	6,535	— 999	—	57	51½	Dec. 31	265,362	46,652,389	5,756,842	—	—	—	—
Burnley Corporation	April 16	1,196	1,184	+ 12	—	19½	19½	Mar. 31	64,261	12,355,958	1,202,380	1·23	12·83	5,971	7·42
Burton Corporation	April 17	254	314	— 60	— 60	6½	6½	,, 31	14,918	3,221,595	430,913	1·04	8·30	1,460	5·88
Cardiff Corporation	April 3	2,000	1,957	+ 43	—	—	—	,, 31	109,979	25,058,146	2,497,169	—	10·57	—	—
Carlisle Tramways Company	June 19	170	175	— 5	— 89	—	—	—	—	—	—	—	—	—	—
Central London Railway	April 16	5,520	4,729	+ 791	+ 126	6·32	6·32	Dec. 31	350,150	41,898,373	1,456,781	2·01	5·769	55,404	20·27a
Charing X, Euston, & Hamp. Ry.	Nov.	6,822	6,092	+ 730	—	7·75	—	—	—	—	—	—	—	—	—
City and South London Railway	April 17	3,090	3,127	— 37	— 574	7·26	7·26	—	—	—	—	—	—	—	—
Colchester Corporation	July 14	200	219	— 39	—	8	—	Mar. 31	10,983	2,308,721	349,539	1·09	7·74	1,477	6·56
Cork E. T. and L. Company	April 14	471	528	— 57	+ 255	9·89	9·89	Dec. 31	24,044	5,737,478	896,945	—	6·43	—	4·43
Croydon Corporation	April 1	2,015	1,258	+ 757	+19,801	11½	—	Mar. 31	74,132	16,277,418	1,884,137	1·06	9·56	3,703	7·100
Darwen Corporation	Oct. 1	239	256	— 17	— 201	7·23	7·23	,, 31	13,899	2,557,654	245,584	1·30	13·68	1,922	9·40
Dover Corporation	Sept. 18	230	252	— 22	— 395	7	—	,, 31	11,593	2,697,672	316,754	·98	8·78	—	—
Dublin and Lucan Electric Ry.	April 15	125	173	— 48	+ 22	7	7	—	—	—	—	—	—	—	—
Dublin U.T.	April 15	5,263	5,807	— 543	+ 3,178	54½	54½	—	—	—	—	—	—	—	—
Dundee City Tramways	Oct. 6	1,332	1,305	— 27	— 569	—	26½	May 15	60,573	16,367,911	1,281,552	·875	1·9	2,371	7·46
East Ham Corporation	April 16	965	1,072	— 107	— 125	15	15	Mar. 31	47,430	15,355,703	1,091,586	·73	10·26	—	6·96
Glasgow Corporation	April 2	18,847	16,179	+2,668	+ 2,135	191	185	May 31	907,494	226,948,290	20,766,722	·96	10·49	5,080	5·99
Gloucester Corporation	Oct. 6	395	425	— 30	+ 535	15	—	—	—	—	—	—	—	—	—
G.N., Piccadilly and Brompton	Nov.	13,429	9,354	+4,075	—	9·25	—	—	—	—	—	—	—	—	—
Halifax Corporation	—	—	—	—	—	52·574	37	Mar. 31	81,872	20,378,672	1,786,390	11·40	11·13	1,528	9·40
Huddersfield Corporation	Dec. 4	1,613	1,357	+ 256	+ 2,663	28	28½	,, 31	84,704	16,200,020	1,960,329	1·29	10·37	2,421	5·10
Hull Corporation	April 16	2,621	2,624	— 3	— 438	29	26	,, 31	128,722	30,964,254	3,022,844	1·	10·22	—	6·04
Ilford Corporation	Feb. 12	451	391	+ 60	+ 1,969	10	10½	,, 31	25,328	6,385,466	634,446	·87	9·58	2,066	6·42
Ilkeston Corporation	April 13	109	177	— 68	— 87	4	4	,, 31	7,214	1,968,850	198,415	9·1	7·9	1,803	7·04
Kirkcaldy Corporation	Sept. 8	269	266	— 7	—	7½	7½	May 15	14,993	4,874,199	459,066	·711	7·838	1,856	5·26
Lancashire United Tramways	April 13	1,172	2,286	—1,114	— 67	39	39	Dec. 31	68,904	12,554,593	2,244,344	—	—	—	—
Leeds Corporation	Sept. 18	6,896	6,624	+ 272	+3,662	108	96½	Mar. 31	340,368	75,734,083	7,694,989	1·06	10·62	3,527	5·51
Leicester Corporation	Sept. 11	2,162	2,130	+ 32	—	—	—	—	—	—	—	—	—	—	—
Liverpool Corporation	Nov. 19	10,803	10,687	+ 116	—1 977	109	104	Dec. 31	572,822	124,043,239	12,231,799	1·108	11·24	5,508	7·94
Liverpool Overhead Railway	April 3	1,472	1,233	+ 239	+ 179	6·65	2·40	June 30	79,004	11,171,515	1,106,386	—	—	—	—
London County Council	April 2	41,885	33,994	+ 7,891	+167498	131½	121½	Mar. 31	1,274,660	279 166,461	25,591,028	1·98	11·74	—	6·79
Lowestoft Corporation	Dec. 11	155	150	+ 5	+ 30	3½	—	Sept. 30	11,399	2,645,206	370,320	1·03	7·36	2,279	6·12
Maidstone Corporation	Mar. 6	157	100	+ 57	—	7·4	—	—	—	—	—	—	—	—	—
Manchester Corporation	Sept. 11	15,631	15,297	+ 334	—2,871	183	181	—	—	—	—	—	—	—	—
Metropolitan District Railway	April 16	10,949	9,326	+ 1,623	+16,239	24	24	—	—	—	—	—	—	—	—
Metropolitan Railway	April 17	16,405	15,894	+ 511	+ 8,732	24½	24½	June 30	680,357	99,846,735	—	1·46	—	—	—
Nelson Corporation	Oct. 16	151	131	+ 20	+ 7	2½	2½	Mar. 31	7,362	2,060,712	204,740	·85	8·63	1,907	—
Newcastle-on-Tyne Corporation	April 2	4,362	3,852	+ 510	+ 37	60½	59½	,, 31	211,085	46,203,164	4,411,745	1·10	11·48	3,504	6·36
Newport (Mon.) Corporation	Oct. 9	663	638	+ 25	— 311	14½	14½	,, 31	35,531	8,174,003	798,029	1·04	9·89	2,450	7·21
Oldham Corporation	Jan. 24	1,778	1,516	+ 262	— 386	—	—	—	—	—	—	—	—	—	—
Portsmouth Corporation	Oct. 10	2,046	1,809	+ 237	—	28½	28½	Mar. 31	97,741	21,247,048	2,309,439	1·10	10·15	—	—
Reading Corporation	April 14	569	736	— 167	— 172	13½	13½	,, 31	32,769	7,933,572	915,481	—	8·93	—	6·65
Rochdale Corporation	Dec. 26	1,240	1,126	+ 114	+ 746	20·9	20·93	,, 31	56,558	10,196,148	1,252,925	1·32	10·83	2,693	6·47
Rotherham Corporation	Feb. 4	555	587	— 32	—	—	—	—	—	—	—	—	—	—	—
Salford Corporation	Sept. 27	4,696	4,662	— 66	—3,326	78	74½	Mar. 31	244,065	45,771,611	5,486,150	1·25	10·67	3,185	—
Scarborough Tramways Co.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Sheffield Corporation	April 3	6,429	5,586	+ 842	+ 445	39½	37	Mar. 25	289,745	17,568,686	7,065,380	·896	9·842	4,225	6·04
Southampton Corporation	Mar. 30	1,201	943	+ 258	+ 1,024	18	18	,, 25	52,647	10,121,887	1,157,451	1·25	11·33	—	7·36
Southend-on-Sea Corporation	Aug 21	995	557	+ 438	+ 1,483	—	—	—	—	—	—	—	—	—	—
Stockport Corporation	—	—	—	—	—	25	25	Mar. 31	52,004	9,155,172	1,335,911	1·34	9·342	1,830	4·75
Sunderland Corporation	Jan. 27	1,310	1,336	— 26	—7,984	—	—	—	—	—	—	—	—	—	—
Swindon Corporation	Mar. 30	122	122	—	—	—	—	—	—	—	—	—	—	—	—
Torquay Tramways	Aug. 26	630	647	— 30	—	8·41	—	Dec. 31	15,065	2,880,420	353,297	1·40	1·023	—	—
Wallasey U.D.C.	April 9	797	967	— 169	—	12·68	12·45	Mar. 31	43,823	8,331,038	891,540	1·2	11·79	3,453	7·72
Warrington Corporation	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
West Ham Corporation	April 7	2,253	2,233	+ 20	+ 19	27	14·7	Mar. 31	122,881	35,502,836	2,556,854	·789	10·95	4,417	6·79
Wolverhampton Corporation	Nov. 3	841	823	+ 18	— 206	21½	—	,, 31	44,432	9,440,369	975,714	—	10·929	2,190	6·509

a Train Miles. h Half-year's figures.

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THE
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NOTES.

THE MONTEFIORE PRIZE.

The first triennial award under the Montefiore Foundation for an original work on the scientific advancement or progress in the technological application of electricity is to be made next year. Such works may be printed or typewritten, in French or English. Twelve copies must be addressed, carriage paid, to "Monsieur le Secrétaire-Archiviste de la Fondation George Montefiore, Hotel de l'Association des Ingenieurs sortis de l'Institut Electrotechnique Montefiore, rue Saint Gilles, 31, Liege, Belgique." Such works may be signed, or bear a pseudonym. In the latter case they should be accompanied by a sealed envelope, bearing the pseudonym and enclosing the full name and address and signature of the competitor. The latest date for the receipt of all works has been fixed for March 31, 1911. The amount of the prize to be awarded on this important occasion is £800. The whole bearing of this competition is discussed in our leader pages.

PROVINCIAL PROFITS AND LOSSES.

As the various electrical undertakings outside of London publish their accounts for the past year, evidence accumulates of the improving financial conditions, which prove even better than we had forecasted in these columns. Most of the municipal concerns have done well, bettering the results of the previous years. Where there has been stagnation or retrogression, we find that the demand for current is chiefly for the purpose of illumination. It is clear that the influence of the metal filament lamp is still adverse to the supply stations. In many places the number of new consumers have not increased sufficiently to counteract the effects of lamp consumption economies. Closer administration in tramway departments (and especially reductions in charge for power) have also brought about if not a drop, then a slackening in the increase of revenue. But there is an enormous aggregate gain of lighting consumers, and above all, a very noticeable increase in the demand for current for power purposes.

COMPANY RETURNS.

The same influences that have been at work in municipal establishments have equally affected company undertakings. Generally speaking, there has been a reduction in expenses, chiefly due to somewhat lower prices for fuel. With the companies, as with the municipalities, we find those concerns which are mainly concerned with lighting, betray the least improvement. Undoubtedly, the Metropolis has been quicker to recover from the effects of the metal filament lamp. The demand for power is most gratifying, and although this influence is naturally most felt in industrial districts, there are proofs that it pays all companies to cultivate consumers who will use current for trade or domestic purposes other than lighting. While there has been no notable increase in dividends (in some cases even a slight falling off), almost in all instances the companies have bettered their positions, the increased revenues and profits allowing more to be spent in renewals and extensions, in strengthening depreciation accounts and reserves, and in providing more healthy carry-overs. Every indication points to extensions and a more energetic policy of propaganda.

TRACTION PROFITS.

While London as a whole seems to have done rather better than the provinces in the matter of current supply, the reverse seems to be the rule as far as electric traction is concerned. Most of the provincial electric traction concerns have done either very well or at least improved their positions. In London, on the other hand, while the electric railways show better returns and the County Council Tramways have done more than maintain their position, the company tramways have done rather poorly. The Metropolitan Electric Tramways, Ltd., is, as Mr. Garcke explained to his shareholders last week, able to look forward to good prospects, although the actual achievements are not very great, and the improvement has taken long to be brought about. But the London United Tramways have an extremely disquieting result to show. While there has been a slight but steady increase of mileage, there has been a notable falling off in passenger traffic, coincident with a rise in general working charges, which have gone up from 63·2 to 71·2% of the receipts. It is true that the actual traction expenses show a slight decrease of £3,566. But the general result is that the Preference shareholders only receive 3¾%, and their dividends are now £78,125 in arrears. And even this has been achieved only by issuing the remaining debentures, selling off all investments and carrying over a banker's loan of £80,000. It is by no means a cheerful outlook for the shareholders.

SEWAGE DISPOSAL AND ELECTRICITY.

An interesting paper on "Electricity and Sewage Disposal" was read by Mr. F. G. Hill before the Birmingham Local Students' Association, affiliated to the Institution of Civil Engineers. It came most appropriately, considering the large use of electricity made by the Birmingham, Tame and Rea District Drainage Board. Mr. Hill pointed out that electricity was specially suited for sewage disposal work because: (1) The machinery plant consisted principally of isolated scattered units, usually small in size; (2) the duties of the plant were to some extent intermittent, and usually variable in amount; (3) quickness in starting and stopping was essential; (4) temporary plants for experimental purposes were continually being required; and (5) attention and working expenses must be reduced to a minimum. While holding that electricity was infinitely superior to steam, Mr. Hill gave a warning that the great improvement in the design and construction of internal combustion engines, and the introduction of the Humphrey combustion pump, threatened the advance of electricity in this department of municipal engineering.

COAL DUST IGNITION.

In our issue of the 15th inst. we gave a brief summary of a paper read by Dr. W. M. Thornton and Mr. E. Bowden before the North of England Institute of Mining and Mechanical Engineers. The discussion which followed the paper brought out some interesting points. Professor Bedson, while confirming the power of the electric flash to ignite coal dust, held that the experiments on the whole demonstrated the wonderful safety resulting from the use of electricity underground in mines, and he promised to read a paper on his own experiments. Mr. J. B. Atkinson, a practical mining engineer, thought that a simple flash would hardly be sufficient to cause an explosion; it would be necessary for a heavy fall to coincide with a fracture of the wire. But he thought the risk would be considerably greater along old haulage roads, where dust was usually thick and very fine. Mr. Futers desired experiments to be carried on with mixtures of gas and coal dust. The gas was, he thought, largely responsible for carrying the arc across the terminals. To Mr. C. H. Steavenson's rather alarmed plea that it was unwise to allow these admissions

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to go forth to the public, both Dr. Thornton and the chairman, Mr. T. E. Forster, said that the experiments ought rather to reassure people. If what had been proved caused anyone to think that electricity should be removed from mines, then they would have to say that gas should be removed from houses. For our part we do think that gas should be removed from houses, because electricity is much safer; but what Dr. Thornton meant to imply was that almost everything was dangerous if not kept under proper control.

LEGAL PITFALLS.

The case of the Corporation of the City of London against the County of London Electric Supply Co., decided last week by Mr. Justice Parker, and reported in another column, illustrates the many legal pitfalls that beset the path of electric undertakings. The company possessed general powers to connect their northern and southern areas, and for this purpose could break up public streets even outside their area, so they naturally thought that they might carry mains across London Bridge. But, alas! for common sense, the bridge is not repairable by any local authority as such, but only under another guise, that is to say, the duty fell upon the Bridge House Estate, of which the City Corporation are the trustees, so the company has to seek the permission of, and no doubt pay some form of compensation to, the City Corporation, unless, indeed, the written consent of the Board of Trade is first obtained. To the layman this sounds very much like the distinction between Tweedledee and Tweedledum. But its hampering effect upon electrical progress is clear enough.

TRACKLESS TROLLEY CARS.

Both Leeds and Bradford have been seeking Parliamentary powers to establish trackless trolley car systems, and the clauses in the Bradford Omnibus Bill have been approved by the Local Legislation Committee of the House of Commons. The Corporation are to have powers to run such a system along any specified route on obtaining a Board of Trade Provisional Order after a local enquiry. It will not be necessary to apply to Parliament, nor will it be if, and when, it is thought advisable to convert such trackless routes into ordinary tramways. This is sensible, as it shortens procedure, lessens expense, and gives a far better chance for local opinion to find expression. The Chairman of the Committee, Mr. C. N. Nicholson, M.P., in announcing the decision said they regarded this as an experiment, and called it the first experiment of its kind in this country. Of course, he was mistaken in saying this, for the trackless trolley has, as we announced at the inauguration, been given a trial at Hendon.

GERMAN FINANCIAL TRUST.

Considerable disquiet is being felt in German industrial circles, including the electricity manufacturing companies, at the proceedings of Prince Max E. Zu Fuerstenberg and Prince Christian Kraft von Hohenlohe, men possessing vast wealth and who have formed a partnership to control various undertakings. The Deutsche Bank is also interested, and it is said that the available capital amounts to over fifty millions sterling. They have succeeded in gaining the upper hand with the Levant and Union steamship lines of Hamburg, the Nieder-Lausitz brown coal mines, and the Berlin General Omnibus Co. In the last named venture they had to fight the powerful Bleichroeder banking interest, but succeeded, and this is considered to be the first step to the control of the Berlin tramways, underground railways, etc. It is considered that other tramways and electrified railways may then be tackled, followed, it is feared, by an attempt to gain control of the electrical engineer manufacturing firms.

ELECTROCUTION FOR EGGS.

Electricity, which has solved so many of the world's great problems, has at length come to the rescue of the egg—not the new laid egg, nor the fresh egg, but the mere Egg. It has long been recognised that when the egg which is intended for export is put into cold storage its nature undergoes a marked change. The cold appears to preserve it at the expense of the flavour, and only too often it happens that when the careful housewife, brings the cold-stored egg face to face with the domestic culinary ordeal, it proves to be the bad one of the family. To-day new hope looms on the horizon. The United States, to which we owe the sweet boon of the electric chair for criminals, has brought the electrocution principle to bear upon the egg. Mr. T. H. Yawger, Superintendent of the Electrical Department of the Rochester Railway and Light Company, has evolved the theory that when the egg is placed in the refrigerator it is slowly frozen to death, and that therein lies the true cause of the loss of its natural characteristics. His proposal is to electrocute the egg before it undergoes the freezing process, and he claims that the outcome of the experiments he has made in this direction is that the electrocuted egg will maintain its true flavour and freshness unimpaired for an indefinite period. His method is to attach metal caps at each extremity of the egg and subject it to a potential difference of 500 volts. The egg thus killed undergoes, he claims, absolutely no deterioration when subsequently placed in cold storage.

THE INTERNATIONAL OHM.

Our New York correspondent transmits the substance of an extremely interesting memorandum which has been communicated to the technical newspapers of the United States by Dr. Edward Rosa, the Secretary of the International Committee on Electrical Units and Standards. This Committee is now sitting at Washington with the object of arriving at a definite international standardization of concrete electrical units, a subject which has been engaging the attention of scientists for something like half a century. The present investigation is the sequel to the international commission which met in London two-years-and-a-half ago, which decided upon the standard ohm and the electrolytically defined standard ampere as the basis for all electromagnetic units. But although the London Conference adopted a definite value for the electrochemical equivalent of silver, it has not hitherto been specified how the silver voltameter shall be used in applying this constant, and there is still, therefore, a marked lack of precision. The Committee at Washington proposes to formulate specifications both for the use of the silver voltameter and for the construction of the standard cell, which will thus fix the numerical value to be applied to the Weston cells. At the London Conference, it will be remembered, a provisional value of 1·0184 volts was adopted for the saturated Weston cell, but there is a strong probability that this value will have to be changed in order to bring it into agreement with the fundamental definition of the volt in terms of the ohm and ampere.

BIRMINGHAM CONTRACTORS.

The third annual dinner of the Birmingham centre of the Electrical Contractors' Association was on Friday at the *Imperial Hotel*, under the chairmanship of Mr. A. Baxter. Mr. W. Finlay (president of the association), in proposing the toast of the association, remarked that the object of their organisation was to improve their trade and their own positions, and he had to congratulate his colleagues upon the formation of the Midland section, which he understood was strong and was doing good work for the trade. They had many interests to uphold, and they needed to co-operate to assist each other, for they had many battles to fight which necessitated combination. Sometimes, unfortunately, they had to fight municipalities. They desired to join with the manufacturers' associations, and to be dealt with in the same businesslike manner as they, as contractors, desired to treat their customers.

Mr. L. G. Tate (general secretary of the association), who responded to the toast, referred to the general growth of the association, and stated that during the past year something like 80 new firms had joined the association, which showed that the association was growing not in numbers alone, but in power. The central board were in negotiation with the Municipal Corporations Association in order to see if they could arrive at some understanding in the matter and limit the trading of municipalities to their proper functions. Let the municipalities have power to supply motors and electric apparatus on hire, but only on the understanding that the work should be done through the trade.

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HYDRO-ELECTRIC INSTALLATIONS.

MR. A. V. CLAYTON'S PAPER DISCUSSED IN LONDON.

Mr. Aubrey V. Clayton's paper on "Hydro-Electric Installations of Sweden," an illustrated abstract of which appeared in our last issue, provided an interesting topic for discussion at the meeting of the Institution of Electrical Engineers, London, on Thursday, the 21st inst.

Mr. J. F. C. Snell observed that adaptations of the great forces of Nature like hydro-electric plants, while not applicable in England to any great extent, must appeal to those who had to do work abroad. The author gave the price per e.h.p. of some completed hydro-electric stations as £7 10s. or £10 per kw. installed. He appealed to Mr. Clayton to amplify that figure and give the price per h.p. year or per kw. year in Scandinavia. With power stations installed for only £7 10s. per e.h.p., he was inclined to think that unless the cost of transmission was unnecessarily high it would be very difficult for a steam-driven station to compete with it. Sweden and Norway, with 8,000,000 h.p. available in water power, were two very favoured countries. He asked Mr. Clayton whether that horse-power was rated upon the drought rating or taken upon the average rainfall for the year.

Mr. Stjernberg considered that Mr. Clayton's estimate regarding the inherent regulation was very low indeed. Had any tests been made by short circuiting the machines? Probably if the regulation had been greater, the effects of short circuits would be very much more severe. The author told them that no short circuit troubles had been experienced in Sweden, but he (Mr. Stjernberg) was informed that in several places choking coils were expressly provided for reducing the effect of short circuits.

Mr. H. Brazil stated that with regard to the resistances used in connection with the lightning arresters, these were very important. He thought it was generally agreed that a very large proportion of the troubles which had been experienced with lightning arrester apparatus was due to the resistance not being of sufficient capacity to withstand the heavy load thrown on them when a discharge occurred. The problem of designing a suitable resistance for the purpose was a peculiar one, as it was required to have a very high ohmic value and at the same time the capacity for absorbing very heavy loads for a short period. Having had a considerable amount of experience with the water and carbon type of resistance, he ventured to disagree with the author's conclusion that a water resistance was the best. He was quite prepared to agree with Mr. Clayton if by carbon resistances he meant only the carbon rod or other compressed type, but would suggest that there were other types of carbon resistance, which, at any rate, to his mind, were much to be preferred to the water type. Failures with the carbon rod type were nearly always due to the fact that it was very difficult to get the resistance per unit length anything like uniform, and when a number were in series, it was more than likely that one of them had a high resistance point or crack in it. His objections to water resistances were that (1) they introduced moisture into the E.H.T. Chamber; (2) they varied in resistance to a very great extent with the ordinary temperatures obtaining in sub-stations; (3) the possible range of temperature, and, therefore, the capability of absorbing power for any length of time was very limited; (4) a very small quantity of impurity getting into the water would alter the resistance value to an enormous extent; and (5) if subjected to severe cold they would freeze. Concerning the permanent leak arrester, he agreed with Mr. Clayton that this was a very valuable piece of apparatus. He had no personal experience of the water jet type, but imagined that it required a good deal of attention, as the value of the resistance varied considerably, especially if anything got into the water. He took it that all engineers, if they could obtain a dry resistance which cost no more and was as efficient, would instal it in preference to the water type. He suggested a resistance consisting of a number of insulating slabs, made of material more clearly resembling porcelain grooves about ¼ in. wide. These grooves were filled with a very high resistance powder, and the slabs were stacked one on top of the other and connected in series.

Mr. W. H. Patchell pointed out that the early forms of transmission apparatus referred to by the author were to be found in operation in mines in Cornwall. It depended simply upon the width of the water wheel cranks as to how far the flat rods were kept apart. If engineers had to go to Sweden to learn how to make transformers, it was satisfactory to know that they had to come to England to find out how to make the cases.

Mr. Clayton (replying to the discussion) explained that the estimate of £7 10s. was not per e.h.p., but really per turbine h.p. The price per h.p. obtained in Sweden varied very much, but £2 15s. per h.p. year might be taken as a fair average. In many contracts made for a number of years at £6 10s. per h.p. year, a supply of the full quantity of energy was guaranteed, but a lower rate was charged when the supply was not guaranteed. The estimate of 8,000,000 water h.p. available in Sweden was made on a computation of the rainfall. He did not know a single power station in Sweden where choking coils had been introduced as mentioned by Mr. Stjernberg. He thought that the circulation of oil in oil-cooling boxes was a very troublesome thing. As to Mr. Brazil's observations, he did not like carbon resistances at all.

A hearty vote of thanks was accorded Mr. Clayton for his interesting paper.

COMMUTATION IN DIRECT CURRENT MACHINES.*

By C. L. ARNOLD.

The following remarks upon commutation are based upon the observation and experience of investigators and designers, and in no way profess to be original. To be original in such a branch of engineering, one must have unlimited time and every facility for experimental research. This is a subject which has already received a vast amount of thought from many brilliant intellects, but even now much is still obscure. Up till quite recently the sparking voltage was one of the chief limiting factors for the maximum output from a given size core for a direct current machine, but since the introduction of the interpole it has taken a secondary place, heating now being the controlling consideration.

I am assuming that all here are aware as to how an alternating current is rectified and transformed into a direct one, and so will get straight away into other aspects of the subject.

The methods for suppressing sparking may be divided up into two classes:

(1) Resistance commutation; that is, when the reactance voltage is suppressed by means of the ohmic resistance of the coils undergoing short circuit, and the resistance of the end connections, plus the brush and brush contact resistance.

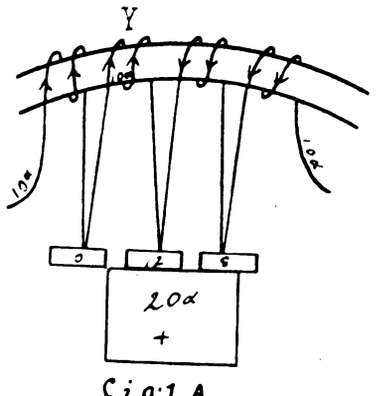

fig:1.A.

(2) Electro-magnetic commutation; that is, when reliance is placed upon some external magnetic field for neutralising the self-induction of the short-circuited coil.

As a general rule the two are combined, but there are cases where dependence is put upon resistance only: such as reversible motors.

Before looking further into the question for *preventing* sparking, it may be as well to see what takes place in the shorted coil itself.

I am going to assume an ideal case, that is, neglecting ohmic resistance of the coil, the self-induction of the coil, and the effect of any field external to the coil.

* Paper read before the Arc Works Engineering Society, Chelmsford.

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Now, resistance of contact is inversely as its area, and the current through each contact will be directly as its area. (See Fig. 1).

Let us look at coil y and follow its career immediately before being shorted, and just after being open circuited.

Again, let us suppose that the total current in the brush is 20 amps. This means that 10 amps. is being supplied from each half of the armature winding.

(A) Coil y carries 10 amps. The area of the segments in contact with the brush are as 3 is to 2, the current, therefore, in the segments is as 12 is to 8.

(B) The area of the segments in contact with the brush are as 1 is to 3 is to 1, the current in the segments is therefore 4, 12 and 4. The current in coil y is 10 minus 4, equals 6 amps.

(C) The area of the segments in contact with the brush are 2 is to 3, and the current in the segments is therefore 8 is to 12. The current in coil y is now 10 minus 8, equals 2.

(D) The area of the segments in contact with the brush are 1 to 1, and the current in the two segments is therefore 10 amps.

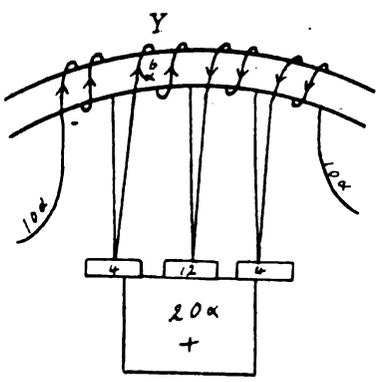


fig. 1.B.

Current in coil y is now zero, the current now passing direct through to the brush from each side of the armature.

(E) The area of the segments in contact is 3 is to 2, and the current, therefore, 12 is to 8.

The current in coil y is now 10 minus 8, equals 2, but, it should be noted, in the opposite direction.

Before leaving Fig. 1, it should be noted that at any point along the brush, that is from segment to segment, there will be no difference of potential, as the current density is the same at all points.

It will be seen that the current in coil y commenced with a maximum of 10 amps., died to zero, and reaches 10 amps. maximum again in the opposite direction. If we plot the different values, we shall obtain a straight line curve, as shown in Fig. 2. This is the state of affairs which should always be aimed at.

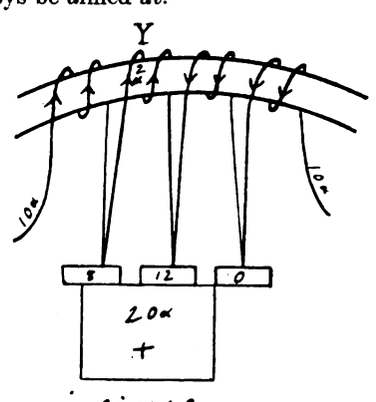


fig. 1C.

We will now pass on, bringing self-induction into the question.

It is well known that if a coil of wire has a current flowing through it, and that if we try suddenly to check the current by any means, the tendency of the current in varying from one value to another, is to set up an electromotive force in the direction of the current, and so prevent itself dying down. In other words, the effect is to retard any change of current.

I would call your attention again to Fig. 1, B, which depicts the distribution of current under the ideal condition; that is, the current is proportional to the area of each segment in contact with the brush.

As we saw before, coil y carries 6 amps., and the coil preceding it carries 6 amps. in the opposite direction. Let us now compare this with Fig. 3.

The position of the brush is as before, but let us suppose that coil y, instead of carrying 6 amps., carries 8, the extra two being on account of the self-induction of the coil which retards the dying down of the current. A moment

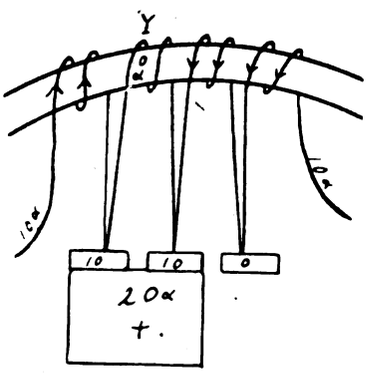


fig 1.D.

before this coil was carrying 10 amps., and under the ideal condition, and in the position we are now considering, should be 6 (Fig. 1, B). Likewise, suppose that the coil preceding it carried 4 amps. instead of 6, as the self-induction prevents the current from growing beyond a certain rate, 10 amps. coming in at each side of the armature, we now see that the distribution of the current under the segments, instead of being as at Fig. 1, B, that is, 4, 12 and 4, which is proportional to the areas, will be as in Fig.

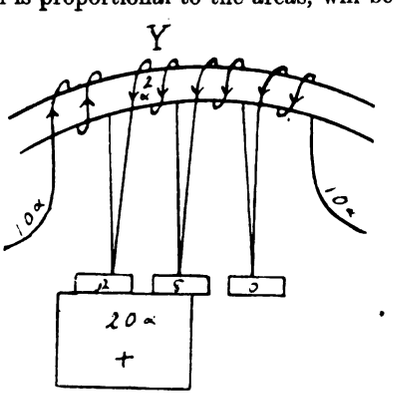
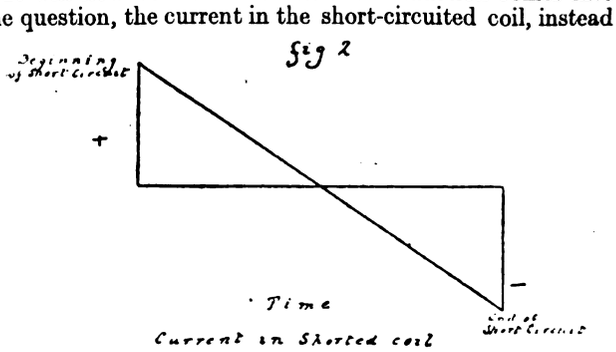


fig. 1 E

3; that is, 2, 12 and 6, and the current densities will be as 2 is to 4 is to 6.

We see from this that in a dynamo the current density in the trailing edge of the brush is considerably higher than that at the leading edge (neglecting any external field), and *vice versa* for a motor.

It will now be seen that when self-induction comes into the question, the current in the short-circuited coil, instead



Current in Shorted coil for Ideal case

of dying down from a maximum to zero, reversing and reaching a maximum again in the opposite direction in a straight line curve, will assume a shape as in Fig. 4.

During the final stages of commutation, the area of the segment in contact with the brush decreases, and the resistence increases. The current at this point changes at a rapid rate, as shown by the steepness of the curve. This

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rapid change induces a high electro-motive force of self-induction in the coil, which may be sufficient to cause a spark to jump across as the brush leaves the segment.

Not only may there be an unequal distribution of current in the brush, but large circulating current may be caused to flow in parts of it if the shorted coil has induced in it an electro-motive force due to its rotation in an external field, this induced electro-motive force in its turn giving rise to currents, the value of which depend upon the resistance of the coil, etc. It is well known that the armature itself gives rise to a flux at right angles to the field flux, and if the shorted coil rotates in this flux it gives rise to an electro-motive force in the coil which helps the electro-motive force of self-induction, and thus retards commutation to a greater extent than if self-induction alone comes into operation.

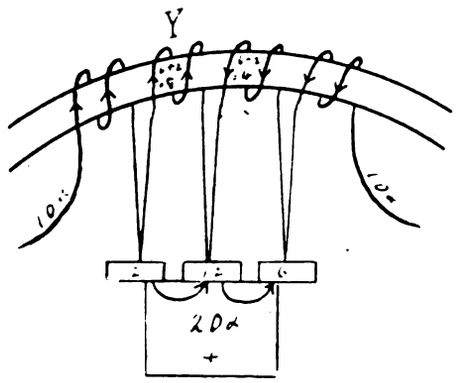
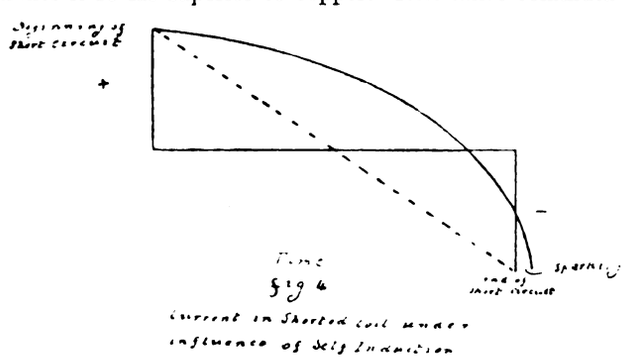


Fig. 3

I wish again to refer to Fig. 3. As we saw before, the densities at the segments were 2, 4 and 6, and there will, therefore, be a greater drop of potential at the right-hand segment (its density being higher) than that at the middle segment. Likewise, there will be a greater drop at the middle segment than the one at the left-hand. We therefore see that there is an electro-motive force acting in the direction shown by the arrows. It should be noted that this electro-motive force opposes that of self-induction.

If we look at coil y, we see that self-induction is in the same direction as the current (indicated by arrows), and the electro-motive force, due to difference of current density in the brush, is in opposition.

Due to the high contact resistance of carbon, a small difference of current density produces a comparatively large difference of potential, and it is this property which makes it so far superior to copper. Resistance commutation depends almost entirely upon the contact resistance, the resistance of the coil itself and its leads being of quite secondary importance.



It will now be expedient to examine the properties of the brush itself in some detail.

As just stated, the contact drop of carbon brushes is much higher than that for copper brushes. Carbon varies from ¼ to 1½ volts according to the quality, whereas copper, under the same conditions would be more of the order of ·05 volts.

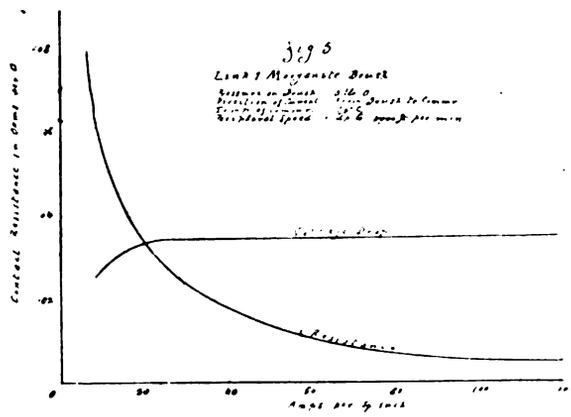
In the following remarks only carbon is being considered:

If the commutator be stationary, the resistance of contact agrees with Ohm's Law; that is, as the current density increases, the drop of volt goes up. But if the armature be rotated, the resistance goes down as the current density increases. Fig. 5 shows the form the curve takes: this is of a Link 1 Morganite brush. It will be noticed that the drop is almost constant after passing a certain value.

Time also has an effect on the contact drop. I have been in correspondence with the Morganite Crucibe Co., the manufacturers of the Morganite brushes, and they have very kindly given me some valuable information.

They state that two days' run is always allowed on their test pieces before taking readings.

Another fact to be noted, and which has a very important and practical bearing on the subject, is that the drop at the negative brush is almost unaffected by temperature, whereas the drop at the positive brush, that is, where the current flows from copper to carbon, goes down as the temperature increases.



The firm just mentioned give the following figures: Drop at 20° C., current density of 60 sq. in. was ·8, but at 80° C. the drop went down to ·5. Although in practice the temperature should never reach the value of 80° C., it will be seen that the drop may be considerable even at normal temperature rises of, say, 45° C. It is often found that a machine may be quite sparkless when first started up, but on reaching a certain temperature it commences to spark at the positive brushes. This is accounted for by the facts just explained.

Professor Bailey and Mr. W. S. H. Cleghorne have given much useful information regarding the properties of carbon brushes.

The effect of pressure and speed, they found, has considerable influence on the contact drop, more especially

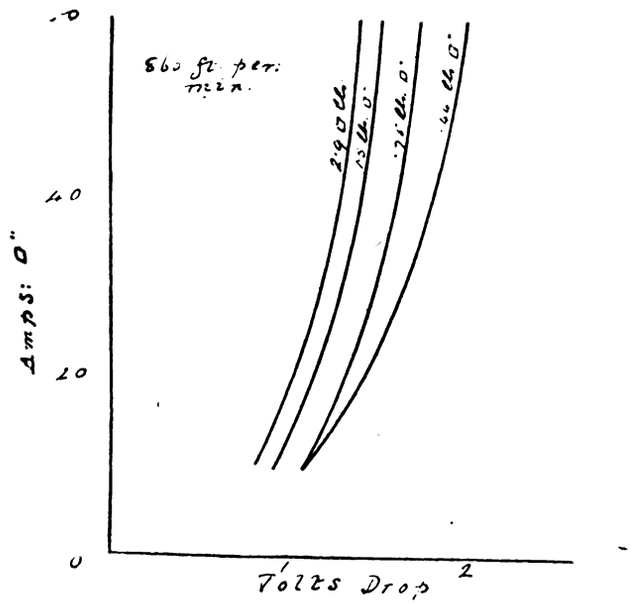


Fig. 6.

when the pressure is below a certain value. It will be seen from Fig. 6 that the speed has very little effect on the drop at a pressure from 1½ lbs., but a very marked effect is produced if the pressure is below about ¾ lb. At ½ lb., with a current density of 60 amps. per sq. in., it varies from 2 at 860 ft. per min. to 3·8 at 3,300 ft. per min. It seems from these curves that there is not much to be gained by increasing the pressure above 1½ lbs. per sq. in. In practice, however, the pressure is generally about 2½ lbs. per sq. in.

Referring to the question of lubrication, often paraffin wax or some such substance is used. When first put on it

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causes sparking and a greater drop at the contact, but when it has become softened and uniformly spread, due to the heating of the commutator, more reliable results are obtained. Then it makes but a small difference to the drop and reduces friction losses considerably. Below a pressure of ¾ lb., however, the drop is considerable, and the contact imperfect. On a lubricated commutator with a pressure of about 2½ lbs. per sq. in. a marked difference is noticeable at different speeds. At 1,200 ft. per min., current density of 60 amps. per sq. in., the drop was 1·3, but at 3,300 ft. it was 2·25, whereas under a non-lubricated commutator, it will be remembered, there was no difference at all.

It is a very remarkable fact that an insulator such as paraffin wax permits large currents to pass at all. On stopping the drum, Professor Bailey found that the resistance went up enormously. I believe it is common practice to put paraffin oil on the plugs of Wheatstone Bridges, a better contact being obtained thereby, and I have heard the following explanation put forward.

Between two surfaces there is always a thin layer of air, and no matter how much pressure one may put on, it is exceedingly difficult to get rid of. Now, oil seems to displace the air quite readily, *i.e.*, it leaves no film of air between it and the metal, and on pressing the two surfaces of metal together with the film of oil between, the oil is more readily squeezed out than is the air in the former case, and better contact is obtained.

I only quote this as being an interesting case. It is very curious that on rotating the commutator the resistance is quite low, yet in stopping it it goes up considerably, depending, of course, upon the quantity of oil and its condition. Generally speaking, I think that lubricating is to be avoided.

Vibration has a very marked effect upon the drop at the brush contacts, and was much emphasised upon by the Morganite Co. They state that it causes sparking and unsteadiness of the drop, and must be avoided as much as possible. This goes to point out how important it is to have well-designed holders.

Having considered the brushes themselves, I think it will now be expedient to look into the question of reactance voltage and the armature ampere turns per pole. It must be noted that sparking ultimately depends upon these two factors, for the deviation of the current in the shorted coil from the straight line condition is directly caused, firstly by the reactance of the coil itself, and the mutual induction of the coils lying close to it, which may be shorted simultaneously, and secondly, by the armature ampere turns. When the brushes are in the neutral position the self and mutual induction create an E.M.F. in the coil, in the same direction as the E.M.F. due to rotation of the coil in the cross flux, and thus directly help each other. When the brushes are shifted to the best average position, the angle of the displacement depends upon the strength of the cross flux. Should this factor be very large, the distortion of the main field flux, and the weakening of the pole tip, towards which the brushes are being moved, will be so great that it will be impossible to get to a position where a reversing field is obtained.

I may state here that the term I shall use a little later on, that is, the sparking voltage, is a different thing to the reactance.

It is reactance volts plus external volts, this latter term being that voltage caused by the coil rotating in the cross field, part of the main field, or the flux from an interpole, in fact, any external flux.

The question of reactance voltage can only be dealt with very shortly, for it is one which could well take up a whole paper.

Up to the present no exact data are available for calculating the reactance voltage with precision. So many conditions come into the question, and it is generally assumed that simply the load current dies down, assuming the form of a true sine curve, so it should be stated at once that values given should be used in a relative sense, and certainly not as representing exact values.

Hobart found that the free length of the conductor 2 c.g.s. lines per ampere turn per inch length could be taken as a good rough standard, and 10 c.g.s. lines for the embedded length. The method by which he arrived at these results are fully given by him, and will be found in Vol. 31 of the proceedings of "Electrical Engineers."

It may be useful to work out an example using these figures:—

Amperes per conductor	29
Turns per section	2
Sections short-circuited	2
Free length per turn	29 in.
Embedded length per turn	24 in.
Revolutions per minute	525
Diameter of commutator	10 in.
Thickness of brush	00·5 in.
Linkage for free length: $2 \times 2 \times 2 \times 29$	= 230
Linkage for embedded length: $2 \times 2 \times 10 \times 24 \times 2$	= 1600
	1830

1830 divided by 10^8 = ·00001830 Henry.

Cycles ($\sim$): $\frac{\pi \times \text{diameter of commutator in inches} \times \text{r.p.m.}}{2 \times \text{width of brush in inches} \times 60}$.

Reactance = $2\pi \times$ cycles $\times$ Henry's $\times$ amperes $\times$ turns in a coil = $2\pi \times 274 \times \cdot00001830 \times 29 \times 2$, = 1·82 volts.

As a rule, several segments are short circuited simultaneously, and the coils may not necessarily be in the same slot, but may be spread out into 2 or 3. Now, if two equal coils are in one slot, the lines emanating from coil will produce in coil 2 an electro-motive force of mutual induction, which is nearly the same as that of the self-induction. In this case, therefore, the ratio of mutual to self-induction is practically unity. But if the two coils are embedded in neighbouring slots, this ratio lies some-

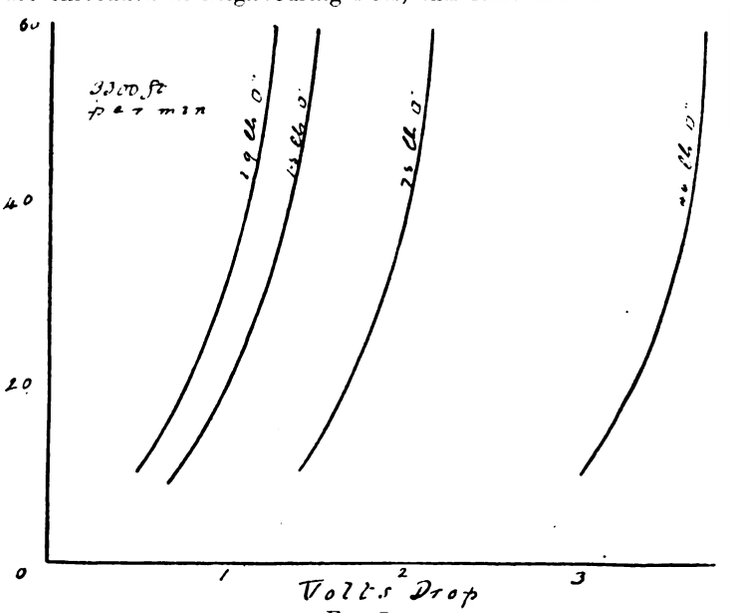

FIG. 7.

where between ·6 and ·8. It will be seen from this that supposing several coils which are shorted simultaneously, and are all in one slot, the effect of reducing the width of brush will reduce the sparking voltage to a greater extent than if we did the same thing, but the shorted coils were spread over several slots.

The question as to whether the sparking is reduced by narrowing up the brush is a complicated one, and can only be dealt with at short length here.

Consider the case of a short circuited coil, neglecting the armature cross flux and the main poles. Due to the ohmic resistance and the self-induction of the coil, a given current will take a definite time to die down to zero value. Now, it is quite obvious that it would be useless to prolong the period of short circuit beyond this time. In the case of a dynamo or a motor there is a variable resistance introduced—due to the brush and the brush contacts. The resistance goes up as the arc of contact is decreased, but is not proportional for the current density affects the resistance of contact.

It will, therefore, be seen that it is a matter of some difficulty to calculate this time. So we see that up to a certain point, increasing the width of brush, under these conditions, is beneficial. The exact amount cannot be stated, for it is a subject which calls for investigation, and so is a very debatable question at present. I think, however, there is no doubt that the width of brush generally used at the present day, ·5 to ·75 of an inch, does give too high

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a periodicity of reversal, to take full advantage of the maximum time allowable due to the constants of the short circuited coil and the brushes.

But when the cross flux and the main poles are introduced into the problem, the state of affairs is quite altered. Under these circumstances an external flux is linked with the coil due to the cross or main field flux. Assume that two coils are shorted simultaneously, and that each coil occupies a slot, the one slot being removed from the other by a considerable distance. Now, it will be seen that it is impossible to get the two coils under a proper reversing field at the same time, one will either be too strong when the other is correct, and so on.

The coil in the strong field will have an electro-motive force induced in it, due to this field, which in turn gives rise to, it may be, large currents, this, of course, depending upon the resistance of the coil and brush.

So we now see that widening the brush up to a certain point may be to the good, insomuch as it reduces the frequency of reversal; at the same time, it permits the coil or coils undergoing short circuit to come too much under the influence of the pole it is approaching, which may give rise to large circulating currents. The last factor

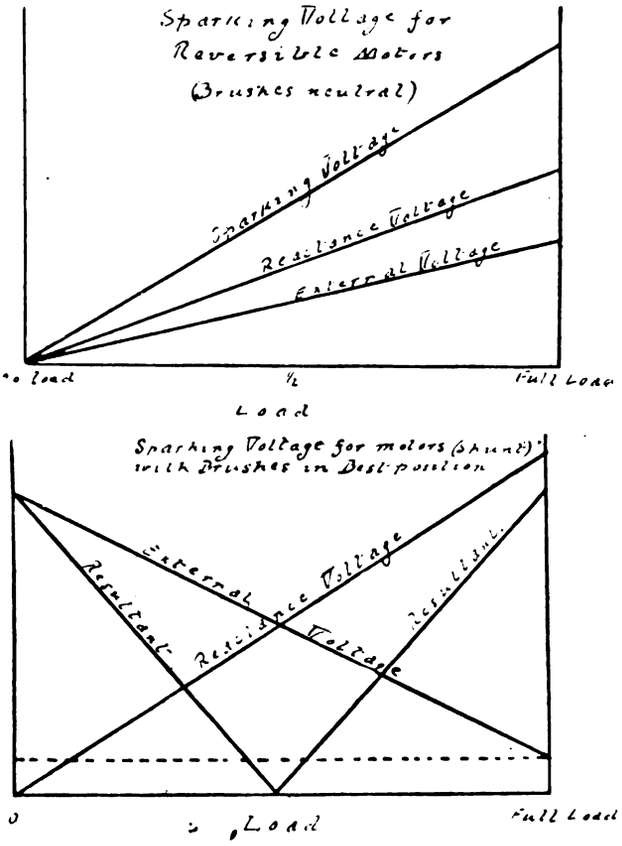

FIG. 8.

seems to be the more important of the two, especially when by widening a brush another coil is shorted, which lies in the next slot, the distance between the two slots being comparatively large.

Generally speaking, and on this nearly all authorities are agreed, reducing the brush to about one and a half times the width of one commutator segment plus one mica insulation is beneficial.

As a rule, we are unable to go to this extent for mechanical reasons and considerations of cost.

Coming now to the one case, which I mentioned at the beginning of these notes, of suppressing sparking by resistance methods alone, *i.e.*, reversible motors, where the brushes are placed in the neutral position.

The state of affairs is represented diagrammatically in Fig. 7.

The external voltage goes up as the armature ampere turns increase from no load to full load. Likewise, the reactance voltage goes up as the output increases. These two add themselves and we obtain the curve 3 (Fig. 7).

It is very interesting to compare this with the condition of affairs when the brushes are placed in the best position. Here, of course, we come to electro-magnetic commutation, for the brushes are shifted until a point is reached where the shorted coil rotates in a flux, which gives rise to an electro-motive force opposed to that of self-induction of the coil itself.

Now, sparking voltage equals reactance voltage plus external voltage, and there is only one *fixed* position for which this equals zero. At any other load it differs from zero, being positive for larger loads and negative for smaller loads.

Sparking depends upon the *magnitude* of reactance plus external voltage, and it is therefore best to choose that position where the voltage at the lightest load equals that at the highest load, but is of opposite sign. Then at half load the sparking voltage is zero. The state of affairs is depicted in Fig. 8.

It will be seen that the external voltage commences at a certain value at no load, and reaches a certain smaller value at full load. That is to say, the brushes are placed in such a position that at no load the flux from the pole induces in the shorted coil in one direction a certain electro-motive force.

Now, when the load comes on, the self-induction goes up until we get to the place where the two cross, and the sparking voltage is nothing for they exactly neutralise each other. After crossing, the reactance voltage still increases, but the external voltage is decreasing, so that the sparking voltage commences to go up again until we get to the limit allowable. The external voltage decreases as the load goes up, for the reason that as the armature ampere turns increase, they oppose more and more the field flux linked with the shorted coil. We now see that with the brushes in the neutral position the reactance (resistance commutation) allowable should be half that for the brushes in the best position (magnetic and resistance commutation).

In the first case, the *reactance* is *helped* by the cross field of the armature, and in the second is *opposed* by the field from the main poles. This tallies very closely with actual results obtained in practice.

It may be interesting to give a few figures. The reactance voltage worked out by the method given for reversible motors should not exceed about $1\frac{1}{2}$ to 2 volts. The field flux should be high and the armature ampere turns fairly low to prevent undue distortion of the flux. Fig. 9 gives the values of the armature and field ampere turns per pole, these being plotted against the D^2L. This curve is to be used in conjunction with the reactance voltage per section given. The reactance voltage for machines with the brushes in the best position should not exceed about $2\frac{3}{4}$ to 3 volts.

Fig. 9 also shows the armature and field ampere turns per pole under these conditions.

The amount of the armature periphery covered by the pole shoes in the above curves is 75%.

It will be noticed that the ratio of field to armature ampere turns is roughly 2 to 1, and higher for machines with brushes in the neutral position.

Often resistance is inserted between the coils and the commutator. It is a very debatable point as to whether adding these resistances is warranted. Some claim to have obtained good results thereby. The longer time of commutation, the more effective is this added resistance, for it will be seen that the resistance of a segment to the brush is a variable quantity, increasing as the area in contact decreases. Therefore, the percentage increase of resistance of these lugs over that of the resistance of the brush contact, is a variable quantity, this percentage being higher for a longer period of time if the commutation is comparatively slow.

There are many other interesting devices for improving commutation, but since the introduction of the interpole, all these are unnecessary complications.

Here we have a means of neutralising the reactance voltage at all loads. For as these are excited by coils in series with the armature, the flux increases, as the self-induction goes up with the load. It is very necessary to keep the iron of the interpole below saturation point, *i.e.*, we must work on the straight part of the curve.

Before we obtain any reversing field, sufficient ampere turns must be supplied to neutralise the cross flux of the armature. To calculate the necessary ampere turns, the following formula may be used :—

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$$B = \left(\frac{E \times 10^8}{v \times l \times c}\right) + \text{armature ampere turns per pole.}$$

It should be noted that E equals the average self-induced voltage. By the method of working it out, given in these notes, we get the maximum. Therefore, we must divide it by $\frac{\pi}{2} = 1{\cdot}57$.

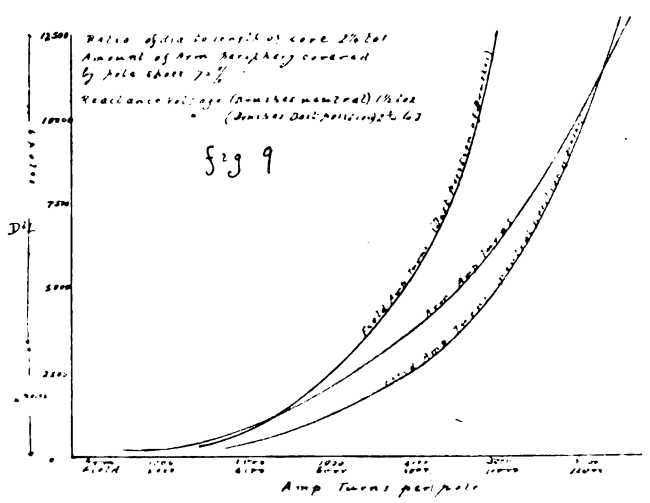
E = reactance voltage of the coil (average).
v = speed in inches per second.
l = embedded length of conductor in inches.
c = conductors short-circuited in series.
B = flux density in air gap of interpole.

The interpole should cover at least the number of slots wherein coils are short-circuited simultaneously.

Machines with interpoles fitted are commonly worked with a ratio of armature to field ampere turns of 1 to 1, the output obtained from a given size, armature core now being limited by heating consideration.

The reactance voltage may be worked to several times the values given for machines without any auxiliary device.

It may here be remarked that for a machine without interpoles the reactance voltage should *never* exceed a certain definite value, irrespective of the length of the core, whereas when interpoles are fitted, it may go up directly as the length, for, at the same time, the length of the interpole can be increased in proportion. As a rule, the length of the interpole is about $\frac{3}{4}$ that of the armature. This is in order that the ventilation should not be impeded more than is absolutely necessary.



Another device commonly used is the Deri winding. This is a winding placed in slots in the pole shoes, and is so wound that it completely neutralises the armature cross flux. This arrangement with interpoles is sometimes adopted.

A dynamo supplying a traction circuit has, of course, large and sudden fluctuations of load, and the interpole flux may be unable to follow these sudden variations with sufficient rapidity. In a case like this, some of the interpole current may be taken through a diverter which has an iron core.

The inductance of this diverter may be made higher than that of the interpole, and on a sudden increase of current taking place, the diverter will offer a greater resistance than will the interpole circuit due to its inductance, and more current will flow through the latter, thus righting matters.

Summing up the points raised in these notes :—

(1) The pressure per square inch on the brush should not be below about 2 lbs. : otherwise the contact drop varies with the speed and introduces an element of uncertainty.

(2) Vibration is to be avoided as much as possible.

(3) Lubricating the commutator is not to be recommended.

(4) The reactance voltage for a machine with the brushes in the neutral position should be about half that for a machine with the brushes in the best position.

(5) The width of brush should always be kept as near as possible to $1\frac{1}{2}$ times the width of one commutator segment plus one mica insulation.

One or two other points which may cause sparking might with advantage be noted here :—

Brush gear not being symmetrical.
Inexact alignment of brushes.
Hard mica between segments, or too soft segments.
Eccentricity in commutator.
Dirty commutator surface.
Inequality in angular speed of prime mover.

It will now be seen what a complicated problem commutation really is. And although the phenomena involved have been the subject of diligent research for many years there still remains a large and promising field for investigation.

In conclusion, I should mention that the works of the following gentlemen have been consulted :—

Messrs. Hobart, Bailey, Cleghorne, and Punga.

I am very much indebted to Mr. F. E. Allen, who most kindly went to the trouble of getting out the diagrams, and to Mr. P. B. Smith, who worked out figures for the reactance voltage. Also to the Morgan Crucible Co., who kindly sent me some interesting curves of the current in the shorted coil and gave much valuable information.

ELECTRODES FOR ELECTRIC FURNACES.

At the Southern Convention of the American Institute of Electrical Engineers at Charlotte, North Carolina, a paper on furnace electrode design was presented by Dr. Carl Hering, containing the results of an investigation by the author of the question of the proper proportioning of electrodes and the losses in them. Believing that no one had made a thorough investigation of this subject, based on unquestioned fundamental laws, the author some time ago made a careful study of the true underlying principles based on indisputable physical laws. The results of this work showed that some of the former rules used for the designing of electrodes were positively wrong, others were entirely inadequate, and still others were very misleading. The investigation was made both analytically and experimentally, and the present paper gives the results of both.

The fundamental principle on which the whole analysis is based is that there shall be no flow of heat through the hot end of the electrode—that is, there shall be no loss of heat from the furnace to the electrode, hence no chilling and no high temperature point within the walls. The electrodes are, therefore, so proportioned that the current through them will heat the hot end just to the furnace temperature.

The analysis shows that under the simplying conditions of uniform conductivities from end to end, this condition is also that of minimum total loss. It also shows that it is not proper to add the heat conduction loss to the resistance loss in order to get the total, as was formerly the general practice ; the proper way is to add the former to only half the latter. It also shows that current density is not a determining factor in the design of electrodes ; also that the resistance is not a matter of choice, but is determined by the conditions ; also that the conditions determine either the length or the section, but not both, hence leaving a choice ; it is only the ratio of the section to the length which is the determined factor ; also that neither the electrical resistivity nor the thermal conductivity alone are governing factors ; it is their quotient and product which are the true measures of the qualities and electrodes. The quotient of the thermal over the electrical conductivity is shown to determine the loss, while the product of the two resistivities determines the proportions, hence it is not necessary to know either one or the other of these properties, but only their quotient and product ; it is, furthermore, shown that these are more easily determined than the others. These two quantities lead to some new quantities not heretofore used, and by means of which the calculations of electrodes become extremely simple.

These two new quantities are the loss factor and the size factor. The values of these are tabulated in the paper for each of various temperature ranges, so that the only calculation left to be performed is a simple multiplication. One of these is the loss factor called " watts per ampere " ; this is multiplied by the current and the result gives the loss in watts directly, under the conditions stated above. The

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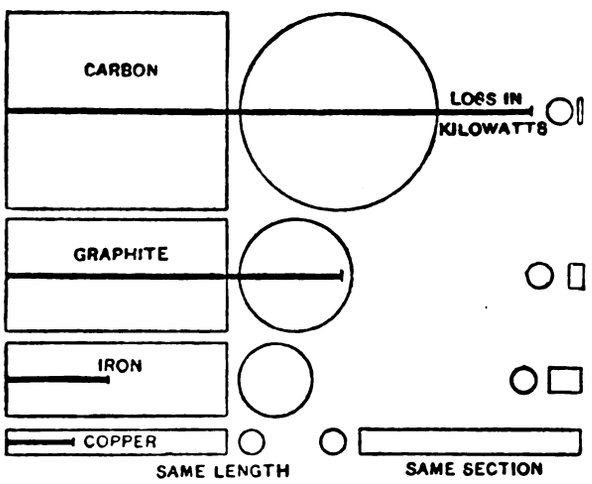
other new quantity, called the " section per ampere per inch of length," is similarly tabulated for various temperature ranges and is such that when multiplied by the current and by the length it gives the cross-section directly in square inches.

This is one of the main features in the paper, and is the final result of the investigation. Tables of these factors are given, besides a long table of other properties of the electrode materials, carbon, graphite, iron and copper, besides a large number of curves in which these values are plotted from the experimental determinations. These plotted values include practically all the different quantities which enter into the problem, and they are believed to be the first set of such values that have ever been determined.

They were determined by the method suggested by the author, in which method rods of the different materials are practically operated as furnace electrodes under the desired condition of no heat flow at the hot end, and the constants are then measured; from these measurements all the others are deduced. Many interesting and useful facts are brought out by the constants, as given by the author in his paper, a number of which had not been known before.

In the analysis the author has followed the process recommended by able scientists in considering the problem first under its simplest conditions, leaving minor correction factors to be considered later, if it is found necessary to do so.

In the author's method described in the paper, however, most of these minor correction factors are taken care of by making the determination of the constants in such a way that these factors are included in the results. Hence, the final results eliminate most of these correction factors by inclusion in the constants.



In this analysis he determines what he calls the laws of electrode losses, the more important of which have already been given above. He shows that these laws are fundamental and absolute under the assumed premises, namely, under the simplified conditions.

Among other things he shows that flow of heat in such electrical apparatus is best measured and expressed in watts, as this greatly simplifies the numerical calculations.

Formulas are given, all of which are extremely simple, showing the relations between all the various quantities.

The experimental constants obtained are the proper mean values under electrode conditions to be used in these formulas, and when so used they include the correction factors due to temperature variations of the two conductivities. These mean values are peculiar to electrodes, as they are neither the arithmetic nor the geometric mean, and he, therefore, terms them the " electrode mean."

The author has ventured to extend somewhat the curves drawn through the experimentally determined points so as to give approximate values for temperatures beyond those at which the tests were made, but he calls attention to the fact that they are only exterpolated values and should be used only as approximate and probable values until they have been definitely established experimentally.

These curves bring out a number of features which apparently have not been known before, and enable interesting and useful deductions to be made. Among other things they show that at moderate temperatures the mean thermal conductivity of carbon under electrode conditions rises instead of falling, as heretofore claimed, and is very much higher than was formerly supposed, being numerically equal to between one-half and one-third that of graphite instead of being one-eighth, one-tenth and even one-eighteenth as was formerly claimed; also that the mean thermal conductivity of graphite is even greater than that of iron.

All the formulas and tables are given in actual units so that they can be used directly in practice. The investigation was made from the standpoint of the requirements of the engineer as distinguished from those of the physicist or academician. By thus neglecting the minor factors, which are too small to be of any importance to the engineer, the results become greatly simplified and are in such form that they are easily applied in practice.

As an example of the general results one of the illustrations is reproduced herewith, which shows the relative sizes and losses of electrodes made of different materials for a furnace requiring 10,000 amperes and having a furnace temperature of 1,400° C. The first set shows the different cross-sections for the same length, and the second set the different lengths for the same cross-section; the heavy lines represent by their length the total losses in the different electrodes. This shows that carbon electrodes tend to become very large in cross-section, often impracticably so, and that even with these much larger proportions the minimum loss is still considerably greater than for graphite, and that both of them are very much greater than for iron.

ELECTRIC LAMP DEVELOPMENTS.

(From our New York Correspondent.)

To the recent meeting at Minneapolis of the Minnesota Electrical Association, Mr. S. E. Doane, Chief Engineer of the National Electric Lamp Association, contributed a paper on electric lamp developments, of which the following is an abstract:—

In the high efficiency lamp, the most interesting development of the year has been the fact of the manufacturers of the world coming together in technical development. When the tungsten lamp first came out in Germany, of course, the American manufacturers all went abroad to purchase the foreign rights. It developed the fact that there are only about 30 men in the whole world who are mentally equipped and competent by training to do high class research work.

Carbon lamp development worked altogether in a different way. Carbon is a curious chemical compound. It is extremely difficult to accomplish anything unless one has a foundation upon which to build, whether it is the building of a house or whatever it may be, you must have a firm foundation upon which to build. Carbon is such a curious thing chemically that we do not know whether we ever saw real carbon chemically. It is hard to get a grasp of the situation. We know the carbon lamp is the result of working with a definite element, but the tungsten lamp is the work of physical research. All carbon is worked at a high temperature, and the film manufacturer had to blaze the way. The manufacturers of the world have now come together, and we exchange among ourselves the results of our investigation and research work. The result is that among these 30 men there are perhaps only a half-dozen men in the United States directing research work, and they have probably 100 men assisting them. Abroad they have more men of that character, but they have less money to work with.

I do not think any art in the history of the world has developed like this, where the whole research ability has been spread among different problems, so that the various men need not duplicate one another's work. That insures the progress of the high efficiency lamp which is almost as sure as the rising of the sun. I know lamps can be built for much higher efficiency than now. We have heard of a few lamps with ·75 as against 1·5 watts, and the fact that a few lamps have done that means that when we have mastered our chemical problem we shall have our wattages reduced considerably. I think a ·5 watt is reasonable to say will come; it may not be next year, and it may not be the year after, but it is certainly coming. The trend of the times has developed another curious situation, and

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that is that the central stations as a class have not attempted to push the tungsten lamps. I do not know of a single case among the 6,000 stations where they have consistently taken the carbon lamps out and put in tungsten. Some have adopted the tungsten policy to see what would come of it, and the unmistakable trend of the times has been toward a lower voltage lamp.

Abroad they have developed a 20-watt lamp; they have produced a 20-watt lamp. The filament of that lamp is 20 one-thousandths of an inch in diameter, and it is worked with a magnifying glass. The times have developed a demand for a low wattage lamp, and we have to produce a lamp that is practical and also a low voltage lamp. One lamp I have in mind at Hartford, Connecticut, where they use a 60-volt and 12-watt lamp as a standard. They also have produced a cheaper filament. A 60-foot filament is cheaper to make than a 100-foot filament. The greatest development has been in the high wattage lamps, 500 to 1,000, and while such lamps have been built upon order, and while we have had some commercially installed, we feel we cannot say they are successful. It may be satisfactory; we have not had time to find out. It takes a great many days to find out even with a 24-hour day.

I think, perhaps, the most interesting work which the lamp manufacturer has done this year has been to determine just why the central station has not been adopting the tungsten lamp. I was talking with one of the largest central station men last week, and he said he had framed a definite policy for his community, and that is to put in the tungsten as fast as his business increased. He could not consider the displacing of the carbon lamps and putting in the tungsten. When we consider that the tungsten is the most remarkable development in the history of the art, it is hard to realise why the central station should take this attitude. If a man should come to you and say he would build a boiler, or could do something of that sort, whereby you could get a pound of steam from three pounds of coal, you would immediately consider ways and means as to how you could install that boiler.

The question of whether or not you wanted it would not enter into consideration, but it would be a question of what it would cost you, and you would throw away the old equipment and put in the new. The lamp manufacturer comes along and does just that same thing. He gives you twice the light from the same energy, from the same investment, the same service wire, you do not have to scrap a single thing to get it, the sockets remain and the new lamps are screwed on in place of the old, and everything is just the same except the lamps. When one considers the enormous possibility in such an innovation, the enormous saving, one's first thought is that the central station would be glad to carry the new lamp. We see the trouble in the situation is based on the tremendous advantage which comes to the customer's side of the meter, and we all know the reduction in cost to the consumer is very much greater than the reduction in cost to the central station.

I hear it all over this country that the central station man is awake to the situation; he is awake to the fact that 70% of his income in general figures comes from lighting. Statistics show there are from a million to 500 million dollars invested in central station equipment, and that is really only about 4%, so it is quite obvious the central station can stand a little reduction in income, and it is quite sure he can stand the reduction if there is no cost to himself.

Note that we have the economic situation where, if it were possible immediately to add twice as many customers to our mains, as we have at present, it would probably be possible to cut the cost to the consumer in half and increase the profits to ourselves.

COMPANIES REGISTERED.

Nu Ads.—£2,000 (£1). To take over certain patent rights from F. J. Blaxley, C. C. Chapman, A. C. Harris, and F. H. Blaxley. Manufacturers of and dealers in electric advertising signs, etc. Private.

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STORAGE BATTERY USES.

"Recent Developments in Storage Battery Application" was the subject of an interesting and instructive address delivered by Taliaferro Milton, district engineer for the Electric Storage Battery Co., at the regular mid-day meeting of the Chicago Electric Club, on Wednesday, April 6.

Mr. Milton, by way of introducing the subject, made a few general remarks regarding the use of storage batteries and the question of their use by many of the illuminating companies, pointing out that in Chicago the Commonwealth Edison Co. has installed about 27,000 kw. in storage batteries, and in New York the Edison Illuminating Co. over 57,000 kw.

However, the most recent application of storage batteries has been for regulating fluctuations in alternating-current loads and Mr. Milton mentioned several installations of this character.

The first equipment mentioned was installed by the East St. Louis and Suburban Railway Co. in its power station at St. Louis. At the time of the installation there was in use at this station a storage battery with the shunt regulating booster and carbon regulator for regulating the fluctuations of the direct-current load. The battery consisted of 300 cells of 12,000 amperes capacity, and was of sufficient size to contain elements of 24,000 amperes capacity momentarily. The equipment of the plant also included two 800 kw., three-phase, engine-driven turbo alternators supplying 13,000 volts to a number of rotary converters, and also a 300 kw. rotary converter which was used to supply current to the 600 volt railway bus.

The battery, with a booster in series, was connected directly to the direct-current terminals of the rotary, the rotary being operated as a shunt-wound machine self-excited, with a series winding cut-out. The current transformers were connected in the alterating-current leads of the alternator and the secondaries of these current transformers were connected in parallel to the solenoid of the carbon regulator, the carbon regulator, in turn, controlling the field of the booster, in the same manner as used in direct-current work.

The booster voltage was therefore made to vary with the variations in current in the alternating-current mains, and the battery, through the converter, was enabled to take the fluctuations from the alternating-current system.

Another interesting installation mentioned by Mr. Milton was in the power plant of the Carnegie Steel Co. at Youngstown, Ohio, in which the watt-solenoid method of control was used to control the field of an alternating-current booster.

The battery in this case was connected directly across the direct-current terminals of a rotary converter without any booster in the battery circuit on the same shaft. With the rotary was placed a small alternating-current booster which consisted of a three-phase generator with three separate windings. Each of these windings was connected in series between the alternating-current busses and one of the slip rings on the rotary.

Other similar installations at Spokane, Wash., and at Gary, Ind., were briefly described, and the features of each installation pointed out.

The speaker then described a new apparatus which has recently been placed on the market, known as the "Average Load Adjuster," which automatically regulates the fluctuations of a load by means of a motor, the armature of which is geared to the adjusting wheel of the carbon regulator. The field of this motor is excited by booster voltage.

In accordance with the recent practice of illuminating companies, using storage batteries only as stand-by batteries in cases of emergency, Mr. Milton stated that the thin pasted plate as used for automobile cells had been successfully used for this class of work. He said that batteries of this construction are of double the capacity of the older types, and the first cost is only about 35% more.

In conclusion, the speaker described a new high capacity and cell switch being placed on the market, which has a capacity of 5,000 amperes continuously, 10,000 amperes for twenty minutes, and 20,000 amperes momentarily. The general design of this switch involves such modifications of the modern cell switch as are necessary to provide for the heavy current to be handled.

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Secretaries and Managers of Companies are asked to furnish Notices of Meetings, Issues of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers.

Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

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THE MONTEFIORE PRIZE.

As is generally known, Monsieur George Montefiore, founder of the Institut Electrotechnique Montefiore, of Liége, allocated a capital sum of £6,000, the interest on which was to be awarded triennially as a prize for original work in electrotechnics. The first award is to be made next year, and the Association of Engineer Graduates of the Institut Electrotechnique Montefiore, of Liége, as trustees of the Montefiore Foundation, have just issued particulars of the trust. The interest on the capital sum (which is invested in Belgian Government securities at 3%) is to accumulate and be awarded every three years, after an international competition, to the best original work for the scientific advancement, of the technical application of electricity in any branch. Mere compilations or works of vulgarisation are not eligible. The first award is to be made next year, when the prize will be no less than £800. Competing works may be either printed or typewritten, and written in French or English; and twelve copies must be sent in not later than March 31, 1911, to the authorities at Liége, as directed in our Notes. The jury is to be composed of ten members, six of whom are to be Belgian electricians (mostly graduates of the Institut Montefiore), and five foreign electricians, who will rank equally for voting powers. A wise provision has been made for the possibility of no work of sufficiently outstanding merit having been presented. In such a case, the two groups, voting separately, may, by a four-fifths majority in each group, decide to divide the prize. But the intention is to offer a substantial reward for really valuable contributions to the science of electricity. On the other hand, by a majority as above described, one-third of the triennial prize may be set aside and awarded to a person who, though not competing, and not having to his credit a work actually complying with the conditions laid down, might yet

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put forward a new idea showing possibilities of important developments in the domain of electricity. If by any chance the whole sum accumulated during the three years is not awarded, then the surplus (and its interest) shall go to augment the sum to be awarded on the next occasion. It is to be pointed out that the primated works will be printed in the *Bulletin* of the Association, and that for this purpose English papers may be translated into French by the Association. It will be seen that the regulations of this important Foundation are conceived in a most liberal spirit, and is in a way best calculated to encourage original work in connection with electrotechnics. It may be said that geniuses and inventors generally will work whether they are offered adequate rewards or not, and no doubt originality is difficult to suppress. Yet material rewards do encourage endeavour, and certainly facilitate the labour of research, and the subsequent drudgery of perfecting and propaganda. Therefore, this Montefiore Foundation should prove a boon to electrical engineers and beneficial to the advancement of electricity. We may take it as a very pretty compliment that this International Foundation, domiciled in Belgium, and owing its origin to a French-speaking Belgian, should recognise the English language as one of capital importance in the domain of electricity. It is to be hoped that this compliment will urge on our fellow-countrymen to do what the Founder most desired—make a bold effort to carry off the prize. Certainly such a victory would have its immediate sweetness, but probably would prove chiefly valuable as a means of hastening forward the acceptance of any new discovery or application. Electricity is so far-reaching, so much still remains to be done, that these triennial contests may be made very notable red-letter days in the progress of the science. Let us hope that this next year's event, the inaugural event, may (as with the Italian Government competition for safe earthing) prove epoch-making.

CORRESPONDENCE.

All communications intended for the Editor should be addressed "The Editor, 149, Fleet Street, London, E.C." Anonymous communications will not be noticed. Letters should reach the Editor not later than Tuesday afternoon to be included in that week's issue of the Journal.

The Editor is not responsible for, nor does he necessarily endorse opinions advanced by correspondents.

DUCTILE TUNGSTEN.

Sir,—In your issue of April 8, 1910, you referred to some work done in this laboratory on ductile tungsten, in a way which reflects credit upon me personally. The successful work referred to is the result of the efforts of a group of operators and research men, foremost of whom are Dr. W. D. Coolidge and Dr. C. G. Fink.

Will you kindly publish the above statement in your next issue?—Yours, etc.,

W. R. Whitney (Director).

General Electric Co.,
Research Laboratory, Schenectady, N.Y.
April 15, 1910.

[We have much pleasure in complying with Dr. Whitney's request, which amplifies the information cabled over by our New York Correspondent.]

GAS v. ELECTRICITY.—THE WESTMINSTER CONTRACT.

Sir,—With reference to the street lighting in the City of Westminster, it may be said that the Westminster City Council cannot be criticised for accepting the lowest tender submitted. For, as business men, they would accept the best value offered for the money, irrespective of the question whether the seller was supplying at a profit or loss.

Apparently, the price quoted by the Gas Co. is in the neighbourhood of £22 per annum per 3,000 c.p. unit for 3,940 burning hours. It is easy to verify from the following figures that this price must be greatly below cost.

Mr. T. Bradley, the engineer to the Westminster Corporation, in his recently published report on this street lighting, gives the most efficient gas lamps as the Whitehall lamps, producing 985 average candle-power, with a consumption of 28 cub. ft. per hour, or 35 c.p. hours per cub. ft. of gas. Mr. Bradley notes that the statements of gas consumption are made by the Gas Co., and cannot be verified by his department.

With this basis, the cost of gas alone, at 2s. 6d. per 1,000 ft., will be £45 per annum; the Gas Co. have, in addition, to provide for cost of mantles, attendance and fines when the lamp falls below the guaranteed candle-power.

Gas Companies usually conceal most carefully the figures for their street lighting; if, however, the above assumptions are wrong, it would be interesting to hear the exact figures they are working on.

The Journal of Gas Lighting has contradicted my statement that with high pressure gas the light falls off very rapidly, and points to the high pressure lamps in Fleet-street as convincing testimony to the constancy of candle-power. I regret I cannot take their statements as being less biassed than my own. I have frequently seen high-pressure gas, and, although I admit in some cases the candle-power of the mantles does not fall off rapidly, this appears to be due only to the fact that the high pressure gas mantles fall off from the lamps still more rapidly.

The high-pressure street lamps are usually attended by active and nimble men running up light ladders and renewing the mantles both morning and evening, the extra efficiency being gained at the expense of mantles blown off by the high-pressure gas.

It has been suggested that a cinematograph record of the attendance given to a high-pressure gas lamp would afford few dull moments.

Apart from photometric measurements that give candle-power only, the distribution and qualities of light are the determining factors in public lighting, and I believe a cab or 'bus driver is as competent as a photometer in gauging the useful effect of street lighting. Drivers prefer the mellow colour of flame arcs placed well above the line of vision, to the sickly green of gas lamps dotted at frequent intervals some 12 or 15 ft. above the roadway.

From the protest raised by the Westminster shopkeepers, there is no doubt that these people prefer the electric light. Mr. Bradley's tests show conclusively that the most modern electric lamps are cheaper in running costs than gas, when the candle-power given by either is sold at commercial prices.

The regenerative lamps at the Marble Arch are costing ·00054 pence per candle hour per annum; figures such as these should be taken, and not the obsolete figures on old pattern electric lamps preferred by gas companies when giving estimates of comparative costs.

Yours faithfully,

A. Denman Jones,
Manager.

The Jandus Arc Lamp & Electric Co., Ltd., Hartham-road,
Holloway, London, N., April 25, 1910.

INSTITUTION OF CIVIL ENGINEERS.

It is announced that the 18th "James Forrest" Lecture will be delivered at the Institution on Wednesday, June 22, at 8 p.m., by Sir John Gavey, C.B., M.Inst.C.E., his subject being "Recent Developments of Telegraphy and Telephony."

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EARTHED v. INSULATED NEUTRALS IN COLLIERY INSTALLATIONS.*

By W. WELLESLEY WOOD, Assoc.M.I.E.E.

A great deal of attention has recently been attracted to the question whether a 3-phase colliery installation should work with an earthed or insulated neutral, and not only are there a number of supporters of both systems, but also a number of long-standing examples of each at work both on high and medium pressures, and with current taken in some cases from a supply company and in others from their own generating plant. Conditions vary so greatly in collieries and mines that what is suitable and perhaps necessary in one case may be absolutely dangerous in another. The principal advantages of each system are as follows:—

Earthed Neutral.	*Insulated Neutral.*
1. Maximum potential to earth of any phase limited to 58% of line voltage.	1. Danger of shock and explosion is reduced, as contact with earth and one phase does not complete the circuit.
2. Leakage to earth probably results in isolation of the damaged circuit.	2. An earth on one phase does not cause an interruption of supply, for the same reason.
3. Leakage tripping devices can be used which switch off the supply when an earth occurs on one phase, reducing danger of shock and explosion.	3. Stress on insulation under normal circumstances is less, and liability to flash to metallic casings considerably less.
	4. Only two-trip coils instead of three are required to protect each circuit where an automatic switch is installed.

Power taken from a Supply Company.—As the principal consideration is the safe operation of the underground plant, it is only proposed to consider briefly how the question affects generating machinery and transmission lines. Many collieries now take their power from a supply company, and where such an installation is connected without the intervention of a transformer, advantages 1 and 2 of the insulated system are minimised, as an earth on any part of the supply company's mains (possibly in another colliery) will have the same effect as an earth on the installation, but be beyond its control. Under such circumstances, and particularly where the voltage is high, say 5,000 or over, it is probably better to earth the neutral so that a faulty installation is isolated, and the stress to earth on healthy plants kept permanently at 58% of the line volts. In a high tension installation the factor of safety of installation is often small, and the sudden rise of pressure produced by an earth on one part of the system may damage the insulation of another part or cause a flash-over on motors. Where the supply is transformed the colliery circuit is a separately insulated one, and the above does not apply.

Generating Plant.—As far as the generating plant is concerned (where a colliery has its own supply) the earthing or insulating of the neutral makes very little difference, as although with alternators in parallel triple-frequency currents may give trouble with an earthed neutral, this can be got over by only earthing the neutral of one generator, or by the introduction of choking coils, and this point was discussed in Mr. Rider's paper on the London County Council tramways. The conditions, moreover, under which most colliery stations work are less strenuous than in those of a supply company, where interruption of the service affects a large number of concerns, so that the earthing of one generator at a time would probably work satisfactorily.

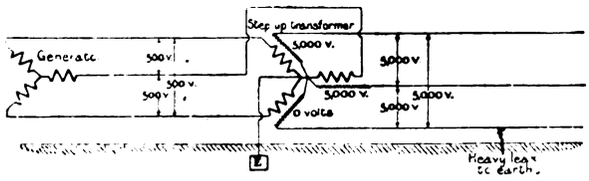

FIG. 1.

1. Transformers connected star to star, neutral earthed, generator neutral unearthed.
2. Earth occurs on one phase and short-circuits it.
3. Voltage on shorted phase falls to zero, on other two rises to full-line volts, increasing stress on insulation of two phases in ratio of 58 to 100.

Transmission Lines.—As far as transmission are concerned, the question of earthed *versus* insulated neutral is a very open one indeed, especially on voltages under 20,000, and the President of the High Tension Committee of the American Institution of Electrical Engineers in opening the discussion on this subject puts his conclusions as follows: "That some plants grounded the neutral, and its engineers considered it safe, and would never think of running in any other way, whilst the engineers of plants which did not ground the neutral would never think of doing such a thing."

Where the neutral is earthed, it has sometimes been found possible in emergencies to keep up the supply with two lines and an earth return, while with an insulated system the supply can be maintained with an earth on one phase, if the insulation of the system has a sufficient factor of safety to withstand the full-line voltage between any part of it and earth. These points are of more importance on a supply company's system than on the average colliery installation.

Before considering the underground plant it is interesting to note that under certain conditions it is possible to get the full-line voltage to earth in two phases of a system even with the neutral earthed on both high and low tension sides of the transformers, if these are connected star to star, and the generator neutral is insulated. This is due to

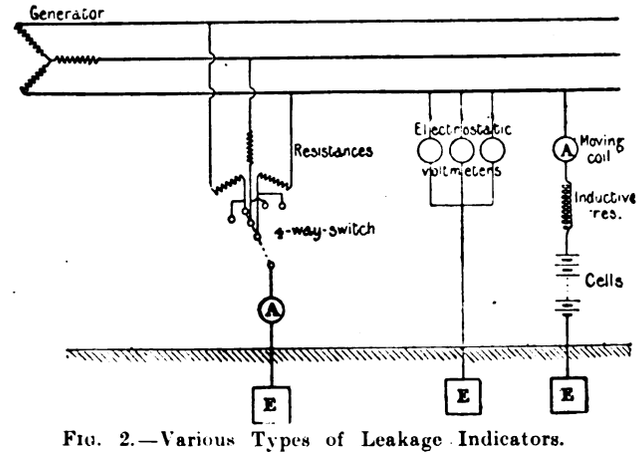

FIG. 2.—Various Types of Leakage Indicators.

the instability of the neutral-point under such conditions, and is illustrated in Fig. 1. Very often the first indication of anything wrong is the arcing of the lighting arresters.

Underground Plant.—The chief considerations in the underground plant are safety as regards shock and explosion, reliability and simplicity in working, and cost both of the installation and maintenance of the same.

Danger from Shock.—Although even on a perfectly insulated system of large size, or working at high pressure, it is possible to get a severe shock from the capacity effect alone, and without any actual circuit being completed, there is no doubt that on such a system there is less danger of fatal results from accidental contact with one live phase and earth, and particularly so on medium-pressure installations. It must be noted, however, that very often on these medium-pressure systems the neutral-point is connected to earth through the resistance of the leakage indicator, the connections being as shown on Fig. 2. This resistance is generally designed to pass several hundred milliamperes, which is sufficient to give a fatal shock, and while it is, of course, much safer to get a shock in series with such a resistance which limits the current, this danger can be reduced by using the same electrostatic type of indicator usually supplied for higher voltages, or by the Nalder type of instrument which only passes a few milliamperes. Considered from this point of view there is no doubt that a system with earthed neutral presents greater dangers.

* Paper read before the Institution of Electrical Engineers, Newcastle Local Section

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Limitation of Voltage.—With an earthed system the voltage between any point and earth cannot exceed 58% of the line pressure, but as fatal accidents have occurred with voltages as low as 150, this limiting of the voltage is not of any very great advantage, particularly in a colliery where the conditions are such as to make the men specially susceptible to the effects of electric shock.

Earthing of Metal Casings.—The best protection against the danger of shock from conducting bodies does not lie either in earthing or insulating the neutral, but in properly protecting or enclosing all live parts, and in efficiently earthing to the surrounding ground all motor frames, switch-cases, etc. The earth wire should be large enough safely to carry the load which will blow the fuses of the plant it protects, and it should be frequently tested for continuity. In a dry pit it is often difficult to get a good earth connection, and to meet this difficulty some engineers carry either a separate cable or core for earthing purposes only, but this method may possibly be a source of danger unless the system is also earthed underground, and Fig. 3 has been prepared to illustrate this. For example, on a 3-phase system with an earthed neutral, and an earthplate at the generating supply end, a leak takes place near the motor on one of the outers. This motor is at work in a more or less insulating stratum, so that the resistance from the ground to the earthplate at bank (except through the earth wire) is very high. The motor makes bad contact with the ground on which it stands, and there is a very considerable difference of potential between this ground and the motor. Anyone standing on this ground and touching the motor-case will get a possibly fatal shock. If the neutral is insulated it is necessary to have a leak on one of the other phases at bank before the same conditions can apply. It may be thought that this is a rather exaggerated case, but a non-fatal shock on somewhat the same principle as outlined above, and due to variations in the resistance of the strata, occurred recently in a colliery in Scotland, and on measuring the resistance between an earthplate at bank and an earth connection at the bottom of the shaft, this was found to be 300,000 ohms. With regard to this question of earthing, Messrs. J. G. and R. G. Cunliffe, in a very interesting paper read before the Manchester Local Section, have shown that the resistance of an earthplate is often very considerable. By the kind permission of the authors several curves from their paper have been reproduced, and curve I. shows that quite apart from any question of the intervention of non-conducting strata (as mentioned above) the resistance between two plates each 1½ ft. square, and arranged 200 ft. apart, may be about 30 ohms, so that a leakage current of a few amperes would cause a big drop in potential. Another very important point is that nearly 50% of this drop occurs within 3 ft. of the plates (curve II.). It appears all the more necessary, therefore, in earthing the metallic dead portions

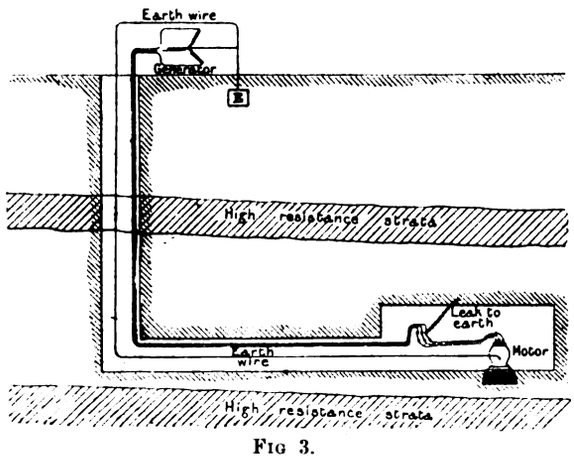

FIG 3.

1. Motor at work in high-resistance strata, or in motor-room with such strata intervening, both above and below, between earth-plate at bank. No earth-plate underground.
2. Leakage or earth on one phase at same level as motor. Latter on concrete foundations insulated from surrounding ground, and maintained by earth-wire at same potential as earth-plate at bank.
3. Considerable difference of potential between motor and surrounding ground, with possibility of shock due to phase volts.

of any system to provide several earthplates distributed over the installation. Curve III. shows that there is no great advantage in making each plate more than about 4 sq. ft. in area.

Danger of Faulty Insulation.—There is, however, a possible danger of shock which cannot be guarded against in this way, and that is by coming in contact with faulty insulation, such as an unarmoured damaged cable. With an earthed system shock as before is certain, with an insulated system it is likely to be less severe. Where cables are armoured or enclosed in a metallic covering this danger cannot occur *as long as the armouring or cover are efficiently earthed and electrically continuous.* If, however, a careless jointer leaves the armouring disconnected after a hurried repair, or the armouring is eaten away by bad water, etc., the conditions are now more dangerous than before, as an earth may cause a considerable length of armouring to be alive, any part of which will give a shock. For this reason many colliery engineers object strongly to the use of armoured cables as being likely to produce a false feeling of security.

Danger from Explosion.—It is very doubtful whether many colliery managers would instal electric plant at all in places where there is real and constant danger of inflammable gas or coal dust, as it seems fairly certain from recent experiments that an arc or flash with any moderate amount of power behind it will ignite either gas or coal dust in suspension if present in suitable proportions. With an earthed neutral failure of the insulation of one phase to earth is practically bound to produce such a flash, while with an insulated system an earth on one phase shows on the leakage indicator, and there is, at any rate, a greater chance of isolating the section before any arc occurs.

Reliability of Supply.—It is sometimes desirable to run certain plant even although it may be in a damaged condition. The stoppage of, say, a main haulage gear will disastrously affect the day's output of coal—a matter of very great importance to the colliery manager—and very possibly if the plant can be kept going for a few hours till the end of the shift, the fault can then be remedied without disorganising the working of the pit. In many such cases it may be perfectly safe and advisable to run, and as the majority of failures of colliery plant are leakages to earth, an installation with earthed neutral is likely to give more trouble than an insulated system.

If leakage trips are indiscriminately used, it is probable that unnecessary interruptions from trivial causes may be sufficiently troublesome to prejudice the manager against electricity and lead him to adopt some other motive power.

Leakage Tripping Devices.—Several very interesting devices have been recently put on the market arranged to cut off current as soon as any leakage current exceeding, say, ½ ampere flows. They are only designed for use on a system with a neutral earthed either directly or through a resistance, and the current at which they operate can be adjusted to different values on different feeders as may be required. It is claimed that by using such switches in connection with armoured cables danger from shock and explosion is largely avoided, and Mr. Wedmore, in a paper read at Barnsley, gave the results of some very useful experiments on cables which tended to show that with such a device and armoured cables it was very unlikely that a fall of the roof could so damage the cable as to cause flashing or arcing externally. Even without the leakage trips and with only the ordinary overload devices it appeared to be generally necessary to subject the cable to "successive blows of a heavy hammer" before flame occasionally issued, and apparently also high-tension supply was safer in this respect than medium pressure. In case a cable were actually suddenly severed, it seems hardly possible that a flash of sufficient energy to ignite an explosive mixture could be avoided, whether a leakage trip was installed or not, and particularly if the point of failure was comparatively near generating plant of large capacity. It must be borne in mind, however, that many cables are run in places where there is no danger of explosion or of mechanical injury. It must be also noted that these devices depend absolutely on the continuity of the armouring or earthing being maintained, and if through carelessness or other cause this is not done they afford little protection against

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explosion and practically none against shock. A motor standing on concrete foundations is on a very good insulator, and if the earth connection is broken or inoperative insufficient current would flow to operate the leakage trip in case of leakage to the motor frame, which would then be raised above earth potential (Fig. 4). We have previously seen that as long as earth connections are kept in good order there is no danger of shock from motor or switch casings or armouring, so that while there are undoubtedly

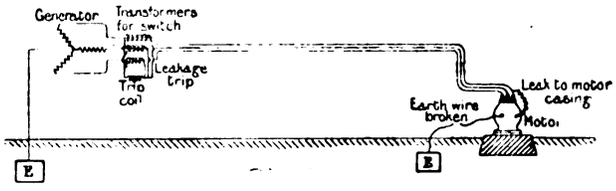

FIG. 4.

1. System with leakage tripping device, and earthed neutral.
2. Earth or leak on motor. Earth wire broken. Motor on concrete foundations, and practically insulated from earth, hence tripping device inoperative.
3. Motor frame at potential of one phase, with possibility of shock to surrounding earth due to phase voltage.

many cases in which a leakage device may be of considerable use there are also many others where it would not justify the increased expenditure and would probably prove rather a nuisance. These devices, moreover, do not protect against shock from live terminals or from contact with a high-resistance leakage.

Simplicity of Installation.—In the author's opinion the simpler the installation can be made the more likely it is to be kept in good working order, and it has generally been found in the past that it is better to rely upon having good men to look after the plant and see that small details such as earthing, etc., are properly attended to than on automatic appliances.

Stress on Insulation.—As long as a system with insulated neutral is in good order the stress on the insulation is 16% less than on an earthed system, so that under equal conditions its factor of safety is greater. There is no doubt also that much greater clearances and creeping distances to all metal work must be provided where the neutral is earthed, to give the same factor of safety as on insulated systems. The advantage of the earthed system is that an earth on one phase soon isolates the faulty part, and does not increase the stress on the other parts of the system, while a similar occurrence on an insulated system doubles the stress on the other places and is likely to cause further breakdowns. This point is of greater importance on extra high voltages.

Cost of Installation.—While not necessarily the first consideration, the question of cost in all engineering problems is of very great importance and one that will not be neglected by the colliery manager, whose business it is to get the best possible financial results.

Where automatic oil switches are used, three relays, one in each phase, are needed with an earthed neutral, and only two with an insulated neutral. If many switches are needed, the difference in first cost may be considerable.

The cost of armoured cable is often nearly double that of unarmoured, so that if these are run in places where there is no danger of accidental contact, damage from falls of roof or sets off the line, or of explosion, armouring is an unjustifiable expense.

The cost of maintenance is generally of greater importance than first cost, and it is here that the simplicity of the installation is of primary importance.

Conclusions.—No hard and fast rules can be laid down, and every case should be considered broadly on its own merits, but it certainly seems that generally an insulated neutral is better where permanent plant is at work and the cables are not very liable to mechanical damage. Where portable machines such as coalcutters are used, or where cables are liable to frequent hard usage, it may be worth while to use automatic devices; and in this case, if a separate transformer were used to supply this plant, its neutral could be earthed (and preferably through a resistance) without interfering with the remainder of the system. Such devices, however, will require constant inspection. There is another very important case which has not so far been considered, and that is where small lighting transformers are used. It would seem desirable to limit the secondary pressure of these to 110 volts and connect either the neutral of one side directly to earth. Finally, the author wishes to disclaim any sympathy with the present scare in regard to the use of electricity in mines. It is necessary in a paper of this sort to consider how accidents can and may occur, but the number that actually do occur is extraordinarily small considering the present widespread use of electricity and the insufficient electrical staff employed in many collieries. The average number of deaths caused by the use of electricity in mines appears to be about 1% of all the accidental deaths in such places, and many of these cases have been due simply to pure accident or carelessness which nothing could have prevented.

INSTITUTION OF ELECTRICAL ENGINEERS.

COUNCIL NOMINATIONS.

At the meeting of the Institution of Electrical Engineers, London, on the 21st inst., the following nominations for the new Council of the Institution were announced:—President, *Mr. S. Z. de Ferranti*; Vice-Presidents, *Mr. W. H. Patchell*, *Mr. J. H. Rider*, Mr. W. Duddell, F.R.S., Mr. S. Evershed; Members of Council, *Mr. H. Dickinson*, *Mr. J. E. Kingsbury*, *Mr. P. V. McMahon*, *Mr. R. K. Morcom*, *Mr. S. L. Pearce*, Mr. W. W. Cook, Mr. G. K. B. Elphinstone, Mr. W. Judd, Prof. T. Mather, F.R.S., Mr. W. M. Morrison, Major W. A. J. O'Meara, C.M.G., Mr. J. F. C. Snell, Mr. G. Stoney, Mr. A. H. Walton, and Mr. C. H. Wordingham; Associate Members of Council, *Mr. S. Morse*, Mr. E. Russell Clarke, and Mr. J. E. Taylor; Hon. Treasurer, Mr. Robert Hammond. The names given in italics represent new nominations.

Mr. Chamen remarked that in many parts of the country, particularly in the west, the Institution was not looked upon with the favour that they all wished. There was a feeling outside of London that no one had any interest in the election of members of the Council excepting members of the Council themselves. Nominating Mr. H. Faraday Proctor as a member of the Council, he said he wished to show by his action that such was not the case. He would like to see more competition for vacancies on the Council.

Mr. W. W. Lackie seconded the nomination.

Dr. Gisbert Kapp (President) laid emphasis on the point that members of the Council wanted to see the Council represent the wishes of all the members. If Mr. Chamen assisted them in that direction they would be much obliged. It was open to any member in the provinces to send suggestions to the secretary before the elections. Having regard to the nomination by Mr. Chamen, he reminded the members that one name must be struck out of the ballot paper.

CARBON FUSION AND DIAMONDS.

Professor la Rosa, of Palermo, calls attention to the extraordinary heating power of the singing electric arc. The Professor states that he has tested it on pure carbon made from sugar, and containing only 0·07% of ash. In a small electric furnace consisting of a fireclay crucible with vertical electrodes (made of carbon giving 0·33% of ash) he covered the lower electrode to a depth of about 3 millimetres with the sugar carbon in fine powder. After the singing arc had been in operation for a few hours the electrodes were covered with a crust of graphite, undoubtedly resulting from fusion of the sugar carbon. When the arc was replaced by a rapid succession of powerful sparks La Rosa obtained tiny crystals of extreme hardness, and having a specific gravity as high as 3·2. He has not yet been able to decide whether these crystals are diamonds or only carborundum, on account of the very small quantities of them which he has so far obtained, but he is fairly confident that he has made diamonds, and perfectly certain that the singing arc has a considerably higher temperature than the silent arc.

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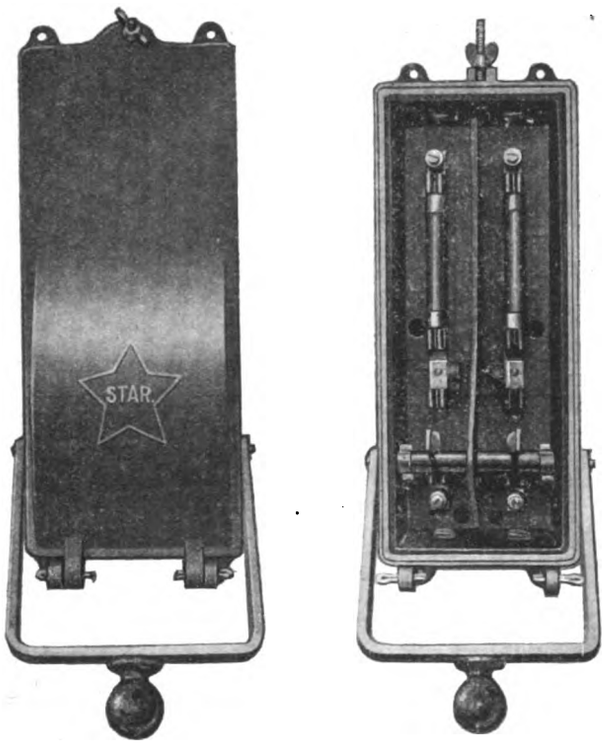
PUBLICITY.

In this Section of "The Electrical Engineer" we give Publicity to New Inventions and Specialities.

THE "STAR" SWITCH.

A moderate priced, high-class switch worthy of attention is the "Star," which, as will be seen from our illustrations, is of the ironclad type, being so enclosed that it is watertight and interlocking. Even the fuses may be enclosed in this type, which is exceedingly easy to wire. It is characterised by quick carbon break, and cannot be opened



while the switch remains in the "on" position, the mere action of opening of the cover making fuse and contacts "dead." It is thus a very safe appliance, both as regards design and the careful finish in manufacture. It is made in sizes ranging from 15 to 100 amperes, either double or triple pole. The "Star" switch is made by Messrs. Tetley & Co., of Manchester.

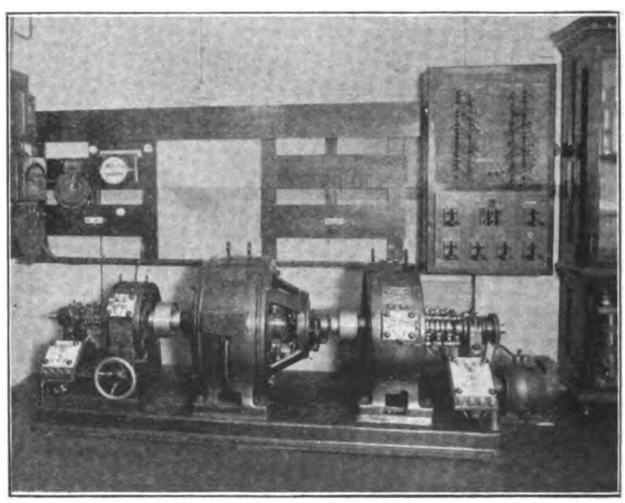
PRIVATE BILLS IN PARLIAMENT.

Several private Bills having been before the Examiners of Standing Order proofs, were sent for second reading in the Commons. They included the Metropolitan Railway Bill, authorising subways, etc.; the Metropolitan District Railway Bill, dealing with finance, and authorising the construction of new railways jointly with the London and South-Western; the London Electric Amalgamation Bill, amalgamating the Bakerloo, Charing Cross, Euston and Hampstead Railway Co., and the Great Northern Piccadilly and Brompton Railway Co.; and the Bakerloo Railway Bill, empowering the construction of a subway at Oxford-circus. These Bills have passed the Lords. The London United Tramways Bill, extending the time for the construction of works, was sent for second reading in the Lords—the first House.

THE NEW TESTING SET AT THE MUNICIPAL SCHOOL OF TECHNOLOGY, MANCHESTER.

The latest addition to the already admirably-equipped electrical engineering laboratories at the Manchester School of Technology, is a small testing set specially designed for testing meters and carrying out experimental work.

This set, which was manufactured by the British Westinghouse Electric & Manufacturing Co., Ltd., is illustrated in the accompanying photograph, and consists of three machines rigidly coupled together on a combined bedplate, and is driven by a 13 h.p. direct-current shunt-wound motor, suitable for operating on a 400-volt circuit. This motor is of the variable-speed type, and capable of running between speeds of 500 to 1,700 r.p.m., giving its rated output throughout this range. Two generators of the revolving-armature type are arranged, one on each side of the motor. These have ratings of 1 to 5 kw. respectively, three-phase, 25 to 85 frequency, 100 to 340 volts at 500 to 1,700 r.p.m. Each machine is designed to give a sine wave, and is fitted with six slip rings. The motor is fitted with a terminal board arranged for connecting the field coils in parallel, as they may occasionally have to be excited from a lower voltage than 400. The one kilowatt



generator has its yoke machined on the outside and fitted into a circular seat on the bedplate, and is arranged with a worm gear for rotating the field which enables this machine to be given a displacement of as much as 200 electrical degrees with respect to the 5 kw. generator. A gradual variation of phase adjustment is obtainable by this means while the set is running. This is necessary, as the phase has to be adjusted for each variation in current output on account of the varying lag with a varying current in the armature. By this arrangement one is able to get from maximum lagging to maximum leading current. Terminals are also provided for making easy and rapid connection with the external circuit. The set is specially balanced, so as to run with no vibration and not to disturb the reading instruments in the standardising room where the set is run. The engineering staff are carrying out a number of very interesting and valuable experiments on the effect of wave form, etc., on the indications of induction type meters, in which this set is employed.

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Electrical Contractors' Section.

A Survey of New Things and Business Prospects.

NOTICE.

Contract and Miscellaneous Advertisements should reach this Office by Mid-day on Wednesday. For rates apply to the Manager, 149, Fleet Street, London, E.C.

CONTRACTS.

CORPORATION OF DUBLIN.

INSTALLATION OF ELECTRIC LIGHT, ETC., IN THE BOLTON STREET TECHNICAL SCHOOLS.

The TECHNICAL EDUCATION COMMITTEE of the CORPORATION OF DUBLIN are prepared to receive TENDERS for the INSTALLATION OF ELECTRIC LIGHT, ETC., in the Technical Schools situated in Bolton-street.

Specification, with General Conditions and Form of Tender, can be received from the City Electrical Engineer, Fleet-street, Dublin, on and after Tuesday, April 26, 1910, on payment of ten shillings and sixpence for each Specification, which will be returned on receipt of a *bona fide* Tender. The plans may be inspected in the Office of the Clerk of Works, at the New Building, Bolton-street.

Tenders, addressed "Chairman of the Technical Education Committee, Lower Kevin-street, Dublin," and marked "Tender for Electrical Installation, Bolton-street Technical Schools," to be delivered not later than noon on Wednesday, May 11th, 1910.

The Contract will be subject to ratification by the Municipal Council.

The Committee do not bind themselves to accept the lowest or any Tender.

(Signed) LOUIS ELY O'CARROLL,
Secretary.

April 22, 1910.

City of Dublin Technical Education
Committee Offices, Lower Kevin-street, Dublin.

COUNTY OF LANARK.

DISTRICT OF THE MIDDLE WARD.

BELLSHILL AND MOSSEND SCAVENGING.

REFUSE DESTRUCTOR ELECTRICITY SUPPLY.

The DISTRICT COMMITTEE of the MIDDLE WARD of the COUNTY OF LANARK are prepared to receive TENDERS for the Construction, Supply, and Erection at the Refuse Destructor at Bogs Brae, near Bellshill, of ONE 3 KW. STEAM DYNAMO; ONE SWITCHBOARD AND MAIN CABLE; COMPLETE WIRING INSTALLATION.

Plans may be seen and Copies of the Specification may be obtained at the Office of Mr. A. J. Abraham, Resident Engineer, Electricity Works, Bothwell-street, Cambuslang, on payment of £1, which will be returned to all who send in *bona fide* Tenders accompained by the filled-up Schedule and Specification.

Sealed Tenders, endorsed on outside, "Bellshill and Mossend Refuse Destructor Electricity Supply," must be lodged with the Clerk to the Local Sub-Committee, Mr. James Forsyth, Writer, The Cross, Bellshill, not later than 10 a.m. on Wednesday, May 4.

The District Committee do not bind themselves to accept the lowest or any Tender.

W. E. WHYTE, District Clerk.

District Offices, Hamilton,
April 7, 1910.

SALFORD ELECTRICITY WORKS.

The SALFORD CORPORATION INVITE TENDERS for the PAINTING of all the Exposed Wood and Iron Work at the Frederick-road Electricity Works and Offices.

Particulars may be obtained from the Borough Electrical Engineer, Electricity Works, Frederick-road, Pendleton.

Sealed tenders, endorsed "Tender for Painting," to be sent to the Electrical Engineer on or before noon, May 9, 1910.

L. C. EVANS, Town Clerk.

CONTRACTS OPEN.

HOME.

DUBLIN.—Technical Education Committee invite tenders for the installation of electric light in the Bolton-street Technical Schools. Particulars from the City Electricity Engineers, Dublin. May 11.

HOYLAKE AND WEST KIRBY.—District Council invite tenders for the supply of coal for the electricity works to June 30, 1911. Class of coal, "Peas and Beans," and also lower grade. Quantity, 3,000 tons. Particulars from Mr. C. J. Turner, electrical engineer, May 17.

LANARK.—Tenders for the construction, supply and erection of one 3 kw. steam dynamo; one switchboard and main cable; complete wiring installation, for Refuse Destructor Works, Bogs Brae. Particulars from Mr. A. J. Abraham, resident engineer, Electricity Works, Bothwell-street, Cambuslang. May 4.

LITTLEBOROUGH.—Urban Council invite tenders for the supply and laying of electric cables and the supply and erection of plant as follows: (1) High tension feeder cables, low tension distributors, road work, etc., for private lighting; (2) transformer kiosk, with transformers and equipment and switchgear in sub-station. Specifications (£5) from Mr. G. H. Wild, Clerk to the Council. May 2.

LONDON.—County Council invite tenders for wiring and fittings for electric lighting of the Fairelough-street and Amberley-road schools. Particulars from the Chief Engineer to the Council, County Hall, Spring-gardens. May 4.

LONDON.—L.C.C. Tramways. Tenders invited for the road-work and platelaying required for the reconstruction, on the underground conduit system of electric traction, of the Council's existing horse tramways in Tooley-street, Bermondsey, Dock-head, Parker's-row, Jamaica-road, Union-road and Evelyn-street, Deptford, and the construction on the same system, of the authorised tramway in Creek-road, Bridge-street and Church-street, from the terminus of the existing horse tramway in Evelyn-street to a junction with the existing conduit tramway in Nelson-street, Greenwich; also for the paving works of the street widenings on the above route. About 8·16 miles of single track. Specifications from the Chief Engineer of the Council, County Hall, Spring-gardens, S.W. May 31.

PERTH.—Town Council invite tenders for the supply of 3,500 tons of small coal during the period ending May 15, 1911, delivered free at their electric lighting station. Forms of tenders from Mr. J. Lambert, Borough Electrical Engineer, Perth. May 11.

SALFORD.—Tramway Committee invite tenders for the supply and erection of a moulding machine, automatic grinding machine, 6 in. lathe and a shaping machine. Particulars from General Manager of Tramways, 32, Blackfriars-street, Salford. May 2.

WHITEHAVEN.—Corporation invite tenders for fuel economiser, feed, auxiliary steam, and exhaust pipe work; main switchboard. Specifications, etc. (deposit £1), Mr. B. Sankey, Electricity Offices, West Strand, Whitehaven. May 2.

OVERSEAS.

ANTWERP.—Lower Scheldt Works.—Electric lift for vehicles on floating pier. Dep., £320. Specification No. 19, 2d., plans 1s. 5d., Direction du Service Spécial de l'Escaut Maritime. June 16.

ANTWERP.—The Municipal Authorities invite tenders for the supply of electrical appliances for the town workshop at the new North Docks. Tenders must be sent in sealed envelopes to the Burgomaster, Hôtel-de-Ville, Antwerp, to arrive not later than May 9. Copies of the *cahier des charges* may be obtained (price 50 centimes) at the Hôtel-de-Ville, Antwerp.

BUDAPEST.—H.M. Consul-General at Budapest (Mr. Esme Howard, C.V.O., C.M.G.) reports that tenders are invited by the Municipality of Pécs for the building and working of an electric railway in that town. Tenders will be received up to noon on June 6, by the "Pécs varos gazdasagi tanacsnokanak, Varosi Székhaz," Pécs, Hungary, from whom also detailed conditions and forms of tender may be obtained at a cost of 2 kronen (1s. 8d.). The plans and other documents can be examined on personal application at the Engineering Office of the town of Pécs.

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CONTRACTS -continued.

COUNTY BOROUGH OF SALFORD.

The TRAMWAYS COMMITTEE are prepared to RECEIVE TENDERS for the SUPPLY, DELIVERY, and ERECTION of a MOULDING MACHINE, Automatic Grinding Machine, 6 in. Lathe, and a Shaping Machine.

Specification, form of tender, and general conditions may be obtained from the General Manager, Tramways Department, 32, Blackfriars-street, Salford.

Tenders, endorsed "Machinery," must be delivered to me not later than 3 p.m. on Monday, the 2nd proximo.

L. C. EVANS, Town Clerk.

Town Hall, Salford, April 21, 1910.

CONSTANTINOPLE.—Public Works Department.—Distribution of electric current in the European part of Constantinople and suburbs, except that required for telegraph, telephone and public traction purposes. Prov., £E10,000. May 28.

LAUNCESTON, TASMANIA.—Municipal authorities invite tenders for the supply of: 1. Overhead electric equipment for tramways; tenders will be received up to 4 p.m. on June 13. 2 Synchronous motor generators and battery, reversible booster, etc.; tenders will be received up to 4 p.m. on June 27. Tenders, marked "Tender for Overhead Equipment," or as the case may be, should be addressed to the Mayor and Aldermen, Town Hall, Launceston, Tasmania. Copies of the conditions, specifications, etc., for these contracts may be obtained from the Town Clerk, Town Hall, Launceston, on payment of £1 1s. each, which will be returned upon receipt of a *bona-fide* tender. Only firms having local agents, who could be instructed by cable, could compete.

MELBOURNE.—The Deputy Postmaster-General will receive tenders up to 3 p.m. on May 17, for the supply of 50 coin attachments, electrically controlled; (2) at the office of the Deputy Postmaster-General, Sydney, up to 2.30 p.m. on June 1, for the supply of eight sections of a common battery switchboard. A deposit will be required with each tender. Local representation is necessary. (1) Twisted pair wire; tenders will be received up to 3 p.m. on May 17. (2) Canvas, cotton duck and tan drill, during two years ending June, 1912; tenders will be received up to 3 p.m. on June 14. (3) Pencils, during two years ending June, 1912; tenders will be received up to 3 p.m. on June 14. Local representation is necessary, who can be instructed by cable. Tender forms, specifications, etc., for each of the foregoing may be obtained, and preliminary deposits paid, at the offices of the High Commissioner in London for the Commonwealth of Australia, 72, Victoria-street, S.W. Copies of the conditions of tender, specifications, etc., together with samples of the canvas, cotton duck, and tan drill, may be seen by British firms at the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, London, E.C.

TENDERS ACCEPTED—Home.

LONDON.—London County Council Tramways.—For the manufacture, supply, testing, and delivery of machine shop equipment for the second section of central car repair depôt: Buck & Hickman, Ltd., Whitechapel, E. (accepted), £2,949 7s. 6d. (Tangye lathes), £3,014 17s. 6d. (Parkinson lathes); Tangyes, Ltd., Birmingham, £3,020; H. W. Kearns & Co., Ltd, Broadheath, Manchester, £3,224; Dempster, Moore & Co., Ltd, Glasgow, £3,460.

LONDON.—London County Council Tramways.—For the supply of watt-meters: The Electrical Co., Ltd., Charing Cross-road, W.C., £364 9s. (alternative tender) (accepted), £389 12s.; the Bat Meter Co., Ltd., Eden-street, Hampstead-road, N.W., £372 5s.; the British Thomson-Houston Co., Ltd., Cannon-street, E.C., £422 19s. 9d.; the General Electric Co., Ltd., Queen Victoria-street, E.C., £450 12s.; Ferranti, Ltd., Hollinwood, Manchester, £544 12s. 9d.

LONDON.—London County Council have accepted the following tenders:—Supply of conduit cleaning trucks, London County Council Tramways: Deptford Engineering Co., Ltd., Deptford, S.E., £152 9s. Supply of tramway equipment: Brass fittings—Hurst, Nelson & Co., Ltd., Motherwell, £186 11s. 11d. Cable, fuse wire and cotton covered copper wire: Liverpool Electric Cables Co., Ltd., Vauxhall-road, Liverpool; London Electric Wire Co. and Smiths, Ltd., Golden-lane, E.C.; British Insulated and Helsby Cables, Ltd., Prescot, Lancashire; General Electric Co., Ltd., Queen Victoria-street, E.C. Electric cable, high and low tension: Western Electric Co., Ltd., North Woolwich; Callendar's Cable and Construction Co., Ltd., Victoria-embankment, E.C.; British Insulated and Helsby Cables, Ltd., Prescot, Lancashire. Indiarubber materials, etc: Midland Rubber Co., Ltd., Eastcheap, E.C.; G. MacLellan & Co., Glasgow; North British Rubber Co., Ltd., City-road, N.; J. G Ingram & Son, Hackney-wick, N.E.; Indiarubber, Guttapercha and Telegraph Works Co., Ltd., Cannon-street, E C.; Irwell and Eastern Rubber Co., Ltd., Manchester. Insulating materials (other than rubber) fibre articles, etc.: A. Cort & Co., Camberwell

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PENDING TENDERS.

LONDON.—The London County Council propose shortly to invite tenders for the supply of 250 electric cars of the bogie-truck, double-deck type, fitted with roof covers and draught screens. It is felt that in connection with the reconstruction of existing, and the construction of new tramways which it is proposed shall be put in hand during the years 1910–11, it will be necessary to provide about 250 new electric cars for the maintenance of services on the routes affected. The construction of cars occupies a considerable time, and delay in delivery would involve a loss in traffic receipts, and, in addition, would cause inconvenience to the public. It is therefore very desirable that arrangements should be made as soon as possible for the necessary cars to be obtained, in order that they may be ready in time for the working of the several lines for which they are required. We would further point out that more favourable prices are likely to be obtained by ordering a large number of cars at the same time than would be the case if contracts were entered into as cars were required for specific routes. The specification will provide for cars of the double-deck type, but a special clause will be inserted so that a certain number of single-deck cars may be ordered if deemed desirable at a later date. The double-deck cars will be fitted with roof covers, and all the cars will be equipped with magnetic track brakes as well as hand brakes. The double-deck bogie-truck cars will be capable of carrying 78 passengers, 32 inside and 46 outside. There is provision for the expenditure involved in the vote on account of the capital votes for 1910–11.

NOTES.

SOLDERING ALUMINIUM.

We have on more than one occasion referred to the old difficulty of joining aluminium to aluminium or to other metals, especially by soldering, and pointed out that the problem had really been solved. Recently we have had the opportunity of witnessing a most convincing demonstration of the "S.A.L." system, belonging to the Standard Alloys, Ltd. The whole process was easy and expeditious, the main thing being to insure perfect preliminary cleansing of the metal surfaces, and then acting with promptitude. We saw aluminium strips soldered in two ways: (1) The edges being brought together flush, (2) by overlapping. In both cases a perfect joint was obtained, which it was impossible to pull or twist asunder. The solder, in fact, actually alloys with the metal. It should be mentioned that it possesses a low melting point, is self-fluxing, and produces no electrolytic action.

IMPROVED STREET LIGHTING.

Another good example of street lighting by means of metallic filament lamps has come under our notice. This is again a case where Osram lamps have been utilised in conjunction with old fittings. Each of the old gas bracket lanterns, affixed to premises on opposite sides of a bye street, and at distances far apart, were fitted with two

100 c.p. Osram lamps, and special reflectors designed to secure the greatest effect from the illumination. That the result obtained was excellent is attested by our illustration, prepared from a photograph taken at night, the negative being left quite untouched.

NEW WIRING RULES.

New wiring rules came into force on May 1 in Glasgow. Copies of these rules are being sent free to all *bona fide* contractors and also intending consumers within the Corporation's area.

ELECTRICAL ENGINEERS TERRITORIALS (London Division)—Orders for week ending May 7, 1910: Monday, May 2, "A" Company, Recruits' Infantry Drill, 6 to 6.45 p.m.: Company Drill, 7 to 9.30 p.m.; Tuesday, May 3, "B" Company, Company Drill, 7 to 9.30 p.m.; Wednesday, May 4, Gymnasium, 6 to 9.30 p.m.; Thursday, May 5, "C" Company, Recruits' Infantry Drill, 6 to 6.45 p.m.: Company Drill, 7 to 8 p.m.: Technical Drill, 8 to 9.30 p.m.; Friday, May 6, "D" Company, Company Drill, 7 to 8.30 p.m.: Technical Drill, 8.45 to 9.45 p.m.; Saturday, May 7, "D" Company, Company Drill, 3.15 to 4.15 p.m. (Signed), P. H. Campbell, Capt. R.E., Adjutant.

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Advertisements under this heading: Twenty-four words, 1s. per insertion; three insertions for 2s. 6d.; or each additional line of eight words, 4d.

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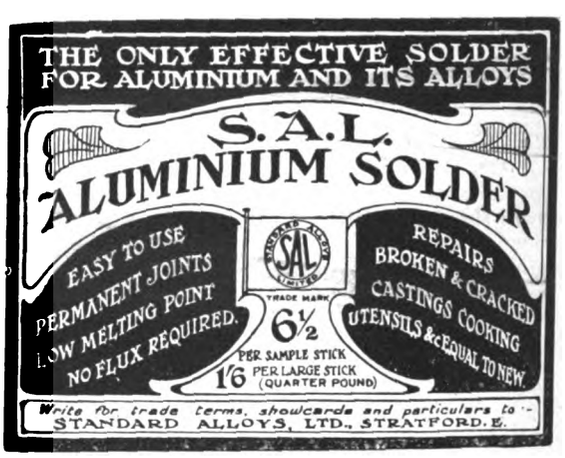

CONTRACTS WORTH WATCHING:—

Canterbury.—Messrs. Jennings & Gray, architects, 4, St. Margaret's-street, Canterbury. Extension of School of Art.

Coventry.—Mr. J. E. Swindlehurst, city engineer, Laundry and Housewifery Centre, Wheatley-street. Schools.

Egremont.—Mr. J. Lowery, secretary to the Trust, 59, Main-street, Egremont. Masonic Hall.

Ellesmere Port.—Mr. H. Beswick, county architect, Chester. County Police Building.

Falmouth.—Mr. S. Hill, architect, Green-lane, Redruth. Additions and alterations to Grammar School.

Glasgow.—Messrs. Robert Scott & Son, measurers, 115, Wellington-street, Glasgow. Reconstruction of Justiciary Courts.

Glasgow.—Clyde Navigation Trustees' engineer, 16, Robertson-street, Glasgow. Construction of goods shed. 1,640 ft. by 100 ft., at Partick.

Halifax.—Messrs. C. Williams & Sons, architects, Post Office-buildings, Commercial-street, Halifax. Arcade and Billiard Hall.

Hartlebury.—Mr. S. S. Reay, architect, 4, Unity-street, College-green, Bristol. New Schools.

Luton.—Secretary of Committee, Town Hall. New School for 350.

Ramsgate.—Drill Hall for local company of the Buffs.

Swansea.—C. T. Ruthen, architect, Bank-chambers, Swansea. Erection of Political Club.

Swansea.—C. T. Ruthen, architect, Bank-chambers, Swansea. Schoolroom.

CHANGE OF ADDRESS.

Pending fresh arrangements, Messrs. Tetley & Co., manufacturing electrical engineers, of the Falcon Works, Salford, Manchester, have closed their London offices and showrooms at 20, Bucklersbury. We understand, however, that they will soon be again represented in London.

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Electrical Progress at Home & Abroad.

A Review by our Special Correspondents.

TYNESIDE.

NEWCASTLE-ON-TYNE.

For a considerable period there has been a strong feeling on the Tyne that there is insufficient protection and repairing accommodation on the North-East Coast for vessels of the Navy should they become disabled in an engagement in the North Sea. Having regard to the fact that our fighting frontier has during the last few years changed from the English Channel to the North Sea in view of foreign developments, and that in the event of naval engagements a disabled vessel would have to be towed either to the North of Scotland or to the Thames for repairs, there is therefore justification for the attitude. Owing largely to the agitation brought about by Alderman Fownes, late Mayor of South Shields, active interest was developed in this, and the Newcastle Chamber of Commerce took the matter up. Last year a deputation was received from this area at Whitehall and the matter was there thoroughly gone into. Since then nothing definite has been arranged, and during the past week attention has again been drawn to the matter by a resolution passed at the quarterly meeting of the Tynemouth Town Council, that the First Lord of the Admiralty should now be memorialised regarding the Tyne as a Naval Repairing Base. The facilities of the Tyne for this purpose are marked; among other locations which are suitable for a repairing depôt is the Jarrow Slake, which would be capable of accommodating, besides three or four of the large vessels, a considerable number of second-class cruisers, etc. Apart from the value to the nation the work which it would bring to the Tyne, both in general and electrical engineering, would be of extreme importance.

Electricity on Board Ship.

In view of the present attention which is being paid to the application of electricity on board ship, it is interesting to note the report appearing in the Newcastle *Chronicle* concerning the launch of the 23rd inst. from the yard of Messrs. Hawthorn, Leslie & Co., Ltd., of Hebburn, of a patent type of ore carrying vessel built to the order of the Rederiaktiebolaget Lulea-Ofoten, of Stockholm. The special feature of the vessel, which is 450 ft. long, 60 ft. broad, and 10,800 tons net weight, is the method of storing the ore on board. This is effected by means of 12 Johnson-Welin gravity discharge ore pockets. Between each of these pockets are discharge compartments containing shoots which pass the ore by gravity into iron skips. These discharge compartments extend from the deck to the bottom of the vessel, and there are 12 powerful cranes operated by electricity which enable the skips to be worked almost continuously. This minimises to a considerable extent the cost of stevedores, coal and incidental labour. The machinery was supplied by the North Eastern Marine Engineering Co., Ltd., of Wallsend, and is especially interesting as a somewhat unusual application of electricity to marine purposes.

The Position of the Coal Trade.

Considerable interest has been aroused in this area regarding the question of accidents in mines owing to the deputation, part of which went up to the Home Office from this area, in order to advocate legislation which would bring into effect the recommendations of the Royal Commission on accidents in mines. Among the members of the deputation were representatives of the Northumberland and Durham deputies and other mining organisations, including an electrical interest, and the points dealt with were signalling in connection with winding engines, shot firing, ventilation and explosions from coal dust. In view of the first item mentioned, the description given in these columns last week of a new method of electric signalling is of especial interest; while ventilation, shot firing and coal dust explosions have all come within the purview of electrical men within recent times, as for example, the demonstration which Dr. Thornton gave recently before the Institute of Mining and Mechanical Engineers in Newcastle on-Tyne, and the papers and discussions which have been given during the past winter in the Institution of Mining Electrical Engineers. It may therefore be said that the electrical men are doing the full share of their duty towards the increase of safety in collieries.

A New Wall Plug for Use in Collieries.

With reference to the question of the prevention of explosion in collieries and the Home Office Regulations which came into force at the beginning of this year, it is interesting to refer to a new type of wall plug for use in mines which Messrs. A. Reyrolle & Co., Ltd., of Hebburn, have lately introduced. The earthing of portable hand lamps is provided for in the rules, and where the older types having exposed metal contacts are employed it is strongly impressed that they should be insulated or provision made for connecting the exposed parts to earth. With regard to motors, there is no alternative but to connect the frame to earth and this involves the use of a special plug. This is met by the earthing device mentioned, and they are made in all sizes suitable for a range of 5 to 100 amperes and are supplied in the dust proof or watertight types. In the smaller sizes a good connection is made between the plug and socket portions by means of phosphor bronze springs gripping on the side of the plug portion each time the plug is inserted or removed, the design being such that the earth connection is always made first and broken last when operating the plug. In the larger sizes the earth connection is made in the form of an extra pin of a different size from current carrying pins, this rendering it impossible to accidentally connect any of the motors to earth. I understand that this type of plug is finding considerable favour with collieries in this area.

THE MIDLANDS.

BIRMINGHAM.

The Handsworth District Council is pushing electrical matters vigorously in the domestic supply department. This branch of the business shows a rapid improvement. During the year 130 new consumers have been secured, while in previous years the average has been between 80 and 90. With a view to accelerate this increase, the department recently issued a circular calling attention to the advantages of electricity in the house as a cleanly and grateful means of lighting, and also to the uses of current for other domestic purposes, such as heating, cooking, ventilating, vacuum cleaning, and the working of all other domestic apparatus. Offers are made to provide wiring, lamps, and plain fittings free of initial cost to the consumer, at a quarterly rental per lamp installed. The rental varies with the cost of wiring, but the normal charge is 5d. per lamp per quarter, and no meter rent is charged, the minimum rental being 4s. per quarter. A condition of such an installation is the signing of an agreement to pay the rental for at least two years, and as much longer as the consumer shall occupy the same house. The whole installation will remain the property of the council, and the landlord's signature to an agreement confirming this is required. The consumer may at any time arrange to purchase the installation for cash, or by paying an increased rental for a period. The supply when the installation is paid for is charged at 4d. per unit, with a discount of 5% for prompt payment.

Small Consumers.

Consumers who have availed themselves of these terms express themselves completely satisfied, as they have found that for a small house they have been able to obtain a good and sufficient light at a total expenditure of from 6s. to 9s. for each of the darker quarters of the year, representing a total expenditure for the year of about three times this amount. This compares very favourably with

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gas, and the light is becoming so popular, and has such obvious advantages from the landlord's point of view, that builders are now coming to the department to arrange for the wiring of new houses. Current has been supplied to a row of ordinary workmen's houses near the station; whilst in another street, in which there are only five houses on one side and six on the other, both rows from end to end have been provided with electric lighting. Lighting consumers are supplied with current for heating, etc., at a penny per unit.

Lighting Small Houses.

The lighting of small houses is a matter which has not been overlooked by the Birmingham Corporation Electrical Department. As an experiment, a small block of houses in Cherry Wood-road, a working class neighbourhood, has been wired, the rent of the houses being 6s. 6d. a week. Each house has six lamps, and is supplied by meter. A charge of 5d. per unit covers the cost to the tenant of current and meter rent. The experiment has been going on now 12 months, and the users declare themselves pleased with the light and quite satisfied as to its economy in comparison with gas. Metallic filament lamps are used, and during the whole 12 months not one case of breakage or failure of the lamp has been reported. At first, 32 candle lamps were used, but after a short trial 25 candle lamps were substituted. The department does not propose to go in for wiring houses on its own account, but hopes by this demonstration to encourage wiring contractors to turn their attention to the lighting of small houses and villa residences. The ordinary rate for consumption of less than 1,000 units per quarter is 4d. per unit, with a descending scale for larger consumptions until for 20,000 units and upwards per quarter the charge is 2d. per unit. For a consumption of 50,000 units or over per annum a special extra discount of 5% is allowed on the total account for the year. There is also a long-hour lighting rate of 2¼d. per unit under the 1,000 per quarter, and 2d. per unit for higher consumption. But this is subject to a guaranteed minimum payment of £15 per annum, with a further guarantee of 25s. per annum for every additional 16 c.p. lamp or its equivalent beyond the first 12.

Coal Cutter.

A new electric coal cutting machine which has been made by the Electric Construction Co., Wolverhampton, for the Haunchwood Collieries, was inspected last week at the company's works at Bushbury. The machine is of the "Simplex" type, patented by Mr. H. C. Peake, managing director, and Mr. J. R. English, electrical engineer, of the Walsall Wood Colliery Co.; and six or seven of which are in use in the pits of that company. The distinguishing feature of the mechanism is that the cutting bar is driven direct from the armature shaft, so that there is no gearing whatever in the cutting part, and the only gearing at all on the machine is that which drives the haulage drum. For haulage, there is a pulley on the outside end of the armature shaft, and this is connected to the pulley which drives the winding drum by a small belt similar to that used on a motor cycle. The motor is one of 25 h.p., compound wound, the winding being of a special character to stand the torque due to the cutter being fixed on the armature shaft. The speed is 550 r.p.m., with a current of 450 volts 40 amps. The cutter is a bar 5 ft. long, tapering from 7½ in. to 2¾ in., and having fixed on its four sides in all 56 pick-shaped cutters of tool steel shaped so as to give a spiral of 1 in. pitch. For the trial of the machine an imitation coal face of cement concrete and coal dust had been built against the wall of one of the shops, the material being really harder than solid coal. This was cut through to a depth of 4½ ft. at a rate which represented a working speed well over 20 yards per hour. Those present, among whom were Mr. A. W. Noott (manager of the Haunchwood Collieries), Mr. English (one of the patentees), Mr. W. Bullock (General Manager of the Electric Construction Co.), and Mr. A. Hall (Consulting Mechanical Engineer to the Electric Construction Co.), were very well satisfied with the trial. Since the machine was taken up by the Electric Construction Co., numerous enquiries have been received with regard to it from mining centres in all parts of the world, including the United States, where coal-cutting machinery was first introduced, the direct driving, and consequent increased simplicity, being regarded as an important advance in machinery for use under conditions such as those of coal mining.

LANCASHIRE.

MANCHESTER.

The only important event from the electrical point of view, which has taken place here during the past week, was the inauguration of the new Textile Institute—a society which may later on bring about a general conversion of textile works to electric driving, through its educational work. The inaugural meeting was held last Saturday at the *Midland Hotel*, Manchester, and presided over by Mr. Sydney Buxton, President of the Board of Trade, until Sir William Holland was formally elected President of the Institute. The society has been divided up into several sections. Those so far established are known as the chemical, cotton, education, engineering, hemp and jute, linen, silk, woollen, and worsted. Sir Philip Magnus is chairman of the education section, and Sir William Mather presides over the engineering. The other sections are in the hands of equally eminent leaders.

A Model to be Studied.

I suggest that this new Institute is a very good model to be copied by a similar organisation representing all branches of the electrical industry. There have now been about four years wasted in professing to deplore the evils of price-cutting and insane competition, but all the time these evils have been growing, and until manufacturers give up the policy of mutual distrust and band themselves into some common association, are likely to continue growing. How much more foreign trade could be got by "striking united" abroad. In most cases English electrical firms have nothing to lose abroad, but everything to gain by combining to provide a proper foreign organisation.

The Students' I.E.E.

At the annual general meeting of the local Students' Section Institution of Electrical Engineers, the report was presented. Seven papers have been read and two discussions have been held. Last year four of the five students premiums were awarded to Manchester papers. The section's strength is now 280, and of these 218 members reside within 10 miles of Manchester. The average attendances at meetings, while no worse than those for other sections, seem very poor for Manchester, the centre of electrical gravity, especially considering the very high standard of the papers—perhaps it is the standard is too high for large attendances. The committee, however, desire the more active support of the members generally at the meetings next session, and any suggestions as to still further improving the meetings and offers of papers will be welcomed, and should be sent as soon as possible to the Hon. Sec. The following members have been elected as the new committee: Messrs. A. K. Bentley, J. I. Law Brooks, H. A. Carney, L. H. A. Carr, J. N. Hindle, L. J. Jowit, L. J. Lepine, R. G. Parrott, W. Parry, C. S. Richards, A. R. Stelling, T. G. Travis, A. Wadsworth. Mr. L. J. Lepine is vice-chairman, and Mr. L. H. A. Carr has been re-elected Hon. Sec.

The Cradle Dynamometer.

After the business meeting Messrs. F. Shaw and J. Davies read a paper on "The Application of the Cradle Dynamometer to the Testing of Electrical Machinery." Discussing various points in the design of cradle dynamometers they considered knife edge suspensions unsatisfactory and unnecessary. They found from tests on a dynamometer, designed by Mr. A. E. Moore, at the School of Technology, that ball bearings could safely be used without introducing any error even at such small torques as 1 lb. ft. They proceeded to show from experimental results that the cradle dynamometer could be used not only for commercial measurements, but also for such accurate work as the separation of the losses in the machine, due to bearings, brush friction, etc. They found it possible to take a complete set of readings for plotting the efficiency curve of a motor from no load to 50% overload, in less than 10 min., while to set up the motor for test would not take

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more than half-an-hour, and where a number of standard machines were being tested in a batch as in a works, setting up would be done much quicker. These times compare very favourably with ordinary methods, while the curves obtained show that the test gives results of a reasonable accuracy.

GERMANY.

BERLIN.

Michenfelder describes in the *Elektro Techniker Zeitung* a magnetic crane supplied by the Allgemeine Elektricitats Gesellschaft and the Benrather Maschinenfabrik, to the blast furnaces of the Hoerder Verein. The crane is intended for lifting iron pigs out of the pig bed while still hot, for conveyance to the breaking machinery. The crane has a span of 18·18 metres and is combined with a five ton auxiliary crane. The source of power is a 220 volts 50 period current, which for the lifting magnets is transformed into a 110 volt continuous current. The magnets have movable poles and are slung by chains to a beam. They cover a length of 12 metres. As soon as a pig is lifted an iron trough is automatically put below it to catch it should it fall, and is automatically removed on arrival at the breakers.

The rate of work per minute and the horse-power produced are as follows:—On lifting the iron, 15 metres, 42 h.p.; on travelling to the breakers, 150 metres, 30 h.p.; on lifting with the accessory crane, 7 metres, 16 h.p.; on cross-moving the load on the latter, 25 metres, 2·5 h.p.

Static Electricity and Dynamos.

In an extremely interesting article, too short, however, in the *Elektrotechnischer Anzeiger*, Franz Weber, of Lodz, treats of this little-understood question. He had occasion to observe a dynamo giving 120 amperes at 115 volts, placed by the side of a compressor working a water pump. The driving belt of the pump was only about 27 in. from the armature. The dynamo has been working for five years, and for a long time faultlessly. However, about eighteen months ago it began to heat, and difficulties arose with the commutators. The collector got rough and black and flashes between the segments appeared which could not be prevented although everything was tried. It heated up extremely, so that at last the solder was melted in the armature. The carbon brushes became brittle and broke repeatedly. After repairs, the same phenomena recurred and it was found that sparks and electric shocks were experienced on touching the machine, especially on the side nearest the compressor belt. Hence the trouble was due to the highly electrified state of the belt, this being its invariable condition while running. When the belt was earthed all the trouble vanished.

Company Notices.

A new company has been founded styled the Electrizitätswerk, Belhingen-Pleidelsheim A.G., to supply Belhingen and Pleidelsheim with current. The power is derived from the river Neckar, and the capital is 2½ million marks.

The Gesellschaft fur elektrische Hoch-und Untergrundbahnen, Berlin, has enormously increased its activity. The number of persons carried has risen by no less than ten millions since 1908–9, to 54,143,394. The net profit for 1909–10 was 2,270,624 marks, as against 1,851,256 marks in the previous twelve months. The dividend of 5% will absorb 1,625,000 marks.

A further instance among many that might be quoted of the prosperity of German electric trams is afforded by Plauen, where the capital is to be increased from 1 to 1¾ million marks. The new shares are issued at 2% premium.

UNITED STATES.

NEW YORK.

An important memorandum on the investigation now in progress at the Washington Bureau of Standards has been communicated to the technical press by Dr. E. B. Rosa, Secretary of the International Committee on Electrical Units and Standards. It will be remembered that the International Electrical Conference in London in 1908 (October) adopted the ohm as represented by the resistance of a specified column of mercury, and the ampere as represented by a certain mass of silver deposited in a silver voltameter, as the two independent fundamental electrical units, and declared that the value of the volt should be derived from these two. The electrochemical equivalent of silver adopted at London was 1·11800 milligrams of silver per sec. per ampere of current, but as different investigators had obtained different values for the electrochemical equivalent of silver, according to the kind of voltameter used and the methods of preparing the silver nitrate, the International Committee found itself confronted with the problem of preparing specifications for the voltameter, when there was a great difference of opinion as to the proper procedure and as to the true value of the electrochemical equivalent of silver. The value for the Clark standard cell (1·434 volts at 15° C.), which was adopted by the Chicago Electrical Congress in 1893, was not accepted by Germany. After further experimental investigations, Germany adopted the value, 1·4328 volts at 15° C. England, America, France and some other countries have followed the Chicago Congress, whereas other countries have followed Germany, and hence there have been two different values for the volt in use. In course of time, the method of preparation of the Clarke cell was improved so that the cell became more reliable, but at the same time its electromotive force was slightly altered. At the Bureau of Standards, an allowance was made for the change in the e.m.f. of the Clarke cell, so as to preserve the unit of electromotive force unaltered. In England, however, the original numerical value was retained in spite of the fact that the new cells had slightly different values from the old. The result was that a discrepancy arose between the values in use in England and America. Hence there were and still are three different volts in use in different countries. The Weston Normal cell, officially adopted at the London Conference in place of the Clarke cell, has the following values: In America, 1·0189 at 25°, equivalent to 1·019125 volts at 20°; in Germany, 1·0186 volts at 20°; in England, 1·0184 volts at 20°. Some of the other countries have the same value as America, others the same as Germany. England adopted the last-named value only one year ago, and no other country, as far as known, has followed its example.

Personnel of the Committee.

The International Committee on Electrical Units and Standards was authorised by the London Conference to complete the work of the Conference and to carry on intercomparisons of standards among different countries, and to promote investigations upon the subject of electrical units and standards, to the end of securing international uniformity with the highest obtainable accuracy. This committee represents eleven different countries, there being two members each from America, England, France and Germany, and one member each from Austria, Italy, Russia, Switzerland, Holland, Belgium and Japan. The president of the committee is Prof. Dr. E. Warburg, president of the Reichsanstalt, Berlin; vice-president, Dr. R. T. Glazebrook, director of the National Physical Laboratory, London; treasurer, Prof. S. W. Stratton, director of the Bureau of Standards; secretary, Prof. E. B. Rosa, physicist of the Bureau of Standards. The other members of the committee are as follows: Dr. Osuke Asano, Dept. of Communications, Tokyo, Japan; M. René Benoît, Bureau International, Sevres, France; Dr. N. Egeroff, director, General Chamber of Weights and Measures, St. Petersburg, Russia; Prof. Eric Gérard, Liege, Belgium; Prof. H. Haga, Groningen, Holland; Dr. Ludwig Kusminsky, Commission of Weights and Measures, Vienna, Austria; Dr. Stephen Lindeck, Physikalisch-Technische Reichsanstalt, Berlin, Germany; Prof. Gabriel Lippmann, The Sorbonne, Paris; Prof. Antonio Roiti, Florence, Italy; Mr. A. P. Trotter, Electrical Standards Laboratory, Whitehall, London; Prof. H. F. Weber, Zürich, Switzerland; and five associate members: Dr. W. Jaeger, of Berlin; Mr. F. E. Smith, of London; Prof. Paul Janet, of Paris; Prof. H. S. Carhart, of Ann Arbor, Mich.; and Dr. F. A. Wolff, of the Bureau of Standards, Washington.

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To Secure Uniformity.

Correspondence among the members of the committee who were connected with national standarising institutions seemed to indicate that it would be impossible to agree upon the specifications of the silver voltameter without further investigation, and it was proposed by the American members of the committee that a joint investigation to clear up, as far as possible, outstanding problems on the standard cell and the silver voltameter be arranged with representatives of several of the national standardising laboratories as participants. In addition to the work on standard cells and the silver voltameter, a comparison is to be made of the resistance standards of the several national standardising institutions. The wire standards of the Reichsanstalt, the National Physical Laboratory and the Bureau of Standards differed only about two parts in a hundred thousand at the last intercomparison about a year ago, the standards of the first two of the above institutions having been fixed independently by legally specified mercury ohms. It is expected that a common value of the international ohm will be agreed upon, so that no difference greater than one part in a hundred thousand will exist between the wire standards of the national standardising institutions. It is also anticipated that the committee will succeed in coming to a satisfactory agreement with respect to the official specifications of the silver voltameter and the Weston normal cell, and will be able to agree upon a value for the latter which can be recommended to all countries of the world for adoption. The degree of accuracy which is now obtainable in electrical measurements, both in absolute measurements and in relative measurements, far surpassed what was possible in 1893, and has increased greatly within the last five years. There is reason to believe that values adopted now will be satisfactory for a generation at least without change. The European delegates have brought with them, from their own laboratories, a quantity of apparatus and chemicals in order that they may reproduce work done in their own laboratories at the Bureau of Standards, as accurately as possible. Standard cells will be set up by the representatives of each of the four institutions and accurately compared and tested. In the same way different forms of silver voltameters will be operated in series with one another, and the quantity of silver deposited in each determined with very great accuracy. The Bureau of Standards has provided every facility for carrying on this work expeditiously and with the highest precision, and it is hoped that it will be completed by the end of May.

Electric Service Possibilities.

Among a number of striking papers read at the third annual convention of the Minnesota Electrical Association at Minneapolis was one by Mr. R. W. Clark, of the Minneapolis General Electric Company, which has a very wide application. Discussing the effect of specialised effort in the extension of business, Mr. Clark urged that if the trouble were taken to investigate and analyse individually the exact origin of the desire that resulted in the influencing of 100 consumers to use electric service, in any community, the results given would prove inestimable in the way of increasing the efficiency of efforts to secure new business. "The pivotal point upon which the major portion of the whole question of business development rests is the ability to let the people know, or to create the desire. The most valuable requisite in the make-up of those engaged in the commercial development of central stations is a thorough practical and intimate knowledge of the possibilities of electric service. In considering the immediate possibilities of central station business there is nothing more susceptible to a large development as residence lighting. This class of business should be gone after now, as there is a wave of popular approval sweeping the country in favour of the use of electric service in the home. This has been given a great impetus by the introduction of high efficiency lamps and much credit is due the manufacturers for the development of these units and the broad-gauged policy pursued in educating the public as to the economies to be derived from their use. The time has come when it is incumbent for central stations to interest themselves in the manner and method of using electricity on the customer's premises, so that the greater possible economics and benefits may be secured from the use of electric service. Many of the economies can only be effected by an extra investment in wiring and switches, but the public must be convinced that it is an investment and not an expense and that it does not take long for the saving in running cost to wipe out the principal."

Electric Drive in Textile Mills.

In the course of a paper read at the meeting at Charlotte, North Carolina, of the American Institute of Electrical Engineers, Mr. Albert Milmow entered into some interesting comparisons of the commercial aspects of electricity and steam in relation to mill drive. Dealing with the first cost of installation for a plant of 25,000 spindles, requiring a power equipment of about 1,000 h.p., he said the whole of the apparatus for electric drive, including transformers and house, shafting, boilers, piping, motors, switchboard, wiring and installation (including lighting), etc., for a 2,300 volt supply, worked out to $33,897, while for mechanical drive and auxiliary electric lighting the cost was $79,043. All possible costs are included in these figures, which show for electric drive a cost of $33.90 per h.p., as against $79.00 per h.p. for steam drive—a saving of $45.10 in favour of electricity. The costs of operation were shown to be difficult of comparison, as with electricity the absolute horse-powers and the indicated horse-power can be determined at any time, thus affording opportunities to check wastes and correct them, a condition of affairs which does not obtain when steam drive is used. Moreover, with electric drive, the elimination of useless shafting does away with a considerable amount of non-productive power. Mr. Milmow also pointed out that the facility for overtime or extra work in one or more departments afforded by the use of electric drive, which is increased by employing extra motors, is lacking in mills using steam drive; one reason being that steam engines are inefficient on any but their normal loads, whereas with electric power as much power as is required can be taken anywhere at any time. Another important advantage of electric drive, he said, is the ease with which extensions can be made at any time. If a mill is designed for steam drive and allowance is made for expansion, it means that the steam equipment must be made larger than that which is required for immediate needs, the extra plant being unproductive at first and adding to the cost of running. With steam drive too, the engine and boiler plant being first decided upon, the mill has to be built to suit this machinery, while with electric drive this is a secondary consideration or does not matter at all.

Furnace Electrodes.

At the same gathering two very interesting papers were read on the subject of furnace electrodes. In the former of these Dr. Carl Hering gave a general review of his own investigations in the direction of determining the correct principles for proportioning electrodes. His results show that these differ radically from the methods heretofore employed. The fundamental principle of his analysis of the problem is that the heat gradient at the hot end shall be zero. This can only be obtained by having the temperature of the hot end equal to that of the furnace, a condition which can be obtained by securing the proper current density in the electrode. Many experiments were made to determine the constants involved in the equations enunciated. The important points brought out are that the electrodes shall not chill the furnace; the length of the electrode is determined by the thickness of the furnace wall; its cross section by an equation bringing in the furnace temperature. The loss in watts is independent of the cross section or length. The hotter the outside terminal the smaller is the loss. The diameter of the external portion of the electrode necessary for making connection are determined by different laws. Graphite forms the best electrode material, carbon the poorest. Dr. Hering's paper was followed by one by Dr. A. E. Kenelly, in which were outlined some important suggested modifications in Hering's law of electrodes as enunciated in the paper read by the latter before the American Electrochemical Society last October. The paper pointed out, firstly, that the combined loss through the cold end of an electrode is equivalent to the sum of the loss by heat conduction alone (when there is no current) and half the I^2R loss; and, secondly, that this combined loss will be least when the loss by heat conduction alone is made

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equal to half the I^2R loss; the total loss will then be equal to the I^2R loss, and no heat will be conducted from the interior of the furnace.

Electrification of Steam Railways.

Professor J. W. Whitehead, of the Johns Hopkins University, in the course of a paper read at Washington at a meeting of the American Institute of Electrical Engineers, said that out of a total railroad mileage of 220,000 in the United States, only about 1,000 had been electrified. He pointed out that the advantages of electric operation included speed, comfort, acceleration, tractive effort and headway, and instanced the fact that on the New York City elevated roads, 50% increase in capacity resulted from electrification. Terminal and suburban, express, and freight service were treated separately, with a consideration of the conditions affecting each. In each case Professor Whitehead reached the conclusion that electric operation is not only possible, but under advantageous conditions decidedly preferable. The great advantage of electric operation is in the centralisation of power generation; its weakest feature is in the feeding of power over a transmission line, for if this fails, operation must shut down. The relative dangers of the two systems were considered. Turning to the question of costs, the speaker stated that the conducting of transportation, the main item of difference in the two systems, is about 56% of the total cost of operation. From a consideration of the different items, it was shown that where 10 or more trains a day were operated, a saving of 20% of the cost could be effected under this heading by electrification. The different methods of electrical operation were next considered, direct current at 600 volts being the most common. Most alternating current equipment is for single-phase, series, commutator motors, although at the Cascade Tunnel on the Great Northern Railroad, three-phase induction motors are used. About 1,000 miles of road are being operated on alternating current, although the Washington, Baltimore and Annapolis road has recently abandoned this for direct current at 1,200 volts. The great advantage of alternating current lies in transmission at high voltage, a transformer in the locomotive serving to reduce to working voltage. Sub-stations can therefore be widely separated, and copper costs also kept down. Line voltage as high as 15,000 volts has been used in this way.

Current Items.

The Rochester Railway & Light Company has devised a method of killing eggs by electricity by means of which they may be preserved in a fresh condition for an indefinite period.

A "Detroit" electric automobile, equipped with Edison storage battery, made a run of 162 miles on one battery charge in Chicago a few days ago. The route was from Automobile-row, in Chicago, north to Highland Park and back again by a circuitous road. This route was covered twice, with a rest between, but with one battery charge.

The Buffalo, Rochester & Pittsburg terminals of the Buffalo, Rochester & Pittsburg Railway are being equipped with electric cranes in order to facilitate the handling of heavy shipments, such as iron pipe, machinery, stone, etc. The new device will replace the old hand-power crane of the chain-fall type, and by its use entire loads of heavy material may be placed either on or off a car, as the case may be, with one turn of the lever.

The Edison Storage Battery Company, of 104, Lakeside-avenue, Orange, New Jersey, began advertising the new battery this week in the electrical journals. The advertisement says: "We have announced before that when the Edison battery was *right* it would be ready. It is ready now. This is the storage battery on which Mr. Edison spent nine years in experimentation, and it is far superior to any other storage battery ever produced. This new Edison Storage Battery is adaptable to all classes of electric vehicles, from the lightest runabout to a five-ton motor truck. It is by far the most practical and efficient battery to use in the ignition system of a gasolene car. It is also available for electric head and tail lamps and for incandescent lighting of enclosed cars, electric launches, storage battery street car work, for testing direct current meters on premises and at central stations, laboratory testing work, or for any other purpose to which a storage battery is adapted."

LEGAL.

ELECTRIC MAINS OVER LONDON BRIDGE.

Mr. Justice Parker heard an interlocutory injunction sought by the Corporation of the City of London to restrain the County of London Electric Supply Co., Ltd., from laying their electric mains across London Bridge without first obtaining the consent of the plaintiffs (the trustees of the Bridge House Estates) as the body in whom the bridge and the liability to repair the same were vested, and also to restrain the company from proceeding with a certain arbitration with reference to the same matter.

Mr. Justice Parker, in delivering judgment, held that the case raised a question as to the construction to be placed on Section 4 of the London Electric Supply Act, 1908 (8 Edw. VII., c. clxvii.). That was an Act which was designed to confer further powers on London electric supply companies, of which the defendant company was one. The preamble to the Act said that in the then existing state of affairs there were companies without power to enter into agreements with each other, and some with areas of supply which were not contiguous. Section 4 (1) of the Act provided for making, under agreement, a connection between the generating station or area of one authorised undertaking or specified company and the generating station or area of supply of another such undertaking or company. Section 4 (2) provided for such an undertaking or company making a connection between any two or more areas which it was authorised to supply, or between any such area and its generating station. It was obvious that under the old Acts the powers of companies were confined to their own areas. By Section 4 (3) (*a*), as regarded electric mains, such an undertaking or company had, with respect to streets in any area which it was authorised to supply, the powers, and was subject to the provisions of the Acts and Orders relating to its powers of supply in that area. This provision was needed for the reason that the power to break up streets was for defined purposes only, and no existing undertaking had power to break up streets beyond its area of supply, and the provision extended the power to outside areas. By Section 4 (3) (*b*) such an undertaking or company, with respect to streets, not with any area which it was authorised to supply, was to have the powers and be subject to the provisions of the Electric Lighting Act, 1882, and certain provisions of the Electric Lighting Clauses Act, 1899, and those provisions, so far as applicable, but subject to the provisions of Section 4 of the Act of 1908, were incorporated with that Act, and were to have effect, and the authorised undertaker or specified company laying the mains was to be deemed "the undertakers." Again, that section conferred powers that were not existing before. The powers were given by reference to former Acts, and the section meant to apply the old powers to streets which were outside the area of supply. Section 12 of the Electric Lighting Act, 1882, incorporated certain provisions of other Acts, including provisions of the Gasworks Clauses Act, 1847, with reference to breaking up streets. But Section 13 of the Act of 1882 placed certain limits on the exercise of these powers, and provided that nothing in the Act or any incorporated Act should empower the undertakers to break up any street which was not repairable by the local authority, or any railway or tramway, without the consent of the authority, company, or person by whom such street, railway, or tramway was repairable, unless in pursuance of special powers, or with the written consent of the Board of Trade. Having referred to the Act of 1899, his Lordship said that Section 4 of the Act of 1908 gave power to the company to connect its northern and southern areas and to break up streets for that purpose outside its areas of supply. London Bridge was not a bridge which was repairable by any local authority, but by the Corporation (as trustees of the Bridge House Estates), and it was within Section 13 of the Act of 1882 and a provision of the Act of 1899, and the company could not lay mains across it, except by the consent of the Corporation or the written consent of the Board of Trade. His Lordship made a declaration accordingly.

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NATIONAL PHYSICAL LABORATORY.

The annual report of the National Physical Laboratory for the year 1909 contains much information, and shows the large amount of valuable work carried on at the Bushey Park establishment. No less than 155 electrical measuring instruments were tested during the year, and under the electrotechnics department 2,328 instruments were tested, this comparing with 1,760 in 1908 and 993 in 1907. In this department of electrotechnics a series of experiments were carried out as regards ebonite and insulating materials generally, the latter on behalf of the Engineering Standards Committee. We quote particulars of these from the report.

Ebonite Investigation.

With the valuable co-operation of the India Rubber, Gutta Percha & Telegraph Works Co., a very thorough investigation into the dielectric strength of different kinds of ebonite has been completed, as well as into other properties of the material.

Ebonites were specially made up by the Company from different rubbers and containing different amounts of foreign matter. The method employed for securing an even potential gradient in the material when under electric stress, was by the use of metal spheres of 2 in. diameter partially embedded in opposite sides of the piece of sheet to be tested. The spheres acted as electrodes and the recesses for them were carefully machined out until the material between them was of the order of 0·5 millimetres thick. The voltages necessary to puncture even this small thickness were so high that the breakdowns had to be made under oil. The dielectric strength of the ebonites tested ranged from 60,000 to 90,000 volts per millimetre for the adulterated samples, and from .100,000 to 150,000 volts per millimetre for the purer samples. Ebonite made from Para rubber was found to give the highest strength. Investigations were made on other properties of the material, and at present samples of the various grades are being exposed to daylight with a view to testing their relative deterioration. It is expected that a full account of the tests will be published in the course of this year.

Research on Insulating Materials.

This investigation was commenced at the beginning of the summer, on completion of the high voltage transformer equipment. It is a continuance of previous work undertaken on behalf of the Engineering Standards Committee, the results of which have been published by them and by the Institution of Electrical Engineers. Since the beginning of the autumn it has been possible to carry on the work without material interruption, in consequence of the appointment of an additional Junior Assistant on the staff of the Electrotechnical Department. His assistance in the general work of the laboratory has practically prevented the test work from interfering with the progress of the research.

The aim of the investigation is to determine the effect of continued electric stress on insulating materials, with a view to obtaining information on which voltage tests for electrical machinery (especially high tension) can be formulated.

A large number of tests has been carried out on insulating materials, chiefly varnished cloth and papers, which show that it is quite possible for the application of a high voltage for some time to cause permanent damage and weakening of the material. This is largely the case at the edge of the metal electrodes used, where the brush discharge in the air has a particularly weakening effect. Recently apparatus has been devised to obviate this trouble.

As the work progressed it was felt that most valuable results could be obtained if it were possible to devise a method of accurately measuring the loss of energy in the insulating materials under test, the consequent heating effect of which appears to be the most important factor in weakening the dielectric. This fact has been pointed out by previous experimenters on the subject, and in particular by Mr. G. L. Addenbrooke, who has conducted a number of similar experiments on cables. Reference may also be made to "Energy Loss in Commercial Insulating Materials," by C. S. Skinner, Trans. Amer. Inst. Elect. Eng., vol. 19, page 1047.

An electrostatic wattmeter has therefore been designed to measure the energy loss in insulating materials when subjected to voltages up to 10,000 or more, and after a considerable amount of experimenting, satisfactory results have recently been obtained with a working model. A large number of observations on insulating materials have been made at 10,000 volts, and the instrument seems to work satisfactorily at considerably higher pressure. The instrument is the same in principle as the other electrostatic wattmeters used for precision measurements, with the necessary enlargement of the working distances and consequent size of moving parts to avoid discharge through the air. The wattmeter has been found so satisfactory that a number of resistance boxes and switches with long insulating handles are now in course of construction, which will enable all the necessary connections to be made without interrupting the application of the voltage.

The results so far obtained with this instrument confirm such previous observations as have been published by other investigators on the subject. The most important results obtained from experiments on varnished cloth (the material chiefly used up to the present), is the great increase, with rise of temperature, in the actual loss of electrical energy in the insulating material, and the consequent heating of the material. The watt loss increases therefore at a rapid rate with time, and just before breakdown takes place, when the material is warm, the increase in the rate of production of heat may be as great in a few seconds as it is in an hour at the beginning of the experiment, when the material is at atmospheric temperature.

The results obtained have only been possible through the very complete equipment for the production and measurement of high voltages, which is described below. The sensitive high tension voltmeter has been of great value and is practically a necessity for such work, since with the insulating materials tested it is quite possible to detect a change in the wattmeter reading due to an alteration of 10 volts in 10,000.

RADIOTELEGRAPHY: TRANSATLANTIC SERVICE.

The new service of radiotelegraphy set up by the Marconi Telegraph Co., in conjunction with the G.P.O., was inaugurated by an exchange of messages between Mr. Lemieux, the Dominion Postmaster-General, and Mr. Samuel, and was opened to the public on Saturday. We gave some particulars of this service in our issue of last week. At present messages are handed in at the headquarters of the Marconi Co. in London, but those who have telegraphic addresses registered with the company can send a telegram from any post office to Clifden, the cost of the wireless message from there being booked to them.

Arrangements are being made to enable anyone to hand in at any post office messages for Canada or the United States, marked "*via* Marconi." The charge for messages to Eastern Canada will be 7½d. per word (the present cable rate being 1s.), and to other places on the North American Continent the rate will be 4½d. per word less than that quoted in the Post Office Guide.

This new service, in conjunction with the drastic steps taken in the Canadian Dominion Parliament to control rates, has given rise to some rather wild talk as to the near approach of the supercession of cables. In this connection it is interesting to have the views of Mr. Charles Bright, M.I.E.E., recently appointed electrical consulting engineer to the Commonwealth of Australia, and who carries on the traditions of his father, Sir Charles Bright, in his keen study of overseas telegraphy. Speaking to a press representative, Mr. Bright was enthusiastic in his acclamation of the Marconi transatlantic "wireless" triumph. But he added: "It is now over 50 years since the first Atlantic cable was laid, the original tariff being £1 a word, with a minimum of 20 words. With 17 cables across to North America, it is clear that the uses of cable telegraphy are considerable. Certainly for the purposes of disseminating news throughout the Empire in such a way that misunderstandings may be avoided, the popularisation of telegraphic communication is a thing to be achieved. The present transatlantic cable rate is 1s. a word, which is, of course, a great reduction on the prehistoric rates. Owing to the initial and working cost of a cable, any such

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tariff as a penny a word is out of the question. Wireless telegraphy may have a useful sphere before it for private messages of a non-urgent character and for reporting speeches. It is not sufficiently realised by people who talk lightly about cable rates that even if reduction enormously increased the traffic it would entail further lines being laid down, and cables are costly things. The cost, however, was over-estimated by the representative of the Marconi Co., whose opinion you quoted on Saturday. He said a new cable would cost £1,000,000. Half that sum would be correct.

"I note also that the same gentleman suggested that the laying of further cables was improbable. Statistics do not bear out that suggestion, the fact being that five times more cable has been made and laid since the existence of the Marconi Co. than during the corresponding period before. Whilst wireless telegraphy has been making enormous strides, the practice of cable telegraphy has by no means been standing still. Its recent developments are associated with high speed and automatic transmission, giving a rate of working that is practically only limited by the type of insulated conductor; in other words, by traffic considerations. It is an everyday affair for an Atlantic cable to be worked at 100 words per minute, with messages going simultaneously in each direction. For Stock Exchange and general commercial purposes, where speed is everything, the cable certainly carries the palm at present, and so far from cables being no longer required, business people continue to put money into them, and more than one new Atlantic cable is shortly to be laid."

As regards the Canadian Cable Rates State Control Bill, Mr. George G. Ward, vice-president and general manager of the Commercial Cable Co., has addressed a letter to the Speaker of the Senate, in which he complains of the attitude taken up, on the mistaken assumption of the public that there was a kind of undertaking between cable companies resulting in their earning too high dividends. Mr. Ward points out that this is a mistake, and goes on to state that: "There is no reason to expect that the transatlantic cables will be free from damage or breakage in the future, any more than they have been in the past. On the contrary, the agencies which inflict the injury are multiplying and extending the field of their operations, and the cable companies must take into account the probabilities that their repair bills and loss of traffic will increase and will not diminish. One of our cables was damaged last year about 65 miles from our cable landing at Dover Bay, Novia Scotia, and we were in consequence deprived of its use for three months. When making the repair, our repairing ship found that for a distance of two-and-one-half miles the cable had been caught about every 10 fathoms by steam trawelrs, and had been flattened, twisted, and subjected to great strain. A large number of steam trawlers are now fitting out in readiness for this season's fishing, and we dread the damage which they may do us, and which we see no way to avert. The strongest, newest, and best cables are not immune from the depredations and devastations of these trawlers.

"The Commercial Cable Co. has had three cable ships at sea at one time repairing or replacing disrupted cables. For over six months continuously during the past year we at no time had our entire facilities working, there being some break somewhere during all that period. The expense connected with all this has been enormous, to say nothing of the loss of business on account of not having complete facilities. In fact, the menace to the business is so great that we have decided to lay still another cable in the Atlantic Ocean, although such additional cable is entirely unnecessary to our present business if we could be sure of having our present facilities uninterrupted.

"The disposition of the cable companies to meet public requirements is conspicuously shown in their attitude towards code language. The cable companies have gradually relaxed their rules, and have admitted artificial, or manutured words, which are supposed to have some resemblance to real words. These so-called words really represent 10 figures each; the 10 figures are 2 groups of 5 figures, and each group of 5 figures represents a separate code word, and each code word easily represents, on the average, at least 10 plain words. The net result is that each of the above so-called code words, representing at least 20 words in plain language, is transmitted at a total cost of 25c. It is almost impossible to transmit by cable these words rapidly and correctly. The result is that the carrying capacity of a cable is reduced over 25%. In addition to that, many of the so-called words have to be repeated. This places upon the cables a large amount of unremunerated work, as repetitions are not charged for. It also delays a great deal of paid work. By reason of all this the earning power of a cable is very greatly reduced, while the expense for operating is increased. When it is borne in mind that 98% of the cable messages are in cipher code, and each code word, as explained above, represents at least 20 plain words, it will be seen that cablegrams in code bring the rate down to less than 2c. a word for the translated message.

"The 25c. rate is a fair rate. It is no more than is necessary to pay operating expenses, and to keep the plant in thorough repair and readiness to furnish the best possible service in point of regularity, accuracy, and speed, and to pay a very reasonable return on the money invested. The service rendered is worth the money, and cannot be rendered for less. The only comparison to be made with it is the State-owned British Pacific cable, which in its best year compelled the taxpayers to increase their taxes to the amount of £62,362 per annum."

ELECTRICITY IN A MODERN INFIRMARY.

DETAILS OF THE ELECTRICAL AND MECHANICAL INSTALLATION IN THE NEW COOK COUNTY INFIRMARY.

There will shortly be opened at Oak Forest, Illinois, a new county infirmary which will be a model institution in every respect, and is of special interest from the electrical point of view, as appears from the account in the *Western Electrician*. It consists of a large group of buildings on a farm of 255 acres, situated about 20 miles from the business centre of Chicago.

The buildings are laid out on the block plan, the cottage system being followed in the homes for the inmates. In the building scheme the buildings for administration service and general purposes are grouped near the centre and the homes for inmates located on either side. The buildings are laid out from the two main axes.

At the east end of the group beyond the chapel are the large dining hall, laundry, workshop, bath house, homes for irresponsibles, and the power house. Outside of the general group are several isolation hospitals, the morgue, and a number of individual farm buildings.

No building is more than two storeys high, except the administration building, the workshop and a portion of the general hospital. Beside the covered walks connecting the buildings already referred to, there are pleasant walks and driveways.

The dining hall will seat 660 persons, and in the rear contains a bakery, kitchen, and store-rooms in which the applications of electricity play an important part.

Back of the dining hall is the laundry building, workshop and the general bath. The laundry building is 57 ft. by 138 ft., and is arranged in the most improved manner for receiving, handling and delivering linen, and is equipped with all modern appliances for such work.

The workshop is three storeys high and contains shops for carpenters, mattress makers, painters, tailors, cobblers, broom makers, and furniture makers. On the second floor is a billiard room and club room with all modern fittings. The top floor provides sleeping apartments for 20 men. All of these buildings are connected by covered corridors constructed of red brick and terra-cotta.

The power house is situated at the extreme east end of the east and west axis and covers a space of 102 by 160 ft. The building is a modern steel, fire-proof structure, constructed of brick with cement floors and roof. The general plan view is shown in an accompanying illustration. No effort was spared in making it a model of its kind, and as a result it is built on the broad and up-to-date lines which are characteristic of the entire institution.

The facilities for handling coal and ashes are elaborate, this being done automatically so far as possible. Coal is brought in from the main line of the railway on a spur track running directly into a train shed which may be seen at the east end of the power house. Cars entering this train shed

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run over a 150-ton, 40-ft. standard track scale, being weighed, pass over a receiving coal hopper located in the upper part of the coal crushing pit and are emptied. By means of a reciprocating feed operated by a 3 h.p. Westinghouse motor, the coal is then fed into a crusher driven by a 25 h.p. Westinghouse motor. It is then conveyed to the east end of the power house and emptied into seven main hoppers which discharge, by means of wrought-iron spouts into the hoppers of the stokers. These chutes are provided with cylindrical valves which regulate the supply of coal to the stoker hoppers.

The ashes are conveyed from the ash pits in the basement directly under the furnaces, by means of conveyors operated by a 15 h.p. Westinghouse motor, to two hoppers above the train shed. From here they are dumped into cars on the spur track and hauled away. There is also provided an extra ash hopper which discharges into a spout protruding out of the side of the power house so that cinders may be taken away by wagon for filling-in purposes about the grounds.

There is also provided a range-coal hopper which empties into a conveyor and is then elevated to a hopper above the train shed from where it is distributed into wagons for domestic purposes. This latter conveyor is operated by a 3 h.p. Westinghouse motor.

The boiler room installation includes five 350 h.p. water-tube boilers, in single settings located in a row. These boilers are equipped with the latest regulator apparatus, including water columns with high and low water alarms, and regulators for the boiler feed. Each boiler contains 174 water-tubes 18 ft. long, and the total heating surface of each is 3,615 sq. ft.

The boilers are provided with chain grate stokers. The stokers are operated from a shaft located directly underneath the boiler room floor, which is operated by a 6½ h.p. Westinghouse motor, with an engine auxiliary.

There is a sheet-iron smoke breeching running the entire length of the boiler room, above the boilers, which extends through the east side of the building to the smoke stack. This stack is a handsome structure, 213 ft. in height and will eventually become a landmark of this institution. From the foundation to a short distance above the ground its construction is of square concrete blocks, and from this point to the top it is octagonal and higher up cylindrical in shape. The stack is panelled off at the top with grey brick, and is lined inside with No. 2 fire brick.

Located at about the centre of the boiler room are two 10 by 7 by 12 in. vertical, duplex boiler-feed pumps. These pumps, which are the only ones located in the boiler room, are provided with pressure regulators and stop automatically. The exhaust from these pumps passes through the hot-water heater.

The engine room, which is partitioned off from the boiler room by a brick wall, is 49 ft. wide, by 134 ft. long, and is exceptionally well lighted and ventilated. The absence of any visible piping and wiring makes its appearance decidedly attractive and pleasing to the eye.

There are three Corliss engines, direct-connected to three Western Electric engine-type direct-current generators rated at 150, 250 and 350 kw. respectively. As may be seen from the accompanying plan the smaller of the three generators is located adjacent to the east wall of the engine room, and the 250 and 350 kw. generators are located in the order named. The generators are wound for 225 volts and are connected on the three-wire system.

The main steam piping is of lap-welded steel, and wherever possible expansion bends of large radius are employed. Steam from the boilers is received into a 16 in. main steam header, and is led to the partition wall between the boiler and engine room where it enters the engines and is then piped to the basement under the generators. This main header is divided into three sections with auxiliary connections to the engine room header, so that the boilers may be cut into three units if necessary for the purpose of making repairs on the engine room header.

To the main steam header there are also connected three lines which discharge into a 12 in. auxiliary header for heating the various buildings. Steam from the 12 in. header is by-passed into the 20 in. main heating line from which connections are made to the various tunnels. Steam is also taken from this 12 in. auxiliary header to supply all of the pumps.

A 14 in. exhaust steam header in the basement collects exhaust steam from all of the engines and pumps, and connections are made to this exhaust for heating some of the near-by buildings. Provision is also made for by-passing live steam into the heating mains if there is not sufficient exhaust steam to heat the buildings. There is also an exhaust header connected directly to the feed wated heater and by-passed at the header so that it may exhaust to the atmosphere through a relief valve.

There are two boiler-feed headers provided, 5 in. in diameter, one being used for the hot water supply of the boilers, and the other for auxiliary feed to the boilers and boiler-washout line. All of the steam and boiler feed lines and fittings are extra heavy.

The general water supply is furnished by two 6 by 36 in. deep-well pumps, one located in the north-west and one in the south-east corners of the engine room, which discharge into a concrete reservoir located in the basement. Suctions are run to this reservoir from two general service pumps, which discharge into a stand pipe in the west end of the power house. From this stand pipe water is discharged about the ground. These two service pumps are 12 by 18 by 12 and 16 by 10 by 12 in size and are located in a line with and adjacent to the generators.

On the north side of the building there is situated a concrete rain-water cistern in which rain water from all of the buildings is collected. Two rain-water pumps in the basement distribute this water to the refrigerating machines, bath houses and the laundry building.

Near the west wall of the engine room are two hot-water pumps 7 by 4·5 by 10, directly connected to two vertical-closed hot-water heaters. In the basement directly underneath these hot water pumps are two vacuum pumps which deliver the water of condensation to the feed water heaters.

All pumps are equipped to be driven by either motors or engines.

The switchboard in this institution is a model of its kind. It is of the self-supporting angle-iron frame type, manufactured by the Western Electric Co., and it is located along the north wall of the power house; north of the line of generators. The board consists of 16 panels of white Italian marble, about 2 in. thick, divided as follows: Three machine panels, two compensator panels, one totalising panel and the other panels are arranged for controlling the light and power circuits.

The switchboard equipment consists of the latest types of controlling and measuring apparatus, including Weston ammeters and voltmeters, I.T.E. circuit-breakers, graphic recording voltmeters and Thompson integrating watt-meters.

In line with the switchboard and directly west of it there are installed two Western Electric balancing sets for the 110 volt three-wire lighting system. One of these sets is of the capacity of 250 amperes unbalanced in neutral, and the other set is of the capacity of 350 amperes unbalanced in neutral.

A feature of the engine room is the refrigerating system installed for cooling water; air for the various service pantries and also for manufacturing ice in the summer. The ice machine is of 40 tons capacity. This machine, driven by a heavy-duty Corliss engine, is in a line with and west of the generators.

An elaborate system of tunnels connects the power plant with each building and all current for lighting and power purposes, as well as piping for steam, hot and cold water and ice water is distributed through these tunnels. The buildings are all served by lead covered cables suspended from the top of the tunnel by special hangers. At each building the cables are tapped and enter a service box and each building circuit is controlled independently by a special service switch in the tunnel.

Where submains are connected to the main feeders a special type of service box is used. In all of the buildings the feeders are run in conduits concealed in the walls.

For the interior illumination of the buildings all types of incandescent lamps will be used, and the fixtures are all tasteful in appearance and scientific as to design. In all likelihood tungsten lamps will be extensively used for illuminating the majority of the buildings.

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The grounds surrounding the buildings are provided with an extensive system of walks and drives. These will be illuminated by arc lamps suspended from ornamental concrete posts. About sixty lamps will be used. Connections will be made underground with the tunnel lines, so that the appearance of the installation will not be affected by overhead wiring. The power plant will be illuminated by 36 arc lamps suspended from the wall by brackets placed about 17 ft. above the floor.

"A.C. AND INDUCTION MOTORS."

The subject of the alternating current and induction motors is one daily gaining in importance, thanks to the increasing demand for electric power both in domestic and industrial circles. Many users, and many more would-be users, however, are entirely ignorant of the whole series of questions involved, and it is well that some work of "vulgarisation" should be undertaken. In several instances the commercial managers of electricity supply undertakings have adopted measures, by the issue of booklets and so on, to initiate the general public in certain "mysteries" connected with electric power and motors. More of this kind of publicity is required, and so we welcome the appearance of the little book "Alternating Current and Induction Motors." (Leeds: T. Harding Charton & Co. Price 1s.). Although the book has been written with the main idea of making known the merits of the firm's own electrical appliances, it may be fairly praised for its general excellence. Certainly the needs of the non-technical reader have been well kept in view by the author, who has managed to describe technicalities with sufficient fulness and lucidity. The reader is first given an account of the alternating current, periodicity, phases, methods of measuring, all being explained, followed by practical details as regards current required by motors, and how speed is effected by periodicity. Other sections treat of the Induction Motor, Heating of Motors and Rating, Speed Control and Reversibility, Selection of Motor, Diagrams of Connections, Management of Motors, and valuable chapters on Private Generating Plants for Power. There are also useful wiring tables, and hints as regards safety fuses and circuit-breakers, and leather belts. Each section is very fully illustrated both with diagrams and photographs. The section on Selection of a Motor is worth re-printing in full:

SELECTION OF MOTOR.

SPECIFICATION for an Alternating Current Motor:—

PARTICULARS OF ELECTRIC SUPPLY on which the motor is to work:

Number of phases; voltage; periodicity.

OUTPUT OF MOTOR:

B.H P. and speed.

PARTICULARS OF MOTOR:

Type of rotor—Short-circuit or wound;

Starting torque (state whether required to start up light or on load, and the limit, if any, as to starting current allowed);

Open, protected, or totally enclosed type;

Continuous or intermittent rating;

Overload capacity required.

The following points should also be considered:—

Efficiency at full, three-quarter, and half-load;

Power-factor;

Temperature rise;

Insulation test;

Protection of windings;

ACCESSORIES THAT MAY BE REQUIRED:—

Starter;

Belt pulley, pinion, or half-coupling;

Slide rails and belt-tightening gear;

Cut-off switch, circuit-breaker, fuses.

SPEED. As only certain speeds are possible for any given periodicity, the speed most suitable for the work required must be chosen with reference to (1) the sizes of pulleys or gear wheels, or (2) to the speed of driven machine—if required to be direct-driven, (3) to the most efficient speed of the motor, and (4) to the cost of the motor.

Example:—A 20 h.p. motor, on a 50-cycles circuit, is required to drive a line shaft by belt at about 120 r.p.m.

A six-pole motor will run at 1,000 r.p.m. light, or, say, about 960 r.p.m. on load, and this gives a speed reduction of 8 to 1. This will be satisfactory for a fairly long, easy drive; but for a short or stiff drive an 8-pole motor running at 750 r.p.m. light, or, say, 720 r.p.m. on load, will be more suitable, the reduction in speed being in that case 6 to 1.

Sometimes the speed of the motor is determined by the maximum diameter of the driven pulley which it is possible to employ.

Suppose that in the above example the largest pulley that could be put on the line shaft was 48 in. diameter. Then, if the speed of the motor was 960 r.p.m., the diameter of the motor pulley would be only 6 in., which would be small. The belt speed being in this case about 1,500 ft. per min., a double belt would require to be 6½ in. wide. But a 6 in. pulley would be rather small for such a belt, and we should, therefore, decide upon a motor to run at 720 revolutions, which would allow a pulley of 8 in. diameter, and which would run with less slipping and less wear on the belt. An even slower speed, say, 580 revolutions, might be better still so far as the belt was concerned, but as a set-off against this the motor efficiency would be lower and the cost higher. A good practical rule to follow is that *the diameter of the motor pulley should be not less than the width of the belt required to transmit the h.p.*

Motors required for *cranes* should run at low speeds on account of the reduced loss of power in the gears and because of the more efficient starting torque obtained from low-speed motors.

TYPE. Choice as to whether a motor shall have a short-circuit or a wound rotor is, except in small sizes, not infrequently settled by the Electricity Supply Co., but unless required to develop a high starting torque, or to be capable of being controlled in speed, the *short-circuit rotor should always be adopted when possible.* The advantages of this type as compared with the wound rotor are:—less cost, less wear and tear, and less liability to breakdown, besides being more simple to operate and having higher efficiency and power-factor and a greater overload capacity.

OPEN OR ENCLOSED MOTOR. When continuous current motors are required to be entirely enclosed, it is not infrequently on account of the risk of dust, inflammable gas, etc., being ignited by sparking at the commutator. But in the case of the induction motor with short-circuit rotor, in which there are no moving electrical contacts, there can be no sparking unless the circuits of either the stator or the rotor are actually damaged, which, with ordinary care, is very unlikely to occur.

And though it is possible for sparking to occur at the slip-rings of a wound rotor, if neglected, the risk is not to be compared with that of the sparking at the commutator of even the very best direct current motor. Slip-rings may, however, be conveniently placed outside the bearing of the motor—the connecting wires to the rotor being led through the centre of the hollow shaft—and enclosed when required without the motor itself being enclosed.

There is thus seldom any necessity to entirely enclose the induction motor unless to protect it against moisture, or against objects being accidentally thrown in that might foul the rotor and thus damage the motor. The latter risk may generally be sufficiently guarded against by the adoption of protecting perforated shields.

If the motor is for intermittent duty, such as for crane work, the fact of its *being enclosed* may make little or no difference to the power which it may be required to develop, whereas if it is to be run continuously on load, *a very considerable reduction may be made in its effective capacity on account of heating.*

GENERAL CONSTRUCTION. Owing to its simplicity of construction and to the facility afforded for ample and effective insulation, as well as to the few wearing parts, the induction motor, when well made, is one of the most reliable forms of motor possible.

But while a motor may be readily tested with precision for actual power developed, speed, efficiency, power-factor, rise in temperature, and insulation resistance, the durability and reliability of the machine depend upon qualities beyond the range of such ready scrutiny, and are to a large extent a measure of the experience and reliability of the maker and of the organisation of the factory.

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Business Notes and News.

LIGHTING AND GENERAL—Home.

FELIXSTOWE.—At the Local Government Board inquiry held in connection with the application for permission to borrow £4,500 for additional plant at the electricity station, the Inspector raised objection to certain items (meters and accumulators) being paid for out of borrowed money, and also of the practice of borrowing for one purpose, and spending the money on other machinery.

ILKESTON.—Mr. H. P. Stokes, borough electrical engineer and tramways manager, in his first year's report, covering the twelve months ending March 31, shows that as regards the tramways, while the gross profit was £1,036, the net loss amounted to £2,086. The total operating expenses were brought down to the low average of 6·02d. per car-mile. As regards the electricity department, the total working expenses came to £1,788, or 1·34d. per unit (as compared with 1·46d. per unit in the previous year). The gross profit was £1,199, but there was a net loss of £85. This is, however, an improvement, as the loss for 1908 was £432. At Ilkeston electricity is purchased in bulk for distribution, and Mr. Stokes estimates that if the town generated its own current, a saving of over £952 would be effected, which would have converted the debit balance into a profit of over £866. A step in the right direction is the setting aside of £350 to form a reserve on the tramway account and £500 on the electricity account.

LEEK.—The District Council have decided to change over their No. 1 engine for one with producer gas, at an expense of £35. Owing to late delivery, the contractors who supplied a new gas engine and dynamo, at a cost of £2,650, have allowed a rebate of £300, which sum is being spent on improving the workshops.

LONDON: BETHNAL GREEN.—A contract has been entered into whereby the Shoreditch Borough Council will supply the Bethnal-green with electricity in bulk, for distribution within the borough. The various Metropolitans had been appealed to for tenders, but none were forthcoming.

LONDON.—The London County Council have completed the following loans to Metropolitan Borough Councils: Hammersmith, £2,000, street lighting; Poplar, £1,766, electricity undertaking; St. Marylebone, £20,900, electricity undertaking; Shoreditch, £2,234, electricity undertaking; Stepney, £13,000, electricity undertaking; Woolwich, £2,199 and £4,529, electricity undertaking.

MANCHESTER.—The Electricity Committee announce a profit of over £35,200 on the year's trading. Of this, £12,000 has been paid in aid of rates, and the balance has been placed to renewals accounts. There was a falling off of over one million units for traction purposes, an increase of only a little over half a million units for lighting, but for power purposes there was the very gratifying increase of over five million units, which promises well for the permanent benefit of the industry. The Tramways Committee have fixed their estimates for the coming year, which provide for a distribution of £60,000 in aid of rates.

PEMBROKE.—The substitution of incandescent metallic filament lamps in clusters for arc lamps has proved satisfactory, and is likely to be extended.

RADCLIFFE.—The Board of Trade inquiry, held in London, into the application of the Lancashire Electric Power Co. to enter the borough areas and supply electricity for power purposes, in competition with the borough electricity department, has been closed. An award will shortly be issued by the Board of Trade. Originally the demand was for permission to supply electricity for lighting and heating and power, but this was ultimately modified into one for permission to supply customers using 30 h.p. and upwards.

RHYL. The Electric Light Committee have entered into an agreement to supply the Rhyl Palace, etc., Co. with electricity, at 5d. per unit under 10,000 units, and at 4d. per unit if the consumption exceeds 10,000.

SOUTHEND-ON-SEA.—The Corporation Electricity and Tramway Departments did excellently for the past year, and a credit balance of over £11,000 has been secured. Part of this goes to reserve, but a large part in relief of the general rates.

STOCKTON HEATH.—Considerable opposition is shown against the Runcorn Urban and Runcorn Rural Electric Lighting Order promoted by the Salt Union. The Parish Council are of opinion that there is ample water power to enable a successful scheme for local generation and supply of electricity being taken in hand. Stockton Heath has a population of over 4,500, and a rateable value of £16,000. A movement is on foot to bring in certain outlying districts and forming an urban area. If this is done, the district would probably apply for its own Electric Lighting Order.

LIGHTING AND GENERAL—Overseas.

BRANDON (MANITOBA).—The Public Utilities Committee have recommended the establishment of a steam electric power plant of four units of 250 h.p. each, to supply power for tramways, pumping, street lighting, etc., and of a steam heating plant.

MAR DEL PLATA, ARGENTINE.—A syndicate has offered the Electric Light Co., of Mar del Plata, $800,000 cash for the buildings and plant of the company. Should the offer be accepted, the new company intends making considerable improvements and extensions.

PRINCE RUPERTS.—Tenders are to be considered on May 3 by the Electric Light Committee of Prince Rupert, British Columbia, for the supply and delivery of boilers, engines, condenser pumps, and piping, together with electrical apparatus. Mr. James Milne, 304, Loo Building, Vancouver, British Columbia, is the consulting engineer.

WELLINGTON (NEW ZEALAND).—H.M. Trade Commissioner reports that a firm at Wellington are desirous of getting into touch with British manufacturers of metallic filament lamps and arc lamps of the latest pattern. Communications in this connection should be addressed to H.M. Trade Commissioner, 9, Grey-street, Wellington, New Zealand.

TRACTION—Home.

BELFAST.—Voting papers in connection with the Cavehill tramways proposal have been distributed to ratepayers, and having been collected on the 28th, will be examined and counted to-day.

BRADFORD.—The tramway clauses in the Corporation's Omnibus Bill have been passed by the Local Legislation Committee of the House of Commons, practically untouched. The Corporation may extend their tramway system, they are to be allowed to introduce the trackless trolley system on obtaining a Board of Trade Order, and they may carry parcels up to 56 lbs. over the whole tramway system; but the powers asked for in regard to carriage of heavy goods have been disallowed.

LONDON: BATTERSEA.—The County Council have notified the Borough Council that it proposes to proceed shortly with the construction of the tramway from Battersea Bridge-road *via* Battersea Bridge, to Beaufort-street. The conduit system will be adopted.

TRACTION—Overseas.

AUSSIG (AUSTRIA).—The district authorities have decided to proceed at once with the construction of an electric tramway from Pokau to Tellnitz, a distance of 3½ miles, at a cost of 270,000 kronen (£11,250).

BAHIA.—A concession has been granted to the "Companhia Brazileira de Energia Electrica" for utilising the waters of the River Paraguassu (State of Bahia) for the development of electric power.

BAKU.—The municipality has raised a loan of twenty-seven million roubles, part of which is to be expended on lighting the town with electricity and part on the electrification of the tramway. With regard to electric lighting and the electrification of tramways, it is intended to light the town with electricity, for which purpose 960 arc lamps will be required. At the time of writing, nothing definite has been settled as to whether the town shall build its own power station or come to some arrangement with the existing power company. The electrification of the tramways is also unsettled, as it depends upon what arrangement is arrived at as regards the power station. Particulars of the route, gradient and number of miles of line may be obtained by British firms on application to the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, London, E.C.

COMO (ITALY).—A concession has been granted to the Società Elettrica Comense A. Volta for the construction and working of a metre gauge electric tramway from Como (Villa Salazar) to Cernobbio, and from Cernobbio to Maslianico. The electrical energy will be conveyed by means of overhead wires.

HOBART (TASMANIA).—A proposal is on foot for the Complex Ores Co., Ltd., establishing metallurgical works near here. Electricity for the works would be generated by water power in the vicinity of the Great Lake. At these works will be carried on operations in the treatment of ores for the production of zinc and other metals, the manufacture of calcium carbide, cinamide for the fixation of nitrogen for agricultural purposes, manufacture of aluminium, steel, corrugated and other forms of iron, all of which products are now largely imported into Australia. For the manufacture of iron the Commonwealth

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Government gives a handsome bonus. In addition, the company proposes to supply electric light and electrical power for any kind of machinery or manufacturing purposes to Hobart and suburbs.

LAUNCESTON (TASMANIA).—The whole of the equipment for the installation for the new common battery telephone system has arrived in Launceston. The work is expected to be completed by the end of the year.

MELBOURNE.—A strong movement is on foot to secure the immediate return of the tramway system under public control. The tramways were constructed by a public trust, and were then leased to the Metropolitan Tramway and Omnibus Co., whose term has still six years to run. The capital expenditure amounted to £1,650,000, and the sinking fund has now reached a total of £1,160,000. While some of the outlying Municipals favour the resumption of control by the Trust, the Melbourne City Council is itself inclined to assume responsibility, while the Minister of Railways advocates the taking over of the tramways by the Government, to be run in connection with the State railways. He also strongly advocates electrification of the whole system.

RIO DE JANEIRO.—The necessary authorisation has been given for the electrification of the northern line of the Leopoldina Railway for the purpose of establishing a suburban service between Rio and Petropolis.

SANTIAGO DE CHILI.—The proposed step for electrification of the railways, as announced in these columns some time ago, has now been decided upon. The Government will invite in May new tenders for the electrification of the railway between Santiago and Valparaiso and its branches, a total length of a little over 156 miles. The whole of the Chilian railways will ultimately be electrified.

TOKIO.—Of the loan amounting to forty million yen (£4,083,000) by the South Manchurian Railway Co., one million will be spent on an electric power house at Dairen, half a million on a tramway at Dairen, and three hundred and fifty thousand yen on electric light plant at various points along the railway line.

URUGUAY.—Concessions have been granted: (1) to Arturo Zabala for the establishment of a telephone system in the town of Maldonado; (2) to Saturno Carbajal for the working of a telephone service in Carmelo and Colonia Arrue, and for the establishment of a telephone system in Colonia; and (3) to Pedro Pomoli for the extension of a telephone line in Tacuarembo.

COMPANIES' MEETINGS AND REPORTS.

TYNEMOUTH AND DISTRICT ELECTRIC TRACTION.

The accounts of the Tynemouth and District Electric Traction Co., Ltd., for the year 1909, to be presented on 25th inst., show an available sum, including £315 brought forward, of £4,566. The directors recommend a dividend of 3½%, carrying forward £148.

CRAIGPARK ELECTRIC CABLE.

The accounts for the year ended March 31 show a net profit of £6,243, which, with the balance of £477 brought forward, makes the sum of £6,721. The directors recommend the following appropriations, viz.: Depreciation written off buildings and machinery, £500; and reserve account, £500. A dividend of 6% is proposed on the Ordinary shares, leaving £1,221 to be carried forward.

COVENTRY ELECTRIC TRAMWAYS.

The report gives the gross earnings for the past year at £28,350, the cost of operation £18,729, and the net earnings £9,621. The net profits, after taking into account the sum of £1,530 paid for interest on mortgage bonds and £1,152 for interest on the amount owing to the New General Traction Co., was £6,939, to which must be added £57 brought forward from 1908. The directors recommend that the profit be appropriated by paying £2,000 to reserve for depreciation, £4,550 to payment of 3½% dividend on the share capital, carrying forward £446. For 1907 and 1908 the dividend was at the same rate.

TRAMWAYS AND GENERAL WORKS.

Presiding at the meeting of the Tramways and General Works Co., Ltd., Mr. Ernest Wooler dealt with the affairs of the Lombardy Road Railways Co., in which they were large shareholders. They could see, he said, considerable additions to the sources of traffic, partly by the prospective building of a large sort of garden suburb some distance out by the side of the railway, and by the opening of some quarries which supplied an increasing demand for building operations in the district of Milan. It was anticipated that they would have to meet an increase in the working expenses, because, in his opinion, the rate of wages was on the increase, and he could not help feeling that it was in some cases rightly so.

ARBROATH ELECTRIC LIGHT AND POWER.

At the annual general meeting of this company, held in Brothock Bank House, Arbroath, Mr. George Balfour, London, chairman of the company, presided. The annual report was submitted. The chairman, in moving its adoption, referred to the satisfactory increase in the business of the company during the past year, and to the advisability of extending the plant at the power station. From the accounts it appeared that the net profit for the year was £426 16s. 6d. To this has to be added £76 13s. brought from the previous year's accounts, making a total of £8,503 9s. 6d., which it was arranged should be carried forward. Mr. A. D. Anderson, retiring director, was re-elected.

LA PLATA ELECTRIC TRAMWAYS.

Presiding at the meeting of the La Plata Electric Tramways Co., Mr. W. Hamilton said that the electrification of the first section of tramways, comprising over three miles of single track, was completed for traffic at the beginning of this year. The inauguration took place on January 3, when the Governor of the Province acted as the company's first motorman. A recent cablegram had informed the board that a second section, comprising 5½ miles of single track, was opened for traffic on the 3rd of this month. These two sections included most of the principal lines of the city, connecting as they did the railway station with the Government offices, banks, and other important public buildings. The results of working by electricity so far as they had gone were satisfactory. The receipts had been about double those under horse traction, while the consumption of power was slightly over one unit per car mile run.

URBAN ELECTRIC SUPPLY.

The report for the year ended December 31, 1909, states that the gross profits amount to £44,872 5s. 6d., and, after deducting the London expenses, there is a balance of £42,733 8s. 1d., which has been carried down to net profit and loss account. After adding, in the last mentioned account, £379 6s. 5d. interest received on deposit, making a total of £43,112 14s. 6d., and after deducting items appearing on the other side of this account, amounting together to £14,234 15s. 6d., there remains a profit balance of £28,877 19s., which falls short by £3,622 1s. of the amount of £32,500, also appearing, required to meet the 5% guaranteed dividends on the capital of the company. This deficit, being the debit balance as shown in the accounts has been duly provided by Edmundsons' Electricity Corporation, Ltd., under their contract. Provision has been made of £1,971 3s. for depreciation of plant and machinery under the terms of the agreement with the contractors.

WINNIPEG STREET RAILWAY.

Earnings of the Winnipeg Electric Railway Co. for the fiscal year ended December 31 last were the largest, for both gross and net, ever previously reported in the history of the company. Net income, after deduction of all operating expenses, taxes, and fixed charges, was equal to 14·39% on the $6,000,000 capital stock outstanding, as compared with 13·14% earned on the $5,669,541 stock outstanding in the year previous.

Gross returns for 1909 rose almost to $500,000, of which improvement nearly $200,000 was saved for the gain in net, and surplus after deduction of 10% dividends was higher than at the close of 1908, when a smaller amount of dividends was paid. The expansion in gross is equal to 18.93%, and that of net 16·63%, operating expenses having risen about $231,700, or 21·29%.

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The company has enjoyed a marked degree of improvement in each succeeding year of operation. The number of passengers carried last year expanded more than 4,300,000, the total carried having been over 26,300,000, while the number of transfers issued was about 1,200,000 in excess of 1908. That the company has kept well apace with the development and population of the centre served is reflected in the per capita earnings since the property was organised. In 1905 railway earnings were at the rate of 6·80c. per capita, which compares with 10·03c per capita for 1909.

UNDERGROUND ELECTRIC RAILWAYS.

At the half-yearly meeting of the Underground Electric Railways Co., Sir Edgar Speyer, who presided, said that over 200,000,000 passengers had been carried by the affiliated companies during 1909, of which the three tubes carried 95,126,973, the District Railway 66,852,501, and the tramways 55,750,807. These figures made one realise what an important contribution to the traffic problem of London they were making, in fact, to imagine London to-day without the tubes would be hardly possible. He regretted to state, however, that the general traffic conditions in London remained unsatisfactory. Owing to the opposition of the adjoining ground owners, the extension scheme of the Charing Cross tube to link up the "Bakerloo" and District at the Embankment Station was rejected by the House of Lords Committee. This junction would have been a very important one, and would have been of great convenience to the public, and he could not but believe that such an important traffic improvement would in some shape or another obtain the sanction of Parliament at no distant date. As regarded the Amalgamation Bill now before Parliament, to amalgamate the three non-competitive tube companies, it was not an ordinary case of railway amalgamation, but purely a measure of financial common-sense. The results obtained this year justified the hope that so far as the Underground Co. were concerned, the period of deficits was at an end, and that they might now look forward with some degree of confidence to the probability that the income bondholders might regard some small distribution on their bonds as a not unlikely contingency in the not distant future.

AUCKLAND ELECTRIC TRAMWAYS.

The report to be presented to the shareholders at the 12th ordinary general meeting, to be held at Electrical Federation Offices, Kingsway, W.C., on May 2, states that the total revenue for the year ending December 31 was £182,594 8s. 3d. The traffic receipts, which amounted to £180,386 15s. 11d., show a satisfactory increase of £16,538 14s. 2d. over the previous year. After deducting all expenses chargeable to revenue, including £16,454 13s. 8d. for debenture interest, the rental and percentage of profits payable to the Auckland City Council amounting to £3,992 10s. 11d. and setting aside £15,000, compared with £12,500 last year, to the depreciation account, there is a surplus of £35,124 1s. 1d., making, with £3,920 7s. 8d. the balance brought forward from the previous year, a total of £39,044 8s. 9d. which the directors recommend should be appropriated as follows:—To be placed to reserve account, £11,500; to the dividend on the preference shares for the year (already paid), £3,000; to the payment of a dividend on the ordinary shares at the rate of 6% per annum in respect of which an interim dividend for the half-year ended June 30, 1909, at the rate of 6% per annum was paid in November last, £21,000; to be carried forward to the next account, £3,544 8s. 9d.

At December 31, 1909, the share and debenture capital of the Company was:—£50,000 in 6% cumulative preference shares of £1 each, fully paid; £350,000 in ordinary shares £1 each, fully paid; £329,002 in 5% first mortgage debenture stock. During the year £3,385 5% first mortgage debenture stock was bought and cancelled under the operation of the sinking fund, reducing the amount outstanding at December 31 to £329,002. The stock was purchased at a premium which has been charged direct to the profit and loss account. The capital expenditure during the year amounted to £56,601 7s. 4d. The largest portion was in connection with an extension of the power house plant and distributing system, which was initiated during the year. An extension of 0·68 of a mile in the Grey Lynn District, which is now approaching completion was commenced, and five additional cars were purchased.

At the request of the Auckland City Council the Company have agreed to construct along Upper Queen-street, the main thoroughfare in the city, an extension of about half a mile. An extension of 0·775 in the Mount Albert-road District to Morningside Station has also been agreed to. Further suggested extensions of the system have been placed before the Board and are receiving careful consideration. In addition to the five cars added to the rolling stock during the year eight further cars have been ordered and are under construction, bringing the total up to one hundred. It having been found inconvenient to close the accounts on December 31, it has been decided in future to close the financial year on June 30; consequently the next published report and accounts will be for the six months ended June 30 and thereafter the annual accounts presented will be for the year ended June 30 instead of December 31 as at present.

CALCUTTA TRAMWAYS.

Mr. E. C. Morgan (the chairman), presiding at the annual meeting, said: It is satisfactory to observe that, now that we have an entire year's working to deal with in Howrah, we find it has added slightly to the general net receipts, instead of showing a loss, as was the case last year; and before proceeding further, I may say that the working of this district continues to improve slowly and steadily, in spite of the competition which we still experience from the ferries, and also without any assistance from the bridge, which appears to be as far off as ever. Coming back to the accounts, it will be noted that after having placed during the year a further 912 preference shares, part of the 20,000 shares offered to the shareholders in 1907 remaining unissued, the amount overspent on capital account stands at £30,827, which has been temporarily met by the continuance of the loan from our bankers, which you will see amounts to £32,500. I may here say that this increase in capital expenditure is not due to new works undertaken during the year, but consists almost entirely of payments made for the new carshed, of which I made mention a year ago, and for the line—about half-a-mile—which connects it with our Calcutta system.

I now come to the revenue account, in which it is satisfactory to note that savings have been effected under all heads, except in the case of maintenance and repair of cars and their equipment. The heavy expenditure under this head is due to the circumstances mentioned last year as to the difficulties experienced through want of space, which had caused much work to fall into arrear, and also, to some extent, to the greater number of cars in service; but this has been largely removed by the new carshed. The cars constitute an item of expenditure which will always be heavy in our undertaking, as the destructive qualities of the Calcutta climate render more frequent overhaul of our vehicles necessary than is the case elsewhere in order to keep them in good condition. As I have already said, however, this can be much more readily and economically done now than heretofore, with the assistance of our new shed. I do not, however, wish you to expect much diminution in expenditure in this direction, as constant attention to the cars is absolutely needed, and with expanding traffic there are more cars in service which require attention. On the saving side, I would call to your notice the considerable reduction in fuel costs of about £1,000, which is very satisfactory, especially in view of the fact that during the year under review we have been paying a price for our coal equal to 10% in excess of that paid in 1908. On the credit side of the account, it is very encouraging to observe the large increase in traffic receipts of nearly £9,000, the figure being £174,367. Last year, when conditions were very unfavourable, we experienced a slight set-back in receipts, as compared with 1907, but this has been more than recovered, and the year 1909 is the best we have yet had. Perhaps, though we are only dealing with last year's figures, I may be allowed to say that during the present year our returns give promise of a substantial increase on those of 1909.

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Howrah is still lagging behind, due to causes beyond our control, but it will not be long, we believe, before it becomes a valuable auxiliary. The line through Alipore is already one of the best in the system, and that to Behala is growing in value, and we have already had numerous applications to extend further to the southward. This district is likely to become in the early future a much more important residential quarter when the extension of the docks in that direction becomes more defined. It may be remembered that our original scheme of extensions comprised one towards the north, to Barnagore, but at the last moment the principal authorities declined to accede to this, save on conditions which were prohibitory, so that our capital expenditure has practically come to an end. The conditions in Calcutta at the present time are decidedly good. Trade is better, and crops have been abundant, so there is good ground for looking forward to the maintenance of the improvement indicated by the returns so far to hand during the current year.

The Chairman then moved: "That a dividend on the Ordinary shares at the rate of 2s. 6d. per share for the half-year ended December 31, 1909, making, with the 2s. per share interim dividend already paid, a total dividend for the year 1909 of 4½%, be, and is hereby, declared, such dividend to be paid on April 20, 1910, free of income-tax."

Mr. John G. B. Stone seconded the resolution, which was unanimously agreed to.

PUBLICATIONS RECEIVED.

"Soldering, Brazing and the Joining of Metals." (London: Dawbarn & Ward. Price 6d. net.)

This is the fourth edition of a useful little book by Mr. Thomas Bolas, revised by Mr. Bernard D. Bolas, and has been brought well up to date.

The Brush Budget for March, besides containing an excellently illustrated record of the progress of the Brush Electrical Engineering Co., publishes a most suggestive note on "Music in the Works." Our lively little contemporary says: "The military and the social value of music is so well known, especially its cheering and consoling qualities, that it is surprising to find no advocate of industrial melody, beyond an old suggestion that dentists ought to employ a gramophone to amuse their patients while sitting gagged in the torture chair.

"Take a bunch of facts which have a bearing on this subject.

"1. Philanthropy in the treatment of wage-earners is gradually solidifying, and is said to pay.

"2. Industrial operations are partaking more and more of the nature of dull and monotonous routine.

"3. Women are doing work of this kind with always more patience and sometimes more efficiency than men, which goes to prove that we should get more benefit from man's strength if the monotony were relieved.

"4. Music can make men march when they would otherwise drop. Music will make the athlete go faster and stay longer.

"The world seems to be waiting, therefore, for some factory to set up a strong-lunged band, giving morning and afternoon concerts. A very small increase of production would pay for the cost; the best workmen would compete for employment at such a factory. To make work cheerful rather than miserable, lively rather than dull, ought to turn out a profitable speculation. It is said to be having excellent results in the training of children; and the only difference between children and grown-ups is that the latter are a little older and are less cheerful in themselves."

"The Treatment of Pit Ponies." (London: *The Colliery Guardian*. Price 1d.)

This is Coal Trade Pamphlet No. 5, and is written by Mr. A. H. Stokes, late H.M. Chief Inspector of Mines for the Midland District.

"Journal of the Institution of Electrical Engineers." (April. Price 5s.)

Among the contents of this number are papers by Messrs. L. J. Lepine and A. R. Stelling on "The German Electrical Industry," Prof. J. A. Fleming on "Quantitative Measurements in Radiotelegraphy," Dr. W. H. Eccles and A. J. Makomer on "Efficiency of Short-Spark Methods of Generating Electrical Oscillations," L. E. Wilson on "Telephones," and G. Wilkinson and R. McCourt on "The Effect of Metallic Filament Lamps on Supply Undertakings."

"The Place of the Battery in Power Station Design." (Bakewell, Derbyshire: The D.P. Battery Co., Ltd.)

In this very interesting and well illustrated pamphlet we are shown the advantages that may be secured by using storage batteries for equalising loads, especially for traction and power work, but we might point out also for lighting purposes under such conditions as were set forth by Messrs. Handcock and Dykes when dealing with installations for small towns or large villages. A concrete example is given of a traction power station, fitted with oil engines and 100 kw. generators. The mean load is about 150 amperes with a peak of 400. When run without storage batteries 10·2 units were produced for every gallon of oil, but when the load was equalised by adopting batteries the gallon of oil gave 12·3 units. We are shown in detail how £136 per annum was saved on fixed charges, £70 on fuel, £30 on engine room stores, and £25 on repairs, or a total of £261 by installing batteries.

FINANCIAL NOTES.

MONTREAL LIGHT, HEAT AND POWER.

The Bank of Montreal have been instructed to make the following notification: The directors of Montreal Light, Heat & Power Co. have declared a dividend of 1¾% on the paid-up capital stock, being at the rate of 7% per annum, for the quarter to the 30th inst. First, to shareholders of record on the 30th inst. on the Montreal and London (England) registers; secondly, to holders of share warrants in redemption of coupon serial No. 36. Dividend cheques will be mailed to registered shareholders on the 17th prox., and share-warrant coupons will be redeemed on presentation at the company's offices in Montreal, or at the banking house of Messrs. L. J. Forget & Co., 8, Rue Auber, Paris.

RIVER PLATE ELECTRICITY.

The directors have declared a dividend of 9% on the ordinary shares for year, placing £10,000 to general reserve, making £30,000 at credit of this fund, and leaving £5,141 to be carried forward.

CATALOGUES AND PRICE LISTS.

A sheaf of publications from the Allgemeine Elektricitats-Gesellschaft, of Berlin, includes an illustration of a new A.C. controller, an electric water pump for household use, and a very full description, accompanied by illustrations, diagrams and maps, of the Danzig hydro-electric high tension generating station.

The Witton-Kramer Electric Tool & Hoist Co., of Witton, Birmingham, send a set of three illustrated leaflets. K17 deals with Portable Tool Equipments, including portable motor with telescopic shaft and enclosed single and double-geared drill press and post, grinding attachment, etc. K5 shows different forms of Electric Hoisting Specialities. It is claimed that, assuming a unit to cost 1d., with a Witton-Kramer Trolley Hoist a load of one ton can be lifted 50 times a distance of 10 ft. at a cost of 1d. K4 shows various uses to which Electric Lifting Magnets may be put, and for these it claims that it is possible to handle 30 tons for sixpence.

Messrs. D. H. Bonnella & Son, Ltd., have issued Section L of their price list, this being devoted to wall and floor sockets and Pressel switches.

A set of price lists in handy pamphlet form, covering respectively "Conduits and Conduit Fittings," "Installation Accessories" and "Zed Fuse System," have been specially prepared by Messrs. Siemens Bros. Dynamo Works, Ltd., for dealers and contractors.

PERSONAL.

Messrs. Ronald Johnstone & Son, Mining and Consulting Engineers, of 190, West George-street, Glasgow, have opened a London office at 60, London Wall, E.C.

Mr. Frederick H. Stott, S.M.Inst.E.E., has been appointed

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by the City of Guelph to superintend the erection of the new hydro-electric power plant equipment which is being supplied by the Lancashire Dynamo & Motor Co.

The following have been elected officers of the Electrical Association of Victoria: President, Mr. A. Henrick Jackson; Vice-Presidents, Messrs. Percy Rosling and J. D. Gillan; Hon. Treasurer, Mr. Percy Rosling; Hon. Secretary, Mr. E. H. W. Westwood; Hon. Auditors, Messrs. W. H. Woodward and W. J. Mountain. It is proposed to change the title of the Association to the Victorian Institute of Electrical Engineers.

Messrs. Tetley & Co. have appointed Mr. Harold J. Jervis, "Inglefield," Oakley Drive, Muirend, Glasgow, as their sole representative for Scotland.

Mr. A. R. Sillar, M.I.E.E., has resigned his post as borough electrical engineer of Colchester. The Committee have appointed Mr. W. Frisby, A.M.I.E.E., senior assistant engineer, to undertake temporary control, acting in conjunction with Mr. P. H. Buzza, second assistant engineer.

"TANTALUM" ATHLETIC CLUB CONCERT.

The first annual concert of the "Tantalum" Athletic Club, connected with Messrs. Siemens Bros. Dalston Works, was held on Monday evening, when a highly interesting programme was arranged. The Assembly Hall of the Dalston Central Mission was requisitioned, being the only building within easy radius of the works in which such a large audience could be accommodated. The hall was illuminated by "Tantalum" and "Onewatt" lamps, which shed their brilliance on the "brilliant passages" of the artistes. The proceedings were confined to the employés of the firm, and there was a good muster. The talent also was entirely from the works staff, and the enjoyable items rendered proved that there was no lack in this respect. Miss Harrison opened with a pianoforte solo, "March Militaire," which was rendered in fine style; Messrs. McFarlane, Dennisor, and Hicks gave excellent account of themselves in such baritone songs as "The Flight of Ages," "The Veteran's Song," and "A Chip of the Old Block." Mr. A. E. Watts delighted the audience with his humorous selections and his "make up," added splendour to his songs. A novel feature of the affair was a singing competition, open to all employés of the firm, for which prizes were offered, the audience acting as judge. The first prize went to Mr. Rodgers for "We've all been doing a bit," the second to Mr. Lewis, "The German Bandsman" (in uniform), and the third to Mr. Hopper, jun., who sang "Thora" in a manner that would put many girls to shame. Very enjoyable items were also rendered by Miss Sabourin, Miss Crisp, and Miss Clark. Mr. C. D. Gray rivalled Harry Lauder as a Scotch comedian (in kilts), his dancing being especially fine, whilst Mr. Gingell shone in the "Broker's Man." Miss Wade gave an excellent rendering of "Il Baccio" on the violin, for which she received an encore, and Miss Topper, jun., and Miss Coutts were the elocutionists. The competition proved very amusing, and brought out much latent talent, which forebodes many such enjoyable evenings in the future. Messrs. Jarvis and Lucken contributed some very good turns, whilst Messrs. Collins and Pryor officiated at the piano very ably. The proceeds are to the war chest of the newly-formed "Tantalum" Athletic Club."

STANDARD ELECTRICAL WORKS.

ADVANCED ELECTRICITY AND MAGNETISM. By ARTHUR W. POYSER, M.A. With 317 Illustrations. Crown 8vo, 4s. 6d. [0133]

ALTERNATING CURRENTS, AN ELEMENTARY TREATISE ON. By W. G. RHODES, M.Sc. (Vict.), Consulting Engineer. With 80 Diagrams. 8vo, 7s. 6d. net. [0143]

ALTERNATING CURRENTS OF ELECTRICITY. By THOMAS H. BLAKESLEY, M.A., M.I.C.E. Fourth Edition, Enlarged. 5s. [1249]

ARITHMETIC OF ELECTRICAL ENGINEERING. For Technical Students and Engineers. Containing 72 Worked Examples and 300 Exercises. With numerous Illustrations. 1s. net; post free, 1s. 3d. [1250]

THE ELECTRICAL ENGINEER, 149, FLEET STREET, LONDON, E.C.

DIARY.

SATURDAY, APRIL 30.

INSTITUTION OF MINING ELECTRICAL ENGINEERS (South Wales Branch).—First annual dinner will take place at *Barry's Hotel*, Cardiff, at 6 p.m. Preceding the dinner, Mr. W. Jno. Richards will read a paper on "Colliery Cables," at 5 p.m.

WEDNESDAY, MAY 4.

INSTITUTION OF ELECTRICAL ENGINEERS (Students' Section).—Annual general meeting at 92, Victoria-street, S.W., at 7.45 p.m. Owing to an accident the paper announced for that date has, unfortunately, had to be cancelled.

THURSDAY, MAY 5.

INSTITUTION OF ELECTRICAL ENGINEERS.—Ordinary general meeting at the Royal Society of Arts, John-street, Adelphi, W.C., at 8 p.m. "A Telephone Relay," by Mr. S. G. Brown.

PATENTS.

Electric Batteries.

4034.—1909. H. DE MARTIS, London, W.C. The battery plate has ribs which prevent it from buckling, and at the same time serve to retain the active material in place. The ribs are so arranged that no straight line can be drawn across the plate without meeting one or more of the ribs. Lugs, fitted with lead caps, are mounted on the plates. These lugs are connected together by means of flexible connectors, each of which is distinct from the other, and of a length greater than the distance between the two consecutive plates.

Telephont.

4162.—1909. S. G. BROWN, London, E.C. Instead of carbon contacts as hitherto used in microphones, it is proposed to employ a metal or alloy possessing the properties of hardness, elasticity, and non-oxidisability, when the resistance of a circuit in which such a contact is employed bears a certain relationship to the resistance of the metal contact. The metals or alloys found to give the best results are osmium-iridium, osmium, and ruthenium.

Metering and Transforming Electrical Energy.

6504.—1909. E. and W. H. WILSON, London, W. The device for measuring and transforming electrical energy consists of a magnetic circuit, a coil associated therewith in series with one of the supply conductors, and adapted to supply an external circuit at reduced voltage, and another coil connected to an external work circuit. A moving part is rotated by the magnetic field set up by the joint action of the series and shunt coils.

Controlling Electric Motors.

6566.—1909. ALLGEMFINE ELEKTRICITATS GESELLSCHAFT, Berlin. The electro-magnetic speed-limiting device is provided with a coil connected in parallel with a resistance in the motor circuit, which is cut out before the motor reaches its running speed. The current coil may be connected across the terminals of the brake magnet coil, or across a section of the starting resistance, or across fractional parts of either in such a way that a fractional part of the armature current flows through the switch coil. The fractional current is then proportional to the main current, and its adjustment for a definite speed may be readily obtained by varying the resistance in parallel with the coil.

Speed Indicators for Electric Motors.

6673.—1909. BRITISH THOMSON-HOUSTON CO., LTD., London, E.C. This improved method of measuring the speed of an electric motor consists in deriving two magnetic fluxes—one dependent on the voltage applied to the motor, and the other on the current through the motor, compounding the fluxes, and acting by the resultant on an indicating member, which is movable in response to the resultant.

Polyphase Relays.

6675.—1909. ALLGEMEINE ELEKTRICITATS-GESELLSCHAFT, Berlin. This is a polyphase relay of the Ferraris type, which has a magnet system for each phase. Each system produces a torque, which acts upon a movable element, or elements, in such a manner that, with equal currents in the separate phases, or with equal potentials between the phases, the torques generated neutralise each other.

Wind-Driven Electrical Generating Sets.

6752.—1909. J. G. CHILDS and T. S. HILL, Willesden-green, N.W. The system comprises a generator driven by a variable source of power such as the wind, a battery charged by the generator and a field rheostat for the generator. The sections of the system are normally short-circuited by electro-magnetic switches controlled by the generator current, so that the turbine is enabled to run at efficient speed for varying conditions of wind.

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Solenoid Brakes for Electric Vehicles.

6849.—1909. G. Rizzo, Brussels. Two solenoids, with windings of low resistance, and with cores having short courses or extent of travel, are provided in connection with a locking arrangement for keeping on the brake after interruption of the current actuating the brake. One of the solenoid has a course or travel regulator comprising a crank handle shaft, a cam co-operating with a stop, and a sliding rod which carries the stop, and partakes of the movement of the core of the solenoid. The course regulator can be operated by the attendant, according to the brake force required.

Rotary Electric Transformers and Motor Generators.

7060.—1909. Crompton & Co., Ltd., J. C. Macfarlane, and H. Burge, Chelmsford. This is an improvement in machines of the type in which two distinct magnetic fields operate upon one armature. The field magnets are so arranged as to be completely isolated from one another magnetically, whereby the cross flux in the armature may be reduced.

Portable Electric Safety Lamps.

7141.—1909. T. W. B. and R. Durant, Chapeltown. The back and two sides of the case for carrying the battery are formed from a single strip of aluminium, and provided with a ledge at the bottom. The front of the case is formed of vulcanite, and is held in position by screws, which fit into the aluminium sides. Two vertical holes are made in the front of the case, into which are fitted the conductors. The case has a movable bottom and separate inside vertical linings of vulcanite.

Secondary Batteries.

7424.—1909. J. Stone & Co., Ltd., and A. H. Darker, Deptford, S.E. This is an improvement in secondary batteries, the positive plates of which rest on a pair of wooden cradles. A third cradle is provided of less height than the other two, and on this cradle the negative plates, resting on lugs, are supported. This method of construction prevents the accumulation of deposits, which generally has the effect of short-circuiting the battery.

Signalling on Railways and Controlling Trains.

7556.—1909. A. Stern and H. Doob, New York, U.S.A. This is a means for signalling the positions of moving trains to a central station in such a manner that the trains are at all times under central control, and can be stopped by the operator signal at any time independently of the driver. A solenoid, with an armature operatively connected to a lever, is adapted to control the throttle valve or air brake system for stopping the train. The solenoid is made active by means of an arm on a revolving indicator being caused to bridge two contact pieces in an electrical circuit, and thus close the circuit.

Jointing Electrical Conductors.

7593.—1909. H. W. Handcock, A. H. Dykes & J. J. Rawlings, London, S.W. The ends of the wires to be connected are stripped for a certain distance, and after being soldered together, are enclosed in a sleeve, formed of two U-shaped pieces of porcelain. A thin brass or copper longitudinally divided casing is fitted over the sleeve, and is provided with grooves to accommodate the ends of the wires. The two halves of the casing, when soldered together, form a water-tight joint.

Discharge Gaps for Producing Electric Oscillations.

8111.—1909. A. W. Sharman, London, S.W. In order to obtain a variable effective length of discharge, one or more pairs of main fixed discharge elements are adapted to operate in conjunction with the same number of pairs of moving elements, the components of each pair of which are connected together, and are capable of rotation in the plane of a pair of fixed elements.

Through Control Magnetic Switches.

10729.—1909. W. N. Cochrane, Bowdon. The object is to provide a means for switching train lights on and off from one point. A coil on being energised attracts its armature, to which is attached a spindle. To one end of the spindle two brush switches are fixed, and at the other end are two small catches. These catches are lifted up with the armature and fixed in a groove in the top plate of a second coil. Before the catches become fixed, the brushes have made contact with fixed contacts, so as to close the circuit and switch on the lights throughout the whole train. When it is required to switch the lights off, another coil is energised and its armature attracted. As the armature advances, it closes the two catches together on the spindle, and just before the armature has reached its full travel the catches leave the groove and fall inside the last-named coil, and thereby break contact at the brushes and switch off the light.

Combined Centrifugal Fan and Electric Motor.

15659.—1909. K. Maxaner, Frankfort a-Main. This is an improvement in blast fans with axial entrance and radial exit of the air driven directly by an electric motor, in which both the motor and the fan are enclosed in a single casing. The invention consists in the arrangement of the driving motor within a guiding cone for the air in order to avoid the formation of eddies. The armature and pole casing of the motor are cooled by the air drawn in by the fan.

Insulating Metallic Threads.

18193.—1909. Farbenfabriken vorm. Fr. Bayer & Co., Elberfeld. The threads are covered with thin paper or cotton and then passed through a solution of resin, cellulose or cellulose derivatives.

Self-Driving Electric Heat and Fluid Pressure Motor.

18511.—1909. G. E. A. Holdsworth, Holland Park, W. Electric heat power is supplied by a small dynamo attached to the motor. When in motion this keeps the accumulator supplied with the electric heat required as the engine works. The dynamo thus practically produces perpetual motion, and consequently produces its own heating power through the storage battery.

Electric Batteries.

19914.—1909. G. Fuller, Bow, E. The porous pot complete for a battery of the Leclanché type comprises a sheet of paper or cardboard made into cylindrical form and surrounded by a porous loosely woven fabric, a disc of non-conducting material to close one end of the cylinder, a centrally arranged carbon rod or stick, depolarising composition tightly packed around the stick, and means for enclosing the composition within the cylinder.

Automatic Telephone Exchange.

22596.—1909. E. Neuhold, Friedenau. This is a system of connections for automatic telephone exchanges in which the subscribers' speaking connection extends over several selectors, each adjusted by an accessory electro-magnet. A single relay set influenced by the calling subscriber serves for the control of all the moving magnets for the selector switches which are drawn up for making the speaking connections concerned. The part of the speaking conductor at the station which runs through the selector switch is used as the local circuit for the regulation of the moving magnet.

Detector of Electro-Magnetic Waves.

23628.—1909. A. G. Rossi, Turin. This is a method for obtaining wireless signals or indications by producing torsional vibrations in a stretched and twisted wire of magnetic material in correspondence with the received electro-magnetic impulses.

Support for Electrical Condensers.

23821.—1909. Siemens Bros. & Co. & C. R. Riber, Westminster, S.W. The support consists of a spring clip which engages with grooves provided in the pressure plate.

Current Collector for Electric Vehicles.

26907.—1909. W. Kohler, Bremen. Instead of a roller running on the lower wire of the overhead conductor, a sliding shoe is provided. The edge of the shoe is bent in accordance with the surface of a sphere, the centre of which is in the upper wire.

Electric Hoists.

457.—1910. H. J. Marshall, Gainsborough. The hoist comprises a motor coupled direct to a worm engaging with a worm wheel on the centre of the hoist barrel. The motion of hoisting, lowering and braking the drum is under electric control from one handle bar. Should the hoist be in danger of overwinding, two insulation bars are caused to make contact and form a short circuit.

Automatic Electro-Magnetic Regulator.

1087.—1910. Société Anonyme Ateliers Jaspar, Belgium. Iron elements in the regulator, separated by air spaces, form a continuation of the core of the electro-magnet. Opposite the spaces between the elements are other iron elements which are movable and capable of being attracted progressively in proportion as the current increases in the magnetising coil. These successive attractions are always made in the same order. This arrangement creates a magnetic lock of the movable contacts.

Control of Alternating Current Electric Motors.

5044.—1909. British Thomson-Houston Co., Ltd., London, E.C. The invention consists in the insertion of a cut-out switch in the ground connection of the transformer secondary. By the use of this switch it is possible to dispense with the cut-out switch usually employed on cars and trains to cut one motor or pair of motors out of circuit when necessary. The reason is that the failure of a motor is ordinarily due to a ground between one of the motor windings and the frame.

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TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns per week.			Increase or decrease.		Miles of track open.		Accounts for past year.						
	Ending	1909-10.	1908-9.	Week.	Current year.	1909.	1908.	Ending	Total receipts.	Passengers carried.	Car miles run.	Receipts per Passenger.	Car mile.	Mile of track.
		£	£	£	£				£					
Aberdeen Corporation	April 20	1,172	1,298	— 126	— 762	27½	27½	May 31	71,930	17,517,304	1,566,119	·98	11·02	4,940
Ayr Corporation	Sept. 18	671	562	+ 108	—	8	8	—	—	—	—	—	—	—
Baker Street and Waterloo Ry.	Nov.	8,141	6,070	+2,071	—	4·25	—	—	—	—	—	—	—	—
Birkenhead Corporation	April 17	1,037	1,078	— 41	— 270	24·003	13·52	—	—	—	—	—	—	—
Birmingham Corporation	April 20	6,643	7,095	— 452	—	56·792	58·52	—	—	—	—	—	—	—
Blackburn Corporation	Oct. 6	1,100	1,293	— 173	— 1,036	24·53	28·3	—	—	—	—	—	—	—
Blackpool Corporation	Aug. 26	2,152	2,050	+ 102	+ 782	—	—	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams	,, 8	2,304	2,309	— 24	—	—	—	—	—	—	—	—	—	—
Bolton Corporation	Oct. 10	2,416	2,337	+ 79	— 259	42	42	Mar. 31	117,799	25,492,902	2,492,147	1·1	11·34	2,804
Bournemouth Corporation	July 21	1,681	1,723	— 42	— 23	29½	29½	,, 31	86,225	13,991,328	1,766,068	1·47	11·71	2,912
Bradford Corporation	April 16	4,727	5,710	— 983	— 2,047	98	54·81	,, 31	235,258	47,839,569	5,331,007	1·17	10·59	2,378
Brighton Corporation	April 24	782	882	— 100	— 685	9·5	—	—	—	—	—	—	—	—
Bristol Tramway Company	April 22	5,574	5,124	+ 450	—	57	51½	Dec. 31	265,362	46,652,389	5,756,842	1·23	12·63	5,971
Burnley Corporation	April 23	1,162	1,222	— 60	—	19½	19½	Mar. 31	64,261	12,355,958	1,202,380			
Burton Corporation	April 24	248	263	— 15	— 75	6½	6½	,, 31	14,918	3,221,595	430,913	1·04	8·30	1,460
Cardiff Corporation	April 8	2,000	1,957	+ 43	—	—	—	,, 31	109,979	25,058,146	2,497,169	—	10·57	—
Carlisle Tramways Company	June 19	170	175	— 5	— 89	—	—	—	—	—	—	—	—	—
Central London Railway	April 23	5,501	5,327	+ 174	+ 300	6·32	6·32	Dec. 31	350,150	41,898,373	1,456,781	2·01	5·769	55,404
Charing X, Euston, & Hamp. Ry.	Nov.	6,822	6,092	+ 730	—	7·75	—	—	—	—	—	—	—	—
City and South London Railway	April 24	3,271	3,152	+ 119	— 455	7·26	7·26	—	—	—	—	—	—	—
Colchester Corporation	July 14	200	219	— 39	—	8	—	Mar. 31	10,983	2,308,721	349,539	1·09	7·74	1,477
Cork E. T. and L. Company	April 21	460	469	— 9	+ 246	9·89	9·89	Dec. 31	24,044	5,787,478	896,945	—	6·43	—
Croydon Corporation	April 8	1,512	1,586	— 74	+ 256	11½	—	Mar. 31	74,132	16,277,418	1,884,137	1·06	9·56	3,703
Darwen Corporation	Oct. 1	239	256	— 17	— 201	7·23	7·23	,, 31	13,899	2,557,654	245,584	1·30	13·68	1,922
Dover Corporation	Sept. 18	230	252	— 22	— 395	7	—	,, 31	11,593	2,697,672	316,754	·98	8·78	—
Dublin and Lucan Electric Ry.	April 22	133	128	+ 5	+ 27	7	7	—	—	—	—	—	—	—
Dublin U.T.	April 22	5,671	5,671	—	+ 3,252	54½	54½	—	—	—	—	—	—	—
Dundee City Tramways	Oct. 6	1,332	1,305	— 27	— 569	—	26½	May 15	60,573	16,367,911	1,281,552	·875	1·9	2,271
East Ham Corporation	April 23	970	977	— 7	— 121	15	15	Mar. 31	47,430	15,355,703	1,091,586	·73	10·26	—
Glasgow Corporation	April 16	17,508	17,610	+ 102	+ 2,225	192½	185	May 31	907,494	226,948,290	20,766,722	·96	10·49	5,090
Gloucester Corporation	Oct. 6	395	425	— 30	+ 536	15	—	—	—	—	—	—	—	—
G.N., Piccadilly and Brompton	Nov.	13,429	9,354	+4,075	—	9·25	—	—	—	—	—	—	—	—
Halifax Corporation	—	—	—	—	—	52·574	37	Mar. 31	81,872	20,378,672	1,786,390	11·40	11·17	1,528
Huddersfield Corporation	Dec. 4	1,613	1,357	+ 256	+ 2,663	28	28½	,, 31	84,704	16,200,020	1,960,329	1·29	10·37	2,421
Hull Corporation	April 23	2,571	2,435	+ 136	— 302	29	26	,, 31	128,722	30,964,254	3,022,844	1·	10·22	—
Ilford Corporation	Feb. 12	451	391	+ 60	+ 1,969	10	10½	,, 31	25,328	6,385,466	634,446	·87	9·58	2,066
Ilkeston Corporation	April 22	122	118	+ 4	— 83	4	4	,, 31	7,214	1,968,850	198,415	9·1	7·9	1,803
Kirkcaldy Corporation	Sept. 8	259	266	— 7	—	7½	7½	May 15	14,993	4,874,199	459,066	·711	7·83	1,856
Lancashire United Tramways	April 20	1,224	1,204	+ 20	— 45	39	39	Dec. 31	68,904	12,554,593	2,244,394	—	—	—
Leeds Corporation	Sept. 18	6,896	6,624	+ 272	+ 3,662	108	96½	Mar. 31	340,368	75,734,083	7,604,989	1·06	10·62	3,527
Leicester Corporation	Sept. 11	2,162	2,130	+ 32	—	—	—	—	—	—	—	—	—	—
Liverpool Corporation	Nov. 19	10,803	10,687	+ 116	— 1 977	109	104	Dec. 31	572,822	124,043,239	12,231,799	1·108	11·24	5,508
Liverpool Overhead Railway	April 17	1,314	1,423	— 109	+ 68	6·65	2·40	June 30	79,004	11,171,515	1,106,386	—	—	—
London County Council	April 9	39,514	35,398	+ 4,116	+ 5,142	132½	121½	Mar. 31	1,274,660	279 166,461	25,591,028	1·08	11·74	—
Lowestoft Corporation	Dec. 11	155	150	+ 5	+ 30	3½	—	Sept. 30	11,399	2,645,206	370,320	1·03	7·36	2,279
Maidstone Corporation	Mar. 6	157	100	+ 57	—	7·4	—	—	—	—	—	—	—	—
Manchester Corporation	Sept. 11	15,631	15,297	+ 334	— 2,871	183	181	—	—	—	—	—	—	—
Metropolitan District Railway	April 23	11,231	9,792	+ 1,439	+17,678	24	24	—	—	—	—	1·46	—	—
Metropolitan Railway	April 24	16,923	16,315	+ 608	+ 9,340	24½	24½	June 30	680,357	99,846,735	—			
Nelson Corporation	Oct. 16	151	131	+ 20	+ 7	2½	2½	Mar. 31	7,362	2,060,712	204,710	·85	8·63	1,907
Newcastle-on-Tyne Corporation	April 16	3,739	4,498	— 759	— 1,757	60½	59½	,, 31	211,085	46,203,164	4,411,745	1·10	11·48	3,664
Newport (Mon.) Corporation	Oct. 9	663	638	+ 25	— 311	14½	14½	,, 31	35,531	8,174,003	798,029	1·04	9·89	2,660
Oldham Corporation	Jan. 24	1,778	1,516	+ 262	— 386	—	—	—	—	—	—	—	—	—
Portsmouth Corporation	Oct. 10	2,046	1,809	+ 237	—	28½	28½	Mar. 31	97,741	21,247,048	2,309,439	1·10	10·15	—
Reading Corporation	April 21	578	585	— 7	— 186	13½	13½	,, 31	32,769	7,933,572	915,481	—	8·93	—
Rochdale Corporation	Dec. 26	1,240	1,126	+ 114	+ 746	20·9	20·93	,, 31	56,558	10,196,148	1,252,925	1·32	10·83	2,688
Rotherham Corporation	Feb. 4	555	587	— 32	—	—	—	—	—	—	—	—	—	—
Salford Corporation	Sept. 27	4,096	4,662	— 66	— 3,326	78	74½	Mar. 31	244,065	45,771,611	5,486,150	1·25	10·67	3,155
Scarborough Tramways Co.	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Sheffield Corporation	April 17	5 833	5,844	— 11	+ 337	39½	37	Mar. 25	289,745	17,568,686	7,065,380	·896	9·842	4,225
Southampton Corporation	April 13	989	1,208	— 218	— 174	18	18	,, 25	52,647	10,121,887	1,157,451	1·25	11·33	—
Southend-on-Sea Corporation	Aug 21	995	557	+ 438	+ 1,483	—	—	—	—	—	—	—	—	—
Stockport Corporation	—	—	—	—	—	25	25	Mar. 31	52,004	9,155,172	1,335,911	1·34	9·342	1,830
Sunderland Corporation	Jan. 27	1,310	1,336	— 26	— 7,984	—	—	—	—	—	—	—	—	—
Swindon Corporation	April 20	126	121	— 5	—	—	—	—	—	—	—	—	—	—
Torquay Tramways	Aug. 26	630	647	— 30	—	8·41	—	Dec. 31	15,065	2,880,420	353,297	1·40	1·023	—
Wallasey U.D.C.	April 23	826	925	— 98	— 553	12·68	12·45	Mar. 31	43,823	8,331,038	891,540	1·2	11·79	3,453
Warrington Corporation	—	—	—	—	—	—	—	—	—	—	—	—	—	—
West Ham Corporation	April 14	2,285	2,929	— 644	+ 624	27	14·7	Mar. 31	122,881	35,502,836	2,556,854	·789	10·96	4,417
Wolverhampton Corporation	Nov. 3	841	823	+ 18	— 206	21½	—	,, 31	44,432	9,440,369	975,714	—	10·929	2,190

a Train Miles. h Half-year's figures.

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THE
Electrical Engineer.
An Illustrated Record and Review of Electrical Progress.
WITH WHICH IS INCORPORATED "ELECTRIC LIGHT."

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NOTES.

Commutation Phenomena and Magnetic Oscillations in D.C. Machines.

In his paper on commutation phenomena and magnetic oscillations occurring in direct current machines, read before the Institution of Electrical Engineers, Mr. G. W. Worrall dealt with a difficult subject in a way that is likely to prove useful in the designing shop. His investigations into the behaviour and influence of the brush are particularly noteworthy, and he gave some practical hints how to keep the temperature low. The importance of keeping the front tip cool, he pointed out, cannot be "over-estimated, for in it lies, to a very great extent, the secret of successful commutation. The overload capacity of a machine can be very greatly increased if the brush-tip be kept cool. The metal case in which the brush is usually fitted is not sufficient unless the case almost touches the commutator, and is in very good contact with the carbon. Since carbon is a very bad heat conductor, any artificial method of cooling must necessarily be deficient, and the best way to avoid a hot tip is to increase the rate of commutation during the early stages of short circuit. This can be effected by the proper distribution of resistance, as already shown, or by a commutating E.M.F. The former method, however, has the advantage of greatly increased stability of the brush. When the tip lifts to any considerable extent, as was the case when no cooler was employed, the brush is exceedingly unstable and vibrates considerably. If the brush be high, as in an ordinary plunger-holder, or attached to a rigid arm, as in a finger-holder, the vibration may be considerably multiplied."

Magnetic Oscillations.

As regards magnetic oscillations, both in the main poles and the armature, Mr. Worrall's experiments went to show that here too the phenomena is dependent, in the first instance, on the position of the brushes relative to the teeth, and in the other to the positive and negative character of the brushes.

General Results.

Summarising the points brought out in the course of his investigations (which, by the way, were made at the Karlsruhe Technical School during his tenure of the Vulcan Fellowship, instituted by the Vulcan Boiler and General Insurance Co.), the author said that the results might be briefly stated as follows:

1. The natural period of the short-circuited coil may be varied by varying its contact resistance, or by properly disposing the resistance over the brush surface.

2. Sparking depends upon the relation of the natural period to the available period.

3. The maximum rate of change of the current during commutation may be reduced by reducing the natural period, and at the same time the overload capacity of the machine as regards sparking will be improved.

4. The maximum rate of change may also be reduced by accelerating the commutation during the early portion of the short-circuit period by means of a commutating E.M.F., and this has the same effect as reducing the natural period of the coil.

5. The ampere-turns necessary on the commutating poles may be reduced if the flash across the slot be used to generate the commutating E.M.F. The E.M.F. generated in such a manner possesses approximately the correct wave shape, and the magnetic oscillations in the armature teeth during commutation are thereby reduced.

6. If only one commutating pole be fitted, the ampere-turns necessary are less than when two are in use.

7. The commutating pole flux fulfils two functions: (1) to generate the commutating E.M.F., and (2) to oppose or press back the armature reaction flux.

8. The negative brush is hotter than the positive; the higher temperature causes the negative to take a higher polish than the positive, thereby reducing its contact resistance. The lower contact resistance increases the natural period, and renders the negative brush more liable to sparking than the positive.

9. The higher temperature of the negative brush caused it to expand more than the positive. The forward tip is generally the hottest part of the brush surface, because it is shielded from draughts. The forward tip is alternately heated and cooled as the segments pass under it, and vibrates with the frequency of the segments. This vibration renders the brush unstable and the commutation irregular.

10. The forward tip may be cooled, the vibration avoided, the commutation made regular, and the sparking limit raised by a piece of metal in good contact with the brush at the forward tip and provided with a relatively large radiating surface.

11. The results in 10 may also be obtained by preventing the rush of current at the end of commutation, either by reducing the natural period of the coil or by accelerating the commutation during the early stages by means of a commutating E.M.F.

12. The vibration of the forward tip of the brush causes a minute arc to be periodically set up between the carbon and the commutator, which causes a brown band to form on the brush and a deposit on the commutator.

The Moor Light.

In the Bradford Corporation Electricity Show Rooms, there are demonstration installations of the Moor Light. This is one of the systems employing rarified gases, carbonic acid being utilised for a white light, and yellow phosphorus for a rosy yellow light. The glass tubes employed may be of any length, and are generally placed in a cornice or against the ceiling. The peculiarity of the Moor system is chiefly the device to maintain a stable pressure, a magnet producing an automatic opening and closing of an air valve; as pressure falls, the valve opens, and air rushes into the chemical containing chamber, the resulting gas, when the electric current is switched on, invading the gas tubes. An alternating current of 220 volts and a periodicity of between 50 and 60 is generally used, a step-up air-cooled transformer, adapted to the requirements of the installation, being used for control purposes. The carbonic acid or phosphorus only requires replacing every two years or so, and the process is quite simple. The illumination is delightful to the eyesight, is agreeably difused, and so admirably adapted for decorative effects. In both America and Germany, we believe, it is claimed that the Moor Light is economical, but this does not appear to be the prevailing opinion among English electrical engineers who have studied the question. So far, however, we have not come into possession of any definite and authoritative figures.

Magnetic Cranes.

Discussing the mechanical handling of materials in iron and steel works in a paper read before the West of Scotland Iron and Steel Institute, Mr. J. H. Huntley pointed out that with the necessity of holding larger stocks of raw material and cutting down cost of labour, the magnetic

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lifting cranes had a specially useful field in future equipment. Speaking of lifting magnets for pigs and finished articles, Mr. Huntley said that the naked magnet was not popular because it looked dangerous. The addition of safety clips made all the difference, and this also allowed economy of current. He quoted a trial test at the Greenville-yard of the Pennsylvania Railroad Co. Two wagons filled with wheels were unloaded respectively by six men, and by four men and a magnetic crane. The four men and crane got through their work in one hour, while the six unaided men had to labour at extra pressure for half a day before their wagon was unloaded. For handling small scrap, Mr. Huntley found that a magnetic lift, if kept at work, could handle the iron at a cost of between 2½d. and 1½d. per ton, including interest, depreciation and maintenance. The economy of electrically propelled ladle-carrying cars was also dealt with, and finally the author showed that cranes with lifting magnets fitted with safety clips, would be used to an increasing extent in handling the finished sections from a mill, and also in dealing with loading and unloading in docks, etc.

Static Electricity in Textile Mills.

One of the troubles of textile manufacturers, spinners and weavers, is that most fibres become charged with frictional electricity, with the result that there is a considerable amount of repulsion, making the process of manufacture very difficult. This is partly got over by humidifying the air, though this is only indifferently successful with silk, wool and certain vegetable fibres, such, for instance, as China grass or ramie. To overcome this, the Chapman Electric Neutraliser has been introduced. The apparatus consists of a special form of transformer, transmitting alternating current through an insulated wire to an inductor. The inductor is a slotted steel tube of about 1½ in. in outside diameter. In the slots are porcelain blocks holding the metal active parts. These are connected to a wire inside the tube. The inductor is placed in some convenient place of a machine where the material to be neutralised (fibre or yarn) passes at a distance of between 1 and 3 inches. Connection between the insulated wire and the inductor is made by means of a plug. The attractive force of the alternating current thus distributed at once neutralises the material, even when it is travelling at a rate of 1,000 ft. per minute, and in this way smooth working is obtained.

Colliery and Mining Exhibition.

A Colliery and Mining Exhibition, in which electrical appliances will form a prominent part, is to be held at the City Hall, Manchester, from October 16 to 30, 1911. It is to be organised by the proprietors of the *Engineering Review*, who are responsible for the Machinery Exhibition to be held in the same place in the coming autumn, which, we understand, is already assured of a big success. It had been suggested that colliery and other mining machinery should form a section of this year's show, but questions of space and time were against this, and so the alternative of a special exhibition next year was decided upon. It is a happy decision, for after all, mining is a very specialised branch of engineering, with a big following of its own. So much is being done to improve mining machinery, and then, again, so much is being done to open up mineral deposits both at home and abroad, that the exhibition should prove attractive to engineers, students and manufacturers. It is possible that by the autumn of next year the findings of the Home Office Committee on the Electricity Rules in Collieries may have been sufficiently studied to have influenced manufacturers of colliery plant, and then new and interesting things could be brought forward.

Russian Electrical Railway Exhibition.

The Imperial Russian Technical Society have now issued a detailed programme of the International Exhibition of Electricity Applied to Railways, which is to be held in St. Petersburg from August 28 to November 28. There will be three sections: (1) Application of Electricity to Steam Railways; (2) Electric Traction (a) on main lines, (b) on light railways, (c) on tramways; (3) Hydro-electrical installations and appliances. One of the features of the exhibition will be a two-mile stretch of normal gauge railway, to be utilised for the purpose of comparing the running of independent electric locomotives and motors, and also for demonstrating different systems of electrification. Classes are provided for every aspect of this important subject. Although the time allowed for preparation, since the first announcement was issued, has been short, it is to be hoped that British firms will be adequately represented. At present Russia is very backward in the matter of electricity, but there is a wide awakening to the many advantages of electricity, and the scope for engineering enterprise is immense.

I.E.E. Elections.

At the meeting of the Institution of Electrical Engineers, London, on the 28th ult., the following were elected:

Associate members (25)—Lieut. Edward David Carden, R.E. (Aldershot), Mr. James Herbert Edwards (Bristol), Mr. Edward Harriss (Bangor), Mr. James Raymond Henry (Johannesburg, South Africa), Mr. Raleigh Hills (Chesterfield), Mr. George John Hollyer (Walthamstow, N.E.), Mr. Frank Henry Horner (Liverpool), Mr. Robert Hunter (Aberdeen), Mr. Edgar S. Hurlbatt (Manchester), Mr. Adolf William Isenthal (West Ealing, W.), Mr. Henry John Alfred Jones (Plumstead, Kent), Mr. Douglas Neill Keith (Lagos, Southern Nigeria), Mr. Frederick James Launchbury (Coatbridge), Capt. Hugh Percival T. Lefroy, R.E. (Aldershot), Mr. Bradley T. McCormick (Montreal, Canada), Mr. Frederick Charles Osborne (Birkenhead), Mr. William J. Richards (Maesteg, Bridgend), Mr. George William Richardson (Madras, India), Mr. Robert James Roberts (Alloa), Mr. Gilbert Rosenbusch (Westminster, S.W.), Mr. Frederick Peake Sexton (Kingston-on-Thames), Mr. James Stewart Smyth (Terang, Victoria, Australia), Mr. James A. V. Thomson (Aberdeen), Mr. George Henry Vaughan (Warrington), Mr. John Anthony Woods (Ealing, W.).

As students (28)—Mr. Singh Anant (Battersea Polytechnic, S.W.), Mr. John Henry Asdell (Handsworth, Staffs.), Mr. Daniel Dadsworth Barber (Manchester), Mr. Harry Edwin Betts (Kew Gardens, S.W.), Mr. Alfred Ernest Boon (Balham, S.W.), Mr. Walter Muir Cranston (Montrose), Mr. Heber Ewart Crowcroft (Stockport), Mr. Rhys Davies (Kensington, W.), Mr. George Martin Doubleday (Dublin), Mr. George Eagar F. Graham (Dublin), Mr. Frank Saunders Heywood (Streatham, S.W.), Mr. Edward Hughes (Edinburgh), Mr. William Inglis (Leith, Edinburgh), Mr. Sydney Norbury Jackson (Manchester), Mr. George Tenison Levinge (Baron's Court, W.), Mr. Robert Edwin Livesley (Manchester), Mr. John Herbert Lough (Manchester), Mr. Douglas Wilson McIntyre (Bristol), Mr. Robert Alfred Mack (Wimbledon, S.W.), Mr. Thomas Francis Phillips (Wallington, Surrey), Mr. Edward Aloysius Riordan (Kelvinside, Glasgow), Mr. Jayaràm Janàrdan Sàvant (Imperial University, Kyoto, Japan), Mr. Percy William Scholefield (Birmingham), Mr. Bertram George Spendiff (Newcastle-on-Tyne), Mr. Frank Percival Swann (Warwick-square, S.W.), Mr. John Lindley Thompson (Newport, Mon.), Mr. Mervyn Stanley Vernal (London), Mr. William Arthur Ward (Sheffield).

AUTOMATIC ELECTRIC STEERING.

It appears that Bailie J. C. Bogle, of Falkirk, a master mariner, has invented a system of automatic electrical control of ships' steering gear. The object of the mechanism is to return the ship to a predetermined course when any divergence to port or starboard has been set up. The correction is effected by rendering the magnetic needle sensitive to attraction and engagement with a finely adjusted lever, called the contractor, having one end connected to the compass card, insulated, and so constructed that the opposite end makes an electrical contact with either of two terminals or contractor rods connected with a reversing electric motor, which in turn controls the steering mechanism.

By this arrangement, to whichever side the magnetic needle is attracted, the contractor is moved to contact with the opposite terminal, and this completes the circuit and enables the steering apparatus to give port or starboard helm as may be required. With this instrument the steering gear remains as at present in use, and if desired to steer in the ordinary manner, the adjustment can be disconnected at once; for instance, when an obstruction appears ahead, or a bank of thick fog is entered.

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A TELEPHONE RELAY.*

By S. G. Brown, M.I.E.E.

The telephone relay is the outcome of six years' study, but has only been brought to its final form during the last eighteen months. Ever since the introduction of the telephone, a real need was felt for a telephone relay when it was discovered that the distance over which telephones could be used was comparatively limited. Many inventors have worked on the problem, and it has been declared by eminent telephone engineers to be insoluble. One of the American telephone companies offered a million dollars some years ago for a telephone repeater, but no one has gained the reward.

Edison, soon after his invention of the carbon button transmitter, caused an electromagnet to act upon the iron diaphragm and thus turned it into a relay, but it was not a success. Hughes,† in his paper before the Royal Society in 1878, describing his extremely delicate microphones, stated that a telephone receiver, if included in the microphone circuit and placed upon the resonant board, caused a continuous sound to be produced. It follows, he says, that the question of providing a relay for the human voice in telephony is thus solved. Unfortunately it was not solved; he had shown how to make a relay that would magnify a noise or musical note, but not one that would intensify articulate speech.

Sir Oliver Lodge,‡ in a paper read in December, 1898, before this Society, described a relay, consisting of three or four reeds or tuning forks, each carrying carbon contacts and working in series with one another. Each reed was arranged to resonate to one particular musical note, and when this note was passed through the string of relays, it was multiplied in power to a considerable extent. An instrument of this character, however, is not effective in intensifying speech. An articulate relay must have its vibrating parts damped, or, in other words, possess no resonating properties, it is, therefore, far more insensitive to sound than one that is arranged to resonate to one particular note.

The invention of the powerful granular transmitters of the Hunning type stimulated further efforts to obtain the speaking relay, and some progress was made with this type of microphone, particularly in America. I will not describe these relays further than to say that they consist in combining the telephone receiver and the granular carbon transmitter, both of these are designed as efficiently as possible, and in some cases automatic means are provided to shake up the granules should they become packed. These relays are only partially successful. Their advantages are not decisive. They require relatively powerful currents to work them; that is to say, when the telephone currents become sufficiently feeble to require their services, it is at this point that the carbon instrument fails to work. The telephone relay to be successful has to magnify in a continuous manner varying currents that are too feeble to properly affect a Bell telephone receiver. Such currents would be of excessive weakness, say of the order of the one, one hundred millionth of an ampere (10^{-8} amp.), and the mechanical movements produced by such currents, which have in their turn to bring about the increased electrical changes, are, therefore, microscopic in dimensions.

The author's telephone relay has had to be developed along quite new lines. It takes as its basis the researches of J. J. Thomson, Earhart, Kinsley, and others, with regard to the flow of electrons across a microscopic air-gap between two conducting surfaces at different potentials.§ Earhart made a series of experiments on the difference of potential required to produce sparks whose length is comparable with the wave-length of sodium light, and he found that when the distance between the metal electrodes falls to less than about 3×10^{-4} cm., the spark potential falls off rapidly with the distance, and seems to become proportional to the distance: that is to say, when the electrodes are placed very close together, within a distance such that the average intensity of force F between the electrodes reaches a value of about a million volts per centimetre, the discharge or current passing is determined by the condition that F, which is V/d, reaches this value (where V is the potential difference, and d the distance between the electrodes). If the metallic circuit of a dry cell be interrupted by a minute opening or space of the order of 5×10^{-7} cm., the metal at the point of interruption being platinum, the current will continue to flow round the circuit and across the opening, and any slight alteration in the length of the space, which I shall call the conduction space, will vary its resistance and greatly affect the value of the current that flows round the circuit. This conduction space is, therefore, exactly what is wanted for the current-varying device of a telephone relay, where microscopic mechanical movements are to be transformed into large current changes. The dimensions of the conduction space are so small that it is difficult to ensure and maintain it by direct mechanical means. The current that flows across the space was, therefore, made to its own adjustment, very much in the same way as the current that passes through the arc of an arc lamp is made to strike and maintain the length of the arc.

Fig. 1 is a side view of the instrument with the brass cover removed. N is a permanent magnet, continued by soft iron poles right up to but not touching the "invar" steel reed P. Round the soft iron pole extensions are wound the two sets of coil windings H and K. The telephone currents to be magnified circulate round the winding H, and thus by varying the magnetism set the reed P in vibration. M O are the top and bottom metal contact-pieces, which are opened to an infinitesimal degree to form a microphone by the fine adjusting screw W and by the action of the local current passing through the contact and round the winding K. It is by the action of the local current operating through this winding that the conduction space is formed and afterwards maintained. So good

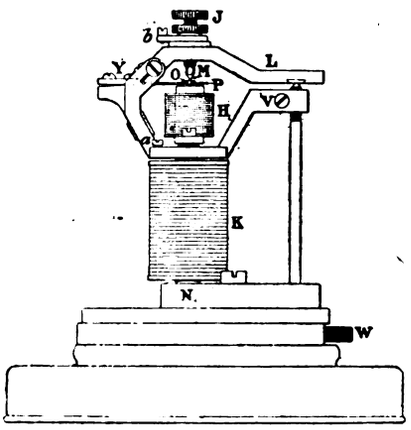

FIG. 1.

is the automatic adjustment, that the instrument may be turned upside down, producing hardly any noticeable alteration in the value of the local current and without any effect on the working of the relay. The regulating winding K must not act when traversed by the rapidly varying telephonic currents; this is brought about by surrounding the iron under the coil by a closed circuited copper sheathing. Eddy currents set up in this sheathing by mutual induction destroy the self-induction of the coil.

Fig. 2 is an enlarged view of the reed P and the contact-pieces M O. In the present instrument the contact is made between metal pieces of hard osmium iridium alloy. The top contact is pointed, the lower one is flat, and is soldered to the reed, both are polished and work under a small drop of thin oil.

In earlier instruments the lower contact O was carried by a thin iron disc, the relay was then very susceptible to outside noises. For this reason a reed is now used, it exposes such a small surface to the air that it is practically unaffected by extraneous sound.

Fig. 3 shows the connections of the relay. C is a dry cell (this is the normal voltage, which is as high as it is desirable to employ), K the low resistance regulating winding, T the receiving telephone or telephone headpiece of approximately 40 ohms resistance, D is an amperemeter or current indicator; when the microphone contact is opened so as to cut down the local current to half its

* Abstract of paper read before the Institution of Electrical Engineers.
† *Proceedings of the Royal Society*, vol. 27, p. 362, 1878.
‡ *Journal of the Institution of Electrical Engineers*, vol. 27, p. 799, 1898.
§ See "Conduction of Electricity through Gases," J. J. Thomson, chap. xv.

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maximum value, the relay is usually at its best adjustment. The telephone currents to be magnified enter by the terminals marked A and circulate through the winding H.

The relay will magnify the very feeblest telephone currents. Speech or signals that are too faint to be heard in the ordinary Bell receiver may be heard clearly through the relay. If a watch be held against the ear-piece of a Bell telephone the induced currents produced, when passed through the instrument, will reproduce the ticking in the receiver attached; this is a severe test.

This property of magnifying feeble telephone currents has made it particularly useful in wireless telegraphy. On replacing the telephone by the relay, the increased sensitiveness thus obtained doubles the distance over which it is possible to receive signals. Its utility in this direction has been tested among others by the Admiralty and the Post Office. In a wireless receiving station, messages, the very existence of which was not even suspected, owing to their extreme feebleness, when listened for under former conditions with the relay in circuit, were easily read. At the invitation of Mr. Marconi I took two instruments to the *Haven Hotel*, Poole. In one of the tests (Clifden, in Ireland, sending with the Marconi musical spark) the signals were heard in the telephone, directly connected, as a faint but clear and pleasing series of musical notes. But with two relays joined to the system and working in series the notes were rendered so loudly as to be heard clearly by every one in the room, and an operator listening at a distance of several yards from the instrument could have deciphered the message. The relay is not easily affected by extraneous noises and vibration. It can thus be carried on board ship and worked in all weathers.

As regards its utility on ordinary telephone lines, speech may be magnified many times in loudness without perceptible loss in the articulation, and it will work with large currents to a point at which the Bell receiver in its local circuit is responding with uncomfortable loudness. In experimenting over a 20 lb. standard cable and speaking only one way, it has been proved that, when the relay is applied, 30 miles may be added to any length through which it is possible now to speak direct. For instance, supposing the length of the core for direct speaking be 20 miles, this may be increased to 50 miles for the same loudness and approximate clearness when the relay is in circuit, either as a single repeater at the end of the first 20 miles, or as a receiver at the end of the 50 miles.

These tests prove that the telephone currents must be increased in strength to the extent of something like twenty times. If still greater magnifications are required than can be obtained with one relay, the simplest method would seem to be to employ two relays working in tandem. Their combined power would then be 400 times. In the majority of cases it is not necessary to add to the natural electrical damping of the reed, but if a piece of soft rubber be made to touch it, the voice can be transmitted with greater clearness even than if the conversation were taking place ordinarily in a room. This may be due to the complete absence of echoes.

By means of the local regulating winding (*see* Fig. 2), the metal contact M O is transformed into the most exquisitely delicate microphone, more sensitive, there is every reason to believe, than could be formed by light pressure between carbons. Such a microphone has rendered possible the construction of an electric stethoscope, an instrument by the use of which the sound of the heart or other internal organs may be greatly magnified. This, I have been informed, may render it possible to detect in the earlier stages heart disease, aneurism, and gall stones.

Fig. 4 is a diagrammatic illustration of the stethoscope. A is the front part, and consists of a shallow brass cell faced by a thin ebonite diaphragm. A is placed upon the part of the body to be examined, say, the heart; the A is the front part, and consists of a shallow brass cell beating of the heart is communicated to the ebonite diaphragm, then to the air inside the tube B, and thus the metal diaphragm D is set in vibration. M O, as before, are the osmium iridium contact-pieces. M is mounted on the diaphragm, and O on the steel reed P. The magnet N S and the reed are carried by a brass frame E, which is pivoted or hinged at the lower support Y. The conduction space is formed between the contacts M O by turning the fine adjusting screw W, and by the automatic action of the local current from the cell C flowing through the winding K and round the magnet. T is a special telephone transformer of equal windings of, say, 20 ohms resistance in the primary and in the secondary.

The electric stethoscope in its present form causes the sound of the heart to be three times as loud as in the ordinary stethoscope. This is scarcely sufficient for practical purposes. But if a telephone relay, such as I have previously described, be attached to the wires x of the transformer, the two instruments combined raise the intensity of the sound some twenty times and more, and this is ample for all ordinary purposes. The sound to be examined is picked up by the end of the tube A, and is heard in the telephones of a head-piece attached to the relay.

At the invitation of two physicians, I took the complete instrument, stethoscope and relay, to the London Hospital, where it was tested upon a number of diseased heart cases. Not being a doctor myself, I cannot discuss the merits of the instrument with regard to its medical value, except to say that it seemed to render diagnosis particularly easy and revealed some phenomena only previously suspected.

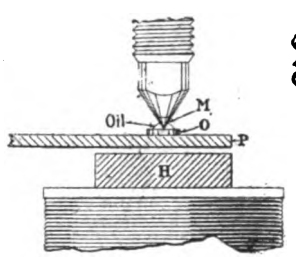

Fig. 2.

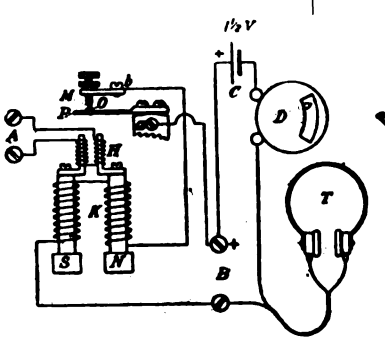

Fig. 3.

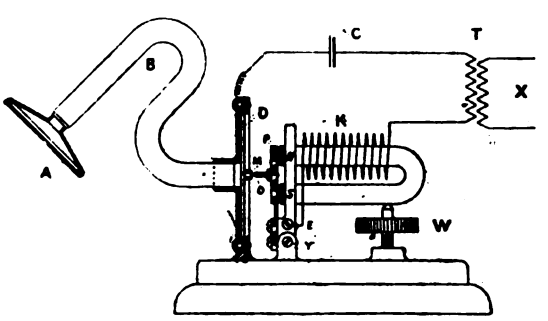

Fig. 4.

From a sound magnifying point of view, the general results were as follows: When the instrument was applied directly to the heart the sound of the beats given out in the telephones was uncomfortably loud, and easily heard by the patient and all those that stood round, and this even if the telephones were in position on the head of the operator. The stethoscope as used increased the heartbeats to the almost complete exclusion of the shriller or breathing sounds. This has been brought about by mechanically tuning the disc D and the reed P of the telephone relay to the corresponding low note, and by a proper proportioning of the volume of air enclosed by the tube B. On other occasions, during private experiments, the instrument has been tuned so that nothing but the breathing sounds were audible, the passage of air through the lungs was heard as the roar of the wind through a forest of trees. This power of discrimination should be of service in allowing the independent examination of various organs of the body.

Replacing the telephone head-piece by a transformer, the stethoscope has been joined to the telephone service in my house, and for the sake of experiment, the sound of the heart has been transmitted over several miles of telephone line to doctors in various parts of London and to other friends who were interested. All of them reported that the sounds received in the telephone were as loud and clear as when heard locally. The line, therefore, does not appear to produce much loss or distortion. This trial proved that it is now possible for a specialist, say, in London, to examine a patient, say, in the country, stethoscopically, and to arrive at a correct diagnosis.

The instrument must of necessity, to replace the ordinary

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stethoscope, be more sensitive to sound than the human ear. This is proved by slight noises made in the room being heard in the telephones as loud noises. In consequence of this, the apparatus is padded and guarded as far as is possible from all outside disturbances, and the patient should be examined in a quiet room. If the instrument is provided with a small funnel in place of the tube B, it will pick up and magnify the slightest sound, and ordinary speaking may be increased to a deafening shout in the telephone. Such an instrument, when properly constructed for the purpose, may be of use to those who are afflicted with deafness.

The relay has been used on the electrophone system, and by its aid, damping the reed with a piece of rubber, the speaking and music from the theatres are rendered with loudness and greater clearness than it is possible to have on the telephones supplied by the company, and by adding a loud speaker with trumpet the sounds can be heard in the room.

I come now to a subject that is interesting me greatly —it is still a matter of experiment—the production of a clear and loud-speaking transmitter. Such an instrument would give considerable comfort to the subscriber, and might save hundreds of thousands of pounds worth of copper for the companies. I am under the impression that the carbon transmitter has been developed to its full extent, ceaseless efforts having been directed to this end by the engineers of the large telephone companies.

To make progress towards an ideal transmitter, carbon had, therefore, to be abandoned, not because of any serious defect in its microphonic qualities, which are good, but because of its bad conducting power. It would not transmit enough energy. One must pass much current in order to speak loudly, and a material was wanted that not only would conduct well, but would change its resistance to pressure more readily than carbon. I am pleased to say that I have discovered something that carries out my wishes well in both of these directions. To indicate that this discovery is a novelty, is quoted the following from Preece & Stubbs' "Manual of Telephony" chapter on carbon transmitters :—

> "Ceaseless efforts have been made by some of the most able of investigators to discover some material other than carbon that was equally efficient—efforts that if they had been crowned with success during the continuance of the monopoly of the use of carbon would have ensured a handsome fortune. Hitherto nothing has been found that even approaches carbon in efficiency for microphonic purposes, and now that the monopoly has lapsed the incentive to investigation is considerably reduced."

Again, in Miller "American Telephone Practice," 1905 edition, chapter on the carbon transmitter :—

> "Many vain attempts have been made to discover a satisfactory substitute for carbon, as the variable resistance medium in telephone transmitters, the patents on the use of carbon electrodes having at first formed one of the mainstays of the American Bell. Telephone Company's great monopoly."

During some experiments with the telephone relay, attempts were made to dispense with the regulating winding and form the microphone by the mere pressure of the electrodes one against the other as with carbon. With gold, platinum, palladium, and rhodium, it was not possible to do so. On the contrary, a microphone could be formed by light pressure between the following : Iridium, ruthenium, osmium, and osmium iridium alloy They are arranged advancing in the order of their effectiveness, which likewise is the order of their hardness. With iridium the action was only just shown, while osmium iridium alloy makes a microphone that can carry large currents, stand high temperatures, and is exceedingly sensitive to small changes of pressure. This alloy is by far the best of the whole series, as it is the hardest, and, although expensive, can be readily purchased as natural grains or granules, sifted to any desired uniform size. As regards the effectiveness of carbon, I should be inclined to include it in the series between iridium and ruthenium. The chemical properties of carbon, ruthenium, and osmium have likewise much in common, in that they resist the action of all acids, and are carried off as a gas by oxygen when strongly heated.

Ruthenium and osmium are of little value for microphonic purposes if purchased in their commercial form as grains or powder. The grains must be first fused into a bead and then crushed into granules. This may account for the failure of previous experimenters who, in their endeavour to compete with carbon, tried nearly everything that could be mentioned, including ruthenium and osmium, but without success.

Several "solid back" transmitters have been taken and altered in various ways to make use of the new metal. In one case, the ordinary carbon electrodes were entirely removed and replaced by sheet iridium-faced ones $\frac{3}{16}$ in. in diameter ; these electrodes were separated by a distance of $\frac{1}{20}$ in., and the space between was nearly filled by 3 grains weight of very fine granules of osmium iridium kept in place by a rubber tube. This new transmitter would take permanently a current of $\frac{3}{4}$ amp. from a 2-volt accumulator. It was connected to the telephone service through a large transformer, which had a low-resistance primary of only $\frac{1}{10}$ of an ohm. The ordinary carbon transmitter, supplied in the usual way from the central battery, was kept in position in series for purpose of comparison. The results of several trials were as follows : Speaking on both occasions with equal force, first, directly into the mouthpiece of the carbon transmitter ; secondly, 12 in. away from the mouthpiece of the metal transmitter, the same volume was given in the receiving telephone. When the new transmitter was spoken into at a distance of 3 in., the sound was two or three times louder than is at present normal, and when spoken into directly, the sound at the far end was uncomfortably loud and the voice could be heard with ease 3 yards away from the receiver. In all cases the articulation was clearer and crisper with the metal than with the carbon transmitter.

The first difficulty to contend with occurred after the instrument had been in use some months. This was a gradual weakening of the power of transmission, which was eventually found to be due to the iridium faces of the electrodes becoming superficially oxidised. To remedy this, the iridium has been replaced by gold, which so far has proved satisfactory. Another improvement was to come inwards the faces of the gold electrodes ; this is to prevent the granules from unpacking, as they had previously a tendency to do when worked between plane faces.

An osmium iridium granular transmitter has been constructed embodying all these later improvements, the electrodes have a diameter of $\frac{1}{4}$ in., and it will work permanently with 1 amp. at 2 volts. When joined to the telephone circuit and spoken directly into, the distant receiver will respond with overpowering loudness. Such an instrument could be fitted in subscribers' premises where long-distance telephony was much in use, and distances could be spoken over which at present offer considerable difficulties. Up to the present no regular long-distance tests have been made, but it has been tried over 60 miles of 20-lb. standard artificial cable, and will work over this length with clearness and reasonable loudness, showing that this was by no means the limit. In all these trials a local battery was used. As most of the transmitters in London are supplied with current from common or central batteries at the exchanges, it would be important to adapt the new instrument to this system, but up to the present nothing has been done in this direction. The metal transmitter has a low resistance ; this would have to be raised by a suitable design to make it really successful. The amount of current received over the telephone wires at my house is only 0·06 amp., supplied by, I believe, a 22-volt accumulator, working through the 360 ohms of the line. On one occasion, as an experiment, the central battery carbon transmitter was replaced by an ordinary low-resistance metal one, and at the far end clearer speech was obtained, which was as loud as before. The upper harmonics of the voice are more faithfully transmitted by the metal granules than by the carbon—this accounts for the superiority in the articulation. As metal replaced carbon in the incandescent lamp to improve the efficiency, it would be curious if it should

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be doing the same thing now with the telephone transmitter. A much smaller quantity of the metal powder or granules is required as compared with carbon, and its sensitiveness in resistance to small changes of pressure is much greater; the new material is, therefore, peculiarly adaptable for the purposes of a relay for use on telephone lines where moderate magnification only is required. Such a relay has been constructed using osmium iridium powder as the resistance varying medium; it is simple in design, requires no adjustment, and so far gives a moderate magnification with good articulation.

APPENDIX.

Referring to the telephone relay, the efficiency of the microphone for speech transmission depends largely upon the metal employed for the contact. Experiments have been made with the following results. The metal must be unoxidisable. Thus materials like brass and aluminium are useless. If they partially oxidise like steel and silvers, the magnifying power is small. With the following, good results were attained: Pt, Pd, Rh, Ir, Ru, Os, and osmium iridium alloy. Carbon has been tried for one or for both of the contact-pieces; the magnifying power is then smaller than with the metals, and less current can be sent through due to its greater specific resistance. Gold, due to its complete absence of surface oxidisation, makes an unstable contact, and the relay will buzz, very much after the fashion of an electric bell, under all ranges of adjustment. (Soft pure gold makes the best contact for an ordinary relay of any material that I am acquainted with.) Even with the metals of the platinum group, the relay can be made to buzz by cleaning the contacts with a cloth, but stability of working can be again secured by oxidising the surface, by exposure to the air, or, what is much better, by applying thin oil to the surfaces of the contact. The nearer the relay is to this buzzing point, the greater its sensitiveness; it is, therefore, advisable to clean the contact so as to obtain the buzzing action and to stop the action by the application of a small drop of thin oil. The harder the contact metal used, the clearer the speech through the relay. With soft platinum the higher harmonics are more or less absent, but with osmium iridium the articulation is quite clear and crisp.

Microphones are sometimes liable to produce faint bubbling and speaking sounds; this is due, I think, principally, to want of hardness in the contact-pieces, especially if the upper bruises the lower piece. This sound can usually be stopped by shunting through a suitable resistance the winding of the telephone circuit. A microphone formed between two hard metals can touch only in one spot. As half the energy liberated from the local battery is normally dissipated at this point, the rise of temperature there may be very considerable. This heating puts a stop to any great handling of power by a single contact. For these reasons it is not advisable, with the normal voltage to pass more than, say, $\frac{1}{4}$ amp.; if the current is too great, the sensitiveness will decrease with time; but if the current is kept small, say, of the order of $\frac{1}{10}$ amp., the delicacy may be perpetually maintained. It is fortunate that the harder varieties of the platinum group are the ones that are able to stand the higher temperatures.

The following rough tests of a special form of my telephone relay may be of interest, the resistance of the coil through which the current to be magnified passed was in this case 1,000 ohms. 0·126 milliamperes switched on through this coil caused the local relay current to vary from 3 to 0·5 milliamperes, the contact volts from 0·36 to 1·19, the contact resistance, as calculated, from 1·0 to 2,370 ohms, and the measured movement of the reed at the place of contact, 8×10^{-6} in. With the contact open and no local current, placing a 10-gramme weight on the reed near the contact produced a measured movement of $2·4 \times 10^{-5}$ in. With the contact adjusted to pass 4 milliamperes, the 10-gramme weight cut the local current down to 1·5 milliamperes and produced a movement of $1·2 \times 10^{-5}$ in., and with 2·5 milliamperes, the same weight reduced the current to 2·0 milliamperes and caused a movement of $0·6 \times 10^{-5}$ in. We have thus the curious effect, that with a given applied force, increasing the local current cuts down the movement of the reed. Perhaps this accounts for the fact that, within wide limits, altering the resistance and thus the value of the current in the local circuit does not seem to change the magnifying power of the relay; this power is more a question of contact and voltage than anything else. If a telephone relay is required to have a high degree of sensitiveness, the voltage of the local cell must be reduced to, say, half a volt. This low voltage can be secured by opposing an accumulator to a dry cell, but the arrangement can only be at the expense of the self-regulating power of the microphone.

A telephone relay, if placed simply in the middle of a long telephone line, can magnify the currents only in one direction—such a device is called a single repeater. The relay for practical use has, therefore, to be associated with balancing coils and placed in the line so that it may work in either or both directions—such a combination is termed a two-way repeater. In a two-way repeater the lines on each side of the coils have to be balanced one against the other, and anything that produces a variation, say leakage, will cause the relay to react upon itself and thus interrupt the conversation till the balance has been restored. Theoretically, it would seem that the two-way repeater can be only one-quarter the efficiency of the single repeater. Although the one-way relay is now solved, it will be seen that there is still much to be done before the two-way repeater is practicable.

THE GIROD FURNACE.*

By W. Borchers (Aix-la-Chapelle).

In all special branches of the chemical and metallurgical industries, in which large electric furnaces became necessary for carrying out new processes or for the improvement of old ones, the development of the electric furnace took place on very much the same lines. The endeavour to make a success of a new idea originated many ingenious designs, which, however, almost universally proved that the safest and shortest way to practical success is to reduce to the utmost simplicity the construction of the necessary apparatus.

Our knowledge of the qualities of materials for building electric furnaces, and of the constituents of the furnace charges, especially as far as their conductivity at high temperatures is concerned, as well as in regard to their chemical affinity towards one another at high temperatures, is, in spite of all scientific progress, far from being complete; and from that it may be deduced that the smaller the number of unreliable factors for the construction and for the running of such furnace the better.

This very natural deduction deserves special attention when an electric furnace for steel-making has to be chosen from the constantly growing number of inventions; for the chief constituent of steel, the element iron, is a substance which, in its liquid state, has so great an affinity for those elements which are to be removed from the charge, that it is very difficult to comply with the following conditions: (1) To heat the refining slag to the highest point of its chemical activity; (2) to prevent the iron from participating in these reactions, or, where this cannot be prevented, to make it participate in those reactions, so that it finally appears in the end product without material losses; (3) to select and arrange the materials from which the furnace is to be built, so that wherever their contact with the furnace charge cannot be avoided, their nature shall be such as not to react upon the constituents of the charge in an injurious way.

About six years ago † the author, reviewing the progress of electrode furnaces up to that date, stated that a furnace simpler than that of Héroult could not be found. He had now to correct that judgment, for, in his opinion, the Girod furnace was now the simplest and safest as far as construction and running of electric electrode furnaces were concerned.

The Girod furnace is the simplest of modern electric steel furnaces, both as an experimental furnace, or as a smelting works furnace on the largest scale possible. In the author's laboratory it was being used with currents of 30 to 36 kw., while elsewhere, for steel smelting, it is being used with

* Paper read before the Iron and Steel Institute Conference, May 4–5.
†Borchers, *Elektro-Metallurgie*, 3rd edition, 1903, p. 536.

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currents of 300 to 1,200 kw. It is a combination of a resistance and an arc-heating furnace. The metal to be smelted serves as one of the electrodes; it is covered by the refining slag as an electrolytic conductor, while a carbon block (or several carbon blocks), introduced from above through the cover of the furnace, forms the opposite electrode above the centre of the bath. The arcs play between the carbon blocks and the slag, and no doubt here the largest amount of heat is produced. A second heat-producing zone is the layer of slag through which the current passes to and from the metal. Last, but not least, the metal itself becomes an important source of heat on account of the effective manner in which the electric current is made to pass through the molten metallic body, and this is the most important feature of the Girod process. The distribution of the electric current through

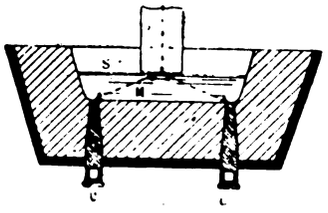

FIG. 1.

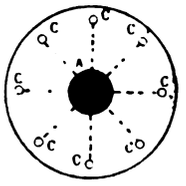

FIG. 2.

the molten metal is clearly shown in Figs. 1 and 2, in which the letters indicate—A the carbon electrode, S the slag, M the molten metal, C contact pieces to connect the metal with the current conductor. These contact pieces are of such cross section and length, that every one of them will take up only a certain part of the whole current without being overheated, and, therefore, without excessively increasing its resistance. An additional regulation of the temperature and resistance of each contact piece is effected by cooling the ends of these bodies, which contain small chambers, by means of circulating water. These bodies, which are made of pure iron to avoid any deterioration of the furnace charge, are, therefore, not only the conductors between the furnace charge and the current generators, but serve also to ensure regular and uniform distribution

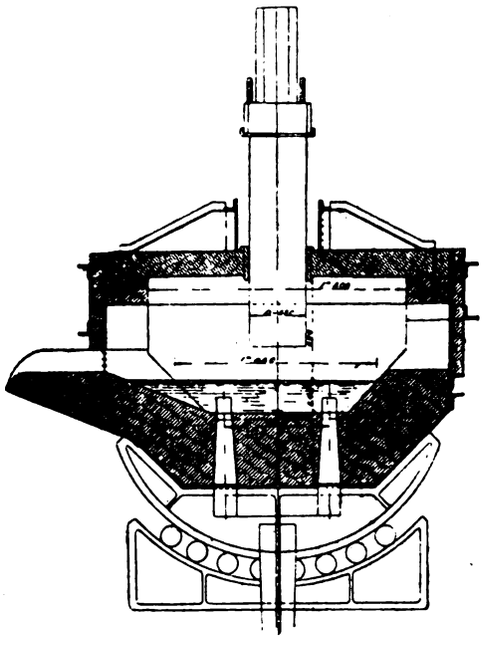

FIG. 3.

of the current traversing the centrally hanging carbon rod or rods radially to and from the periphery of the bath. This is important not only for uniformly heating the bath, but also for keeping every part of the liquid metal in constant motion. In running a furnace with as high a current density as is found necessary to smelt iron and steel, it can easily be observed that the passage and the transformation of the electric current into heat is accompanied by violent mechanical motion of all particles of the liquid. This movement, however, accelerates the contact between the impurities of the iron and the refining slag floating on top of the bath. The Girod system of arranging the electrodes and contacts is a safeguard against any stagnation of parts of the liquid furnace charge, and for this reason the advantages of the induction or transformer furnaces and of electrode furnaces are combined in the Girod furnace, while the imperfections of both forms have been overcome.

The peculiar arrangement of electrodes and contacts gives the Girod furnace a special advantage over other electrode furnaces when cold scrap is to be smelted. As soon as possible after charging the hearth of the furnace, the upper electrode is lowered until it rests upon the heap of scrap, and the current is compelled to pass by means of numerous small arcs through the whole mass of scrap to

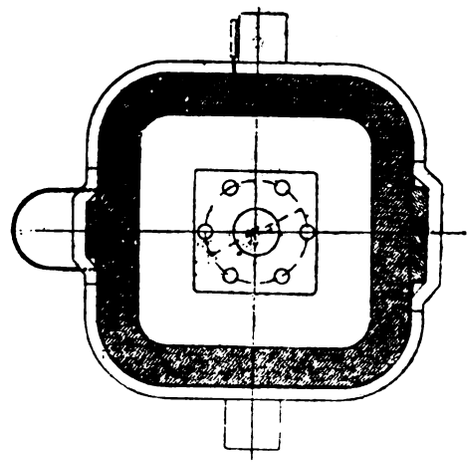

FIG. 4.

the periphery of the heap on the hearth bottom. The heap breaks down simultaneously in all parts in a very short time, and there is no sticking of cold pieces to the bottom of the furnace, and no necessity for stirring up and loosening such lumps from the hearth and endangering the latter.

After what has been said as to the principles of this furnace, the illustrations (Figs. 3 to 8) will not need much further explanation. Figs. 3, 4, and 5 show plans and views of a 2½ ton furnace, and Figs. 6, 7, and 8 those of a 12 ton furnace. The most important dimensions are given in metric figures.

It will easily be understood, that if, during a smelting operation, pieces of the ends of the contact bodies melt and dissolve in the steel, no harm will be done to the

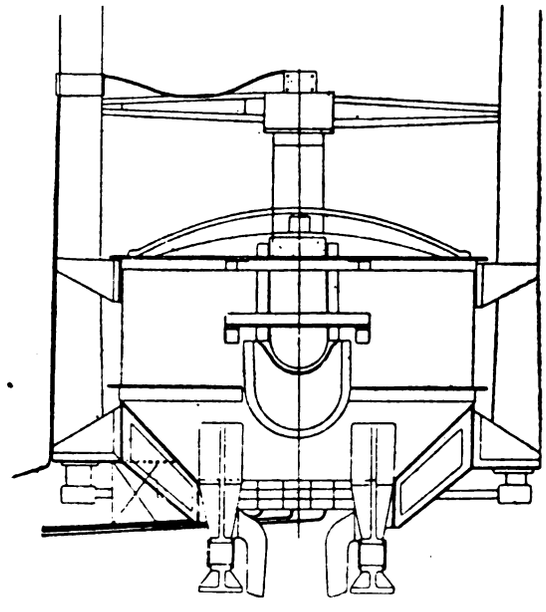

FIG. 5.

latter, as the contacts consist of pure iron, and the quantity of iron, which in such a case combines with the liquid charge of the furnace, is proportionally so small, that the qualities of the charge will not be influenced thereby to any perceptible degree.

The applicability of the Girod furnace is in no way restricted by the nature of the raw materials. It may be fed with cold scrap or with molten metal. When feeding cold scrap, the whole charge is not put in at one time. After the larger part of the charge has been shovelled or

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otherwise thrown upon the hearth, the current is sent through the heap in the manner already described. The rest of the charge is put into the furnace together with the first batch of the refining ingredients. Taking a 2-ton furnace as an example, the charge consists of 2,000 to 2,500 kilogrammes of iron scrap, and the first batch of flux usually consists of about 80 kilogrammes of lime and 220 to 250 kilogrammes of iron oxide in the form of ore, which, with the iron oxide that covers the scrap, serves as an oxidising agent. The smelting of the iron charge and of the first batch of refining flux requires four and a half to five hours. On the slag becoming exhausted of iron oxide, and, therefore, of its oxidising power, samples of the bath are taken and tested to ascertain the degree

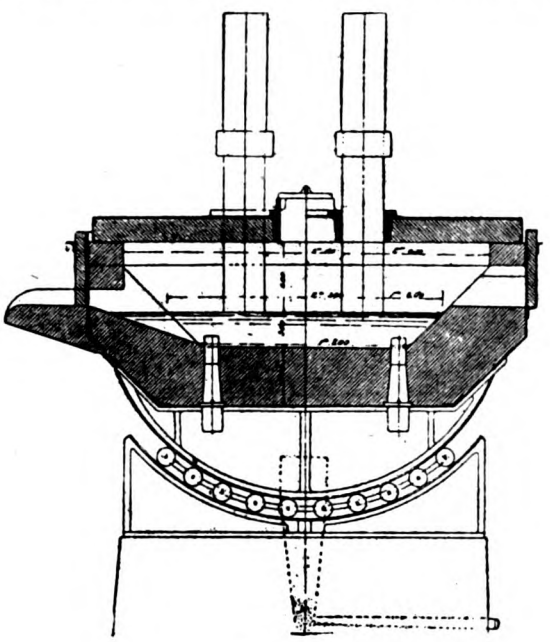

FIG. 6.

of refining of the molten metal. According to the degree of purification, the furnace now receives (of course, after the first slag has been skimmed off) a second, and, if necessary, a third batch of lime-iron oxide. After the removal of the last slag, the surface of the metal bath is thoroughly cleansed by throwing in about 30 to 40 kilogrammes of lime and skimming this off after a while. The further treatment of the iron bath depends upon the presence or absence of impurities which could not be removed by the lime-iron oxide refining and upon the quality of steel to be produced. According to these circumstances, deoxidising or otherwise refining agents are employed, such as ferro-mangano-silicon, ferro-aluminium-silicon, ferro-mangano-aluminium-silicon, and other alloys. For producing carbon steels, an addition of Swedish charcoal iron or of a kind of iron very rich in carbon, made in a separate electric furnace of the steelworks, can be made.

The final step in the production of special steels is the addition, after these refining operations, of iron alloys with metals like nickel, tungsten, and chromium.

It is not the purpose of this paper to discuss the reactions during the refining process, and the author would, therefore, confine himself to describing the practical working of this useful electro-metallurgical apparatus.

The total duration of one smelting operation from the starting of the current to the casting of the finished product into ingots or moulds covers about eight hours, assuming that the raw material is not pure. Pure raw material, of course, will require less time and less power.

The smaller of the two types of furnaces used in steelworks are run with alternating currents of about 300 kw. at about 60 to 65 volts. The larger furnaces require 1,000 to 1,200 kw. at 70 to 75 volts. Taking into account a loss of 10 to 11% of the charge by oxidation and evaporation, the power required to make 1 ton of steel in a small furnace is 900 to 1,000 kw. hours, and, in a large furnace, 800 to 900 kw. hours.

The consumption of carbon electrodes amounts to 12 or 15 kilogrammes per ton of steel, including the short pieces, which remain in the holders, when the latter have reached the lowest point at which they can withstand the radiating heat of the bath.

The lining of the furnaces, mostly consisting of calcined dolomite, will withstand at least 80 charges. Thereafter, the side walls, into which cavities have been eaten by the slag around the level of the molten bath, will require repairing, and these repairs will subsequently need to be effected at shorter intervals. The bottom of the furnace will, however, stand 120 to 160 charges without repair. The thickness of the bottom will have by then been reduced by about 100 mm. Furnace linings will stand a considerably longer time if liquid charges are used. One furnace working in this manner was run for 200 charges without any repairs.

The linings of the furnace covers require more frequent renewal. In the small furnaces they need repairs after 25 to 30 charges, and in the larger furnaces after 20 to 25 charges.

The other parts of the furnace are not worn out as fast as the linings and electrodes. The furnaces which have so far been put into operation still possess their original outfit.

At the works at Ugine only scrap iron is used as raw material for steel-making as well as for the manufacture of iron alloys. The larger part of the scrap is soft iron and steel, the smaller part pig and cast iron. The average percentage of impurities in the raw material used over a long period of operation was :—

	Per Cent.
Carbon	0·400–0·500
Silicon..	0·150–0·250
Manganese	0·500–0·700
Sulphur	0·060–0·090
Phosphorus	0·080–0·100

The cost of the different types of Girod furnaces and of complete plants are as follows :—

A small 2½ ton furnace, including regulators for the electrodes, measuring instruments, tilting device mechanism, and the conductors from the furnace to a dynamo or transformer near the furnace-room, costs about £600.

A large 12½ ton furnace with a similar outfit will cost about £1,200.

The manufacturing costs of the electrodes amount to three or four francs per ton of carbon body.

A complete plant with one 2½ ton fnrnace for regular running and one furnace for reserve, and with all appliances and melting-house, but without dynamo or transformer, will cost approximately £8,000 to £12,000 ; and a plant working with a large 12½ ton furnace, £12,000 to £16,000.

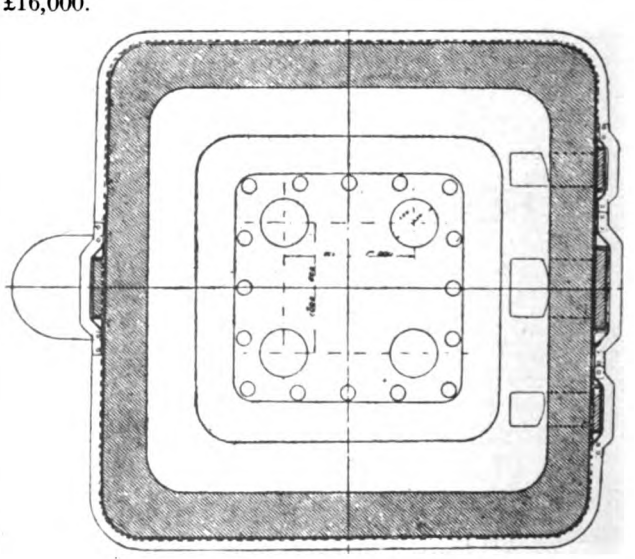

FIG. 7.

To carry out the Girod processes for the purpose of making alloys and steel, a company, under the name of Société Anonyme Électrométallurgique Procédés Paul Girod, Ugine, Savoy, in France, was formed several years ago. This company is owner of the Girod Alloy Works, in which also the first experimental 2 ton steel furnace was tried. The fact that at the present day nineteen furnaces with 400 to 600 electrical h.p. are kept running, and that twelve new furnaces, of 1,200 electrical h.p. each,

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are being put up, shows to what extent this manufacture has been developed. In the future the older works will only make alloys, and the old steel furnace will be transferred to the new steelworks.

The company also owns an electrode factory with the most perfect and modern installation, capable of turning out daily 10 to 12 tons of electrode carbons in diameters up to 350 mm. and in lengths up to 1,600 mm. of round or square cross section. At present, only 7 tons are made daily, for which only one furnace is required; a second furnace will be built as soon as the demand increases. The raw materials for the electrodes are retort graphite, petroleum coke, anthracite coal, and anhydrous tar. The solid materials are ground in ball-mills, kneaded with tar in double screw mixers and in Chilian mills. The mixture is then stamped to big blocks, which are finally pressed into blocks of the dimensions given above. The burning of these blocks is effected in gas-fired ring furnaces, the blocks being placed in large fireclay tubes and covered with coal dust.

The company owns several water-powers. The power-house which was built for the old works is situated about 3 kilometres above Ugine, on the Arly river. Here a strong dam with gates diverts the water into a tunnel, which leads it to a pipe-line directly above the power-house at Ugine. Ten Pelton-wheel turbines drive as many direct-

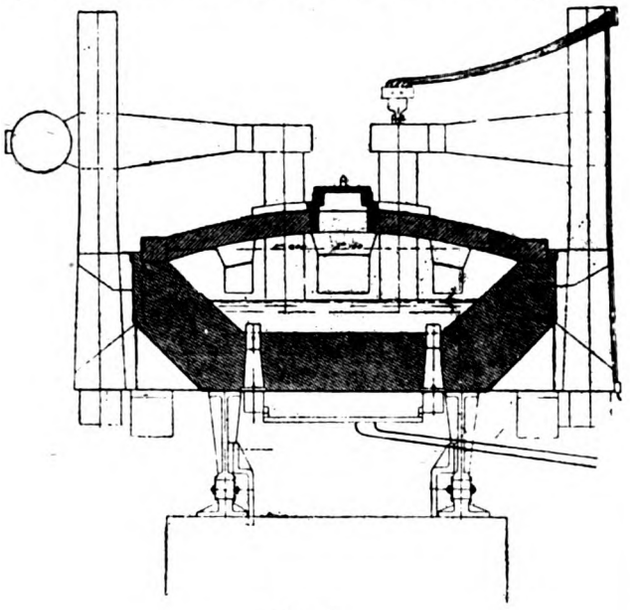

FIG. 8.

coupled dynamos furnishing 8,000 to 9,000 electrical h.p. The second power station, furnishing a further 12,000 electrical h.p., is situated above Le Fayet. The tunnel and the pipe-lines are large enough for carrying the water for 20,000 h.p., but the turbine-house is only fitted with turbines and dynamos for the lower power. It will soon be enlarged. The three-phase current is transmitted at a pressure of 45,000 volts to Ugine, where it is transformed into current of 2,500 volts for the large machines, and of 60 to 75 volts for the furnaces. The 2,500-volt current is again transformed into current of 500 volts, and this current into a 110-volt current for lighting and for small motors, and a 500-volt direct current for locomotives, cranes, and the like.

Besides this power, the works of Ugine are obtaining on lease 6,000 electrical h.p. from a power station at Bionnay, upon the Bonnant river, near St. Gervais, and during the winter months they also obtain 8,000 to 10,000 electrical h.p. from the Société d'Électrométallurgie Sud-Est, at Veuthon, near Albertville. From both stations the current is furnished at a pressure of 45,000 volts. The current from St. Gervais is conducted to Le Fayet, and there enters the line Le Foyet-Ugine.

The plant which has been installed for the new steelworks, most of which is now in running order, is as follows:

Three electric furnaces of 2 tons capacity each. One of them only makes small steel castings.

Two large electric furnaces of 10 to 12 tons capacity each.

The steel produced in all these furnaces, except the one mentioned, is cast into large ladles worked by electric cranes, and run into ingots, which are sent to the rolling-mills.

Working with several furnaces steel castings (dynamo frames) up to 20 tons have been made.

For the mechanical and thermal treatment of the steel ingots, the most effective modern machinery and other installations have been erected.

The rolling-mill has two three-high stands of rolls, one of which is able to take ingots up to 525 mm. diameter and 400 kilogrammes weight, and rolls them down to rounds of 125 mm. diameter, while the other stand will roll ingots of 325 mm. diameter to smaller rounds, squares, and sections. The other outfit of this mill consists of two furnaces for heating the ingots before they go to the rollers, and of the necessary cutting and sawing machinery for the rolled blocks.

There is a large forge containing nine hammers operated by compressed air. The heaviest of these hammers weighs 5 tons; the weights of the other eight hammers ranging from a ton to 2 cwt. Here specially tough forgings are made for automobile machinery, shaftings, gears, tool-steel rods, and projectiles. Besides several annealing furnaces already in operation, a large shop is being built for tempering, annealing, and hardening large forged or cast steel pieces.

A second forge is being erected, which is to be fitted up with a 1-ton forging press, one forging hammer of 10 tons weight, and three stampers with falling hammers of 3 tons, 2 tons, and 1 ton respectively.

The steel foundry contains a carpenter's shop for making the patterns, a sand separating plant, a number of moulding machines, the necessary moulding frames, drying and heating furnaces, and a sand-blast plant for cleaning the finished castings. The foundry with its present installation will be able to turn out about 10 tons of steel castings daily, but as mentioned above, pieces up to 20 tons in weight can be cast.

The following firms have ordered Girod furnaces, and in some cases have been operating them for some time past:

Oehler & Co., Steel Foundry, Switzerland.
Société John Cockerill, Seraing, Belgium.
Stotz & Co., near Stuttgort, Germany.
Stahlwerk Becker, Krefeld, Germany.
Gutehoffnungshütte, Oberhausen, Germany.
Ternitzer Stahlwerk, Schoeller, Ternitz, Austria.
Danner & Co., Judenburg, Austria.
Ungarisches Staats-Stahlwerk, Diosgyor, Hungary.

INSTITUTION OF ELECTRICAL ENGINEERS.

Birmingham Local Section.

In accordance with the New Rules of the Institution relating to Local Sections, the Committee have prepared the following list of officers to act during the Session 1910–11: *Past Chairmen*—R. A. Chattock (1906–7); Gisbert Kapp, D. Eng., M.Inst., C.E. (1907–8–9); R. K. Morcom, A.M. Inst., C.E. (1909–10). NOMINATIONS: *Chairman*—M. Railing. *Vice-Chairman*—A. M. Taylor. *Present Ordinary Members of Committee (remaining in office)*—J. H. Barker, J. P. Kemp, M. Kloss, Dr. Ing.; J. F. Lister, F. J. Moffett, W. E. Sumpner, D.Sc. *Ordinary Members of Committee (new nominations)*—W. C. Goodchild, W. J. Larke, F. M. Lea, A.M. Inst., C.E.; D. K. Morris, Ph. D.; C. E. C. Shawfield, R. Threlfall, F.R.S. *Hon. Secretary*—H. B. Matthews.

The Committee's nominations are given in italics. They herewith invite other nominations, and it is suggested that the members in each important centre should send in a nomination for that particular centre.

In compliance with Rule 7 of these General Rules, Messrs. V. Bornand, A. R. Everest, A. Lindsay Forster, A. Pearson, and J. C. Vaudrey, who are members of the present Committee, are not eligible for re-election this Session, having served for three years consecutively.

Nominations must reach the Hon. Secretary at Winchester House, not later than Saturday morning, May 7, and in the event of any being received, a ballot list will be prepared and circulated. The list of officers for 1910–11 will be declared at the annual general meeting of the section on May 25.

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HYDRO-ELECTRIC EMERGENCY STATIONS.*

By A. M. HUNT.

No matter what care and skill are exercised in designing and constructing a hydro-electric plant, with accompanying high-tension transmission lines, absolute continuity of service is a thing which cannot be assured. This is more particularly true of our western plants as compared with those of the eastern section of the country, and is especially true in California. Practically all of our important hydro-electric plants are located on streams which find their way down the western slope of the Sierra Nevada range of mountains through deep canyons. The sides of the canyons are usually very steep, and furnish very poor foothold for ditch construction. The cost of driving tunnels is usually prohibitive, and in the majority of cases, box flumes, built of lumber, are used to carry the water.

Our winter season is one of rains and heavy precipitation, and it is not infrequent that flumes go out, due to water-soaked foundations, slight leaks undermining footings, breaks caused by falling rocks, or other causes. This means an interruption of power service. Interruptions may and do come from line troubles due to many causes.

Interruptions of service were more than occasional in the earlier days of transmission work on the coast, and even to-day, with the better construction and design, and greater care and watchfulness in operation, they occur often enough to be matters for serious consideration.

The best means for avoiding the serious results from interruptions of service, is to reduce the period of time during which power is off the line. Any interruption of service is serious, but if a prospective power purchaser could be assured that his interruptions would be a minimum, and that when they did occur, they would be of very short duration, he would not be so apt to refuse to purchase power from the hydro-electric company on the score that the supply was not dependable. Such shortening of duration of interruption can best be accomplished by having at the receiving and distributing point an emergency generating station, maintained at all times in such a state of preparedness that it can be started and put on the line in the shortest possible time.

Under the conditions existing in California, it may become necessary to operate such a stand-by plant continuously for considerable periods, due to seasons of low water, and it is, therefore, desirable that its economy should be good. In fact, I believe I may safely state that no stand-by plant has been installed on the coast which has not become an important operating factor of the system with which it is connected.

I propose to discuss the type of stations for this service, making comparison between a station having generators driven by gas engines, and one in which steam-driven turbo-generators are used. I shall try to establish the thesis that the turbine station can be so designed as to be built at much less cost than the gas engine station; that it can be kept in a state of preparedness where it can be put into service on the line as promptly as the gas engine station; and that its stand-by charges will be less than for the gas engine station; and that its economy, when called on for continuous operation, will be at least as good as that of the gas engine station.

Premises Assumed. The station shall have a capacity for continuous operation of 25,000 kw. at 85% power factor.

Crude petroleum will be the fuel used both for generating steam and for gas making.

The station to be located at a point where spur-track facilities are available, and where ample water supply can be had.

In making comparison of economies with station in continuous operation, it is assumed that the load factor will be 50%.

General Outline of Gas Engine Station.

The station will contain 12 units, each having a continuous load capacity of 2,085 kw. at 85% power factor. The size of unit is small for a station having such a large capacity, but it is extremely doubtful if any of the engine builders will agree to build and guarantee larger engines, especially for use with gas made from oil. The experience with the large gas engines in the Martin station of the Pacific Gas and Electric Co. indicates that the safe limit was passed there.

The following quotations from recent letters received from one of the large gas-engine builders is also confirmatory:—

From reports made by various members of our engineering department, who have noted the large continental engines in operation, we gather that while some very large cylinders are still operating in the single-acting type, the European, and particularly the German companies, who have built larger than 42 in. or 44 in. diameter, using cast iron as the material, have been compelled to replace practically all of their cylinders, leads us to believe that they should not be attempted at all in cast iron, and if steel is used with cast-iron bush, the cost per brake h.p. will be much larger than a smaller sized unit, without any gain in efficiency or lessening of operating expense.

If economy is the controlling factor, it would seem to us that a size such as our 37½ in. by 48 in. (3,100 brake h.p.), which can be made safely, with cast-iron cylinders, would be a better proposition than a larger engine with longer stroke and larger diameter of cylinders which it would be necessary, or desirable, at least, to make of cast steel. We can readily understand how large power houses want turbine units of very large capacity of 10,000 kw. or more, as the economy of the turbine unit increases perceptibly as the sizes grow larger, and these very large units can show economies which are difficult to reach with the smaller sizes, but with the gas engines, if there is any difference at all, the reverse is the more likely to be true, as cylinders of moderate size can be effectively cooled and used with water of ordinary temperatures, while with the very large cylinders, in order to keep certain spots from getting hot enough to ignite the gas, other parts of the cylinders have to be kept unnecessarily cold. The desirability of good parallel operation also tends to cause a choice of smaller cylinder diameters, as with very large engines the slow speed and great number of poles cause the generator builder's requirements for operation to be very close indeed, and the weight of the flywheels becomes prohibitive, both from the point of first cost and from the ability of the bearings to stand the load without heating.

The gas required per 42 hours will be 7,500,000 cu. ft., based on 650 B.T.U. per cubic foot, 50 % load factor, and assuming that by reason of the relatively small size of units, the engines will always be operated at approximately full load.

The gas-generating plant will consist of three oil gas sets, each capable of producing 2,500,000 ft. of gas per day, with necessary condensers, scrubbers and purifiers, and a holder capacity of 2,250,000 cu. ft. to equalise the daily load. It is assumed that the units will have twin tandem engines, and the over-all size of foundation for one unit will be 70 ft. by 30 ft. Allowing for passages, the size of electric generating station will be 76 ft. by 400 ft. if engines are placed in one continuous line, or 152 ft. by 200 ft. if placed in two parallel lines. The station will have the usual compressed-air starting equipment.

General Outline of Turbo-Generator Station.

This station will be assumed to contain two turbine units, each having a continuous capacity of 12,500 kw. at 85% power factor. Each unit will have its condensing equipment, and the boiler plant will contain water-tube boilers in units of the largest size available. The boiler settings to be built so as to lose as little heat as possible by radiation from exposed surfaces. All boilers to have tight fitting dampers, which may all be opened from a central point. The oil and steam supply for burners to be controlled from the same central point, and so arranged that burners may be operated from such point. It is also figured that igniters will be fitted in the furnaces which can be operated from the central point, so that fires can be started under all boilers simultaneously.

The boiler capacity in the station is assumed to be such, that maximum load can be carried by forcing boilers 33⅓% beyond builders' rating. This is easily done with oil fuel. Neither economisers nor superheaters will be used.

In connection with the plant will be installed heat storage, consisting of vertical steel cylinders containing

* Abstract of paper presented at the San Francisco meeting of the American Institute of Electrical Engineers, May 5.

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water under a temperature due to 200 lb. steam pressure, thoroughly protected with heat-insulating material. The water and steam spaces of these cylinders will be connected with the boilers through automatic stop valves, which will open whenever the pressure in the boilers is greater than in the heat storage cylinders. In the heat storage cylinders will be installed internal electric heaters having capacity sufficient to maintain the temperature of the water in them, or, in other words, to supply the heat losses from radiation and convection. The capacity of these heat-storage cylinders to be such, that by reduction of the gauge pressure from 200 to 25 pounds, sufficient steam will be formed to operate the plant at full capacity for thirty minutes. All steam connections to be as short and direct as possible, and all precautions used to keep radiation and condensation losses at a minimum.

On the above assumptions, the following calculations are based:

Rated Horse-Power of Boilers Required.—The turbines will require at 12,500 kw. load with 175 lb. steam pressure, 28 in. vacuum, and without superheat, 16 69 lb. of steam per kw. hour. To handle auxiliaries of the plant and the oil burners will require 10% of that required for the main units, or the total maximum amount of steam per hour required will be 459,000 lb. This can be furnished by 11,475 rated h.p. of boilers, working at 33⅓% overload. It is assumed that this boiler power will be installed in 16 units of 720 rated h.p. each.

The amount of heat storage required in connection with each of the above boiler units is calculated as follows:—

When the pressure on water under a temperature due to 200 lb. steam pressure is reduced to 25 lb. about 13% of the water will pass into steam at gradually reducing pressure. The assumption was made that the heat storage shall be capable of furnishing steam for the plant for 30 min. at full load, or 229,500 lb. This is increased by 33⅓% to allow for reduced economy of the turbines with the falling pressure, which calls for 229,500 plus 76,500, or 306,000 lb. As 13% of the water in the storage cylinders passes into steam, they must contain 306,000 divided by 0·13, or 2,353,847 lb. Each of the 16 boiler units will, therefore, need 147,116 lb. of hot water in storage. Assuming the water to weigh 60 lb. per cu. ft. at temperature due to 200 lb., the volume of the containers will be about 2,800 cu. ft. This volume will be provided by one cylinder, 12 ft. in diameter by 26 ft. in length, allowing steam space over the water. Each of these cylinders will weigh approximately 120,000 lb., and will cost delivered and in place not to exceed 6½ cents per lb., or £1,560. Each storage cylinder will supply 1,563 kw. of station capacity or the cost of storage per kilowatt capacity of plant will be about £1. These figures are given to show that the cost is not prohibitive.

Comparisons.

Comparison of First Costs.—The cost of the gas-making station, as above outlined, is assumed as being £200,000, complete with buildings and storage. The figure is based on data procured within the past two years, and if in error, is possibly too low.

The cost of the electric generating station complete, including gas engines, generators, piping, switchboards, wiring, foundations and buildings will be approximately £450,000, based on recent quotations.

At these figures, the cost per kilowatt capacity of station for combined gas and electric plant will be £26 per kw.

The cost of the steam-turbine plant complete, including turbo-generators, boilers, heat-storage cylinders, piping, condensers, switchboard, wiring, foundations and building will not exceed £300,000, based on recent quotations. The cost per kilowatt capacity of station is, therefore, £12.

The steam-turbine station cost is approximately 46% of that of the gas engine station.

Comparison as to Rapidity of Getting into Operation on the Line.—It has been demonstrated in the Martin gas engine station, previously referred to, that one of the large engines can be brought up to speed, its generator synchronised, and connected to the line in 30 sec. In order that this may be done, however, the operator must be at his station when the signal is given. In the station assumed, 12 engine operators would be required, each at his post, all equally trained to accomplish this, and probably an equal number of switchboard operators. Even then, difficulties in synchronising such a number of machines simultaneously would probably take a longer time. The expense of keeping such a large operating force as this calls for, is too great to be feasible, and I assume that each operator will handle two engines, and that he will get the two generators on the line in two minutes. I should consider it exceptional work if the entire station could be in operation on the line in two minutes.

In the case of the steam turbine plant, the following sequence of operations would be followed: The turbo-generators would be operating on the line as synchronous motors to assist in regulating power factor, and with vacuum maintained on the steam ends, with the air pump operating. Steam would be in the main line up to the throttle valves, also on oil-burner line. If current on the line fails, the rotors of the units will continue to revolve for many minutes. Immediately on notice, the operator will begin opening his throttle valves, and energising his fields from a storage battery, and could easily synchronise the two machines and get on the line within less than two minutes. The air pump, if operated during the period of starting from the storage battery, would require no attention, and if a jet condenser is used, the only requirement in connection with circulating water is that the injection valve shall be opened.

Concurrently with the above, the boiler-room operator will release and open all boiler dampers at one operation, and from the same central point put steam and oil on all burners, and by the use of electric igniters start fires under all boilers simultaneously. The steam pressure in the heat-storage cylinders will gradually fall until at the end of 30 min. it will have reached 25 lb. By the expiration of that time, the boilers can be brought to steaming condition under a pressure of 25 lb. or more, and will pick up the load.

I consider that I have reasonably established the fact that the steam-turbine station can be put on the line as promptly as the gas engine station.

Comparison as to Stand-by Charges.—I shall consider this on the basis of the annual stand-by charge per kilowatt of capacity of plant.

Assuming that the fixed charges of interest, depreciation and taxes will amount to 10%, which favours the gas engine plant, the annual charge against the gas engine plant will be £2 12s. per kw. and £1 4s. against the steam-turbine plant.

I will assume that the gas engine station proper can be taken care of by two crews of six men each at the engines, and two at the switchboard, which is certainly more than fair to it. These men will get not less than £20 per month, or an annual pay roll for station of £3,840.

The gas-making plant will also require two crews, each assumed to require six men, which number is an absolute minimum. Their average wages will be not less than £20 per month or an annual pay roll of £2,886. The combined pay rolls will be £7,720, or an annual charge of 5s. 5d. per kw. of capacity.

To keep the gas-generating plant in condition such that it can begin making gas with a reasonable degree of promptness, the generators must be kept fairly hot, which will require expenditure of fuel. I have no data of my own as to the fuel necessary for this purpose. Mr. E. C. Jones, chief engineer of the Pacific Gas and Electric Co., informs me that with an expenditure of 150 gal. of oil per day, it is possible to keep a 2,500,000 cu. ft. oil-gas set, at a temperature such that it can be brought to condition for commencing to make gas in 20 min. Three such sets will, therefore, take 450 gal. per day. The annual stand-by fuel charge, oil being figured at 4s. per barrel, will amount to £782 4s., or 8d. per kw. of capacity.

It is assumed that the steam-turbine station will require two crews, each composed of the following: two turbine operators, one switchboard man, and two firemen. The average monthly wage is taken at £20 per month, which would make the annual pay roll £2,400, or 2s. per kw. of capacity. The heat-storage cylinders will be covered with extra thick heat insulating covering, around which will be built an enclosing shell of brickwork. It is assumed that the heat losses per square foot of shell, per Fahr. degree difference of temperature per hour, will not exceed

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0·1 B.T.U. The total surface of all heat storage proposed is 37,728 sq. ft. With a temperature of external air of 70° Fahr., the heat loss per hour will be 689,790 B.T.U. The main steam piping that will be under steam will have a surface area of not to exceed 3,500 sq. ft. The loss from this surface is taken as 0·2 B.T.U. per degree difference of temperature per hour, or a total loss on account of such surface of 221,900 B.T.U. The combined loss of 911,690 B.T.U. is equivalent to 359 h.p.-hour, or 270 kw.-hour.

In other words, it will only be necessary to use a little over 1% of the capacity of the plant to keep the heat storage and main steam pipes up to temperature, as the electric heaters will transform the energy at practically 100% efficiency. I think I may safely state that any of our hydro-electric plants have for at least 22 hours per day energy going to waste in an amount much greater than 1·1% of the peak load, and that under such circumstances the waste energy should not be conssidered a charge against the plant. The radiation losses, as above taken, would in two hours reduce the temperature of the water in storage less than 1° Fahr., so if no waste energy were available for two hours daily, the effect so far as the value of the heat storage is concerned would be negligible. The original heating of the water, and restoration of temperature of the water in the storage cylinders after a run would be accomplished by the use of steam from the main boilers.

It is assumed that steam will be kept on one 300 h.p. boiler, to operate pumps, to supply steam to burner lines and as an emergency precaution. An allowance of 450 gal. per day will maintain pressure on this boiler, and permit the use of 1,000 lb. of steam per hour, and at 4s. per barrel will amount to a yearly charge of £782 4s., or 8d. per kw. of capacity.

The stand-by charges per kilowatt capacity of the two plants will be as follows :—

	Gas engines			Turbines		
	£	s.	d.	£	s.	d.
Fixed charges	2	12	0	1	4	0
Pay rolls	0	5	5	0	2	0
Fuel used	0	0	8	0	0	8
Total stand-by charges ..	2	18	1	1	6	8

The stand-by charges for the turbine plant are less than 46% of those for the gas engine plant.

It would be entirely legitimate to make a small charge against the gas-making plant for maintaining steam on one of its boilers, but this has been neglected in the above.

If the entire loss of heat from storage cylinders and piping were made good from the auxiliary boiler, the annual fuel charge for this service would not exceed £200.

I believe the above discussion proves my statement that the stand-by losses of the turbine station will be less than for the gas engine station.

Comparison as to Costs of Continuous Operation.—If I have been correctly informed, the manufacturers of the large gas engines at the Martin station, previously referred to, guaranteed them to deliver a brake horse-power-hour on 18 cu. ft. of oil gas. No data as to the results actually obtained have ever been given out, but from such information as I have been able to get, I do not believe that the results are any better than those indicated above.

From a paper read before the Detroit meeting of the American Gas Institute by Mr. E. C. Jones, chief engineer of the Pacific Gas and Electric Co., in October, 1909, I take the following data :

There will be required 8⅓ gal. of crude oil to produce 1,000 cu. ft. of gas, and from the process of manufacture there will be a by-product of 20 lb. of dry lampblack per 1,000 ft. of gas made, which should be credited to the gas-making process. A portion of the lampblack will be required for generating steam used in the manufacturing process. It is impossible by any method of treatment so far found economically practicable, to reduce the moisture content much below 25% and it is generally fired when containing at least this much moisture. I assume that at least 5 of the 20 lb. will be used for generating steam, leaving 15 lb. to be credited.

There is no way in which this lampblack can be used in the plant outlined herein for gas-making, although water gas apparatus could be installed to utilise it. Mr. Jones, in the article previously cited, states that using the lampblack in water gas apparatus, 40 lb. wet lampblack (30 lb. dry) will make 1,000 cu. ft., using 6·8 gal. of oil for enriching. As 8⅓ gal. of oil are used for 1,000 cu. ft. of gas under the straight oil gas process, each 30 lb. of lampblack saves 1·53 gal. of oil, or for the 15 lb. excess produced in making 1,000 ft. of oil gas, 0·77 gal. In order to give the gas-making process every credit it can be entitled to, I deduct this 0·77 gal. from the 8⅓ gal., leaving 7·56 gal. net, chargeable to each 1,000 cu. ft. of gas made.

If the generator efficiency is 95%, and 18 cu. ft. of gas are used per brake horse-power, the amount used per kilowatt hour will be 25·24 cu. ft. The number of kilowatt hours per barrel of oil, from the data above, is 220·1.

To arrive at the kilowatt hours at the switchboard per barrel of oil in the steam-turbine plant, the following assumptions are made : That the average load-factor on the turbines will be 75% when in operation ; that the auxiliaries of the plant will require 10% of the steam taken by the main units ; that the evaporation of water will be at the rate of 12 lb. per lb. of oil.

The turbine assumed, is one where the steam consumption at three-fourths load will be no greater than at full load, or 16·69 lb. per kw.-hour. Adding 10% for auxiliaries gives 18·36 lb. of steam required per kw.-hour, or at the evaporation assumed, 1·53 lb. of oil. The oil weighs 336 lb. per bbl., and the number of kw.-hours per bbl. of oil will be 219·6 as against 220·1 for the gas engine. Attendance and fixed charges have been previously shown to be less in the case of the steam plant, so I consider that I have established the remaining statement as to economy made in the earlier part of this paper.

I have endeavoured in the argument made to use data and assumptions that in all cases favour the gas engine station, and fell that on this score I have opened the door to criticism by proponents of steam plants for this class of service.

In closing, I cannot refrain from calling attention to the desirability of fuller information relative to the gas engine station at Martin, which I have previously cited. Judging from current reports it does not seem to have been an entire success. It is said that it is still in the contractors' hands, five years after installation, and that the purchasing company has abandoned it so far as use is concerned. Nothing has ever been published regarding its difficulties and troubles nor as to its economic results, and I hope that in the discussion of this paper those who know the facts will give the engineering profession the benefit of them.

CITY OF SANTOS IMPROVEMENTS.

Presiding at the annual meeting, Mr. D. M. Fox said shareholders were to be congratulated on the improved state of affairs in Brazil, especially in Sao Paulo and the port of Santos. There had been satisfactory progress in the amount of gas consumed and in water supplied. The electrification of tramways to the suburbs on the seashore had been a success, and the inhabitants were anxious for the electrification to be extended to the whole system. The Camara, however, sought to impose conditions which the directors thought too onerous, and consequently up to the present no definite arrangement had been arrived at. The electrification so far had entailed a large outlay, and the directors asked the shareholders to agree to an increase of the Ordinary capital by 10,000 additional shares of £10 each.

MUNICIPAL WORK.

An Interesting Exhibition.

The second Municipal and Health Exhibition, which opens its doors at the Royal Agricultural Hall, London, to-morrow, Saturday, promises to be of especial interest to borough surveyors and engineers and others interested in matters municipal, several novel and interesting features having been introduced into this year's exhibition.

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THE

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Contracts, Patents and Small Advertisements by 9 a.m. on Wednesday.

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Municipal Central-Station Engineers and Tramway Managers are invited to send advance notes of new work being undertaken by them, and of successful results obtained from the undertakings under their charge.

Secretaries and Managers of Companies are asked to furnish Notices of Meetings, Issues of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers.

Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

Contractors can make use of our columns to obtain the names of the makers of any specialities they require in their business.

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SPINNING MILL ELECTRIFICATION.

When discussing the advantages of electric driving in textile factories it is well to deal, as far as possible, with concrete cases. Such an opportunity is afforded by the recent reorganisation of Messrs. J. Rhodes' Mersey Spinning Mills at Longdendale Valley, an establishment containing 47,100 weft spindles, 33,178 twist spindles, 5,928 ring spindles, with all the necessary "follow ups," as well as a weaving shed, containing 1,855 looms. We gather from the *Textile Recorder*, which gives full particulars and is evidently anxious to impress the merits of the electric drive on its readers, that this is an old-established and successful business, one which has grown and necessitated enlargement of buildings and plant. Four engines are used, and a somewhat complicated arrangement of shafting had to be adopted owing to the planning of the building. This resulted in certain of the spinning being operated by indirect mechanical drives. The experts called in—the Vulcan Boiler and General Insurance Co., Ltd., of Manchester—first overhauled the steam raising and power plant, with the result that more economical boilers and engines were installed. Then they turned their attention to the driving, and it was finally decided to adopt partial electrification, the aim being to do away with the indirect mechanical drive, to which was due the deviation from the total periodic fluctuation of speed of the engines per revolution of less than 1½%, to 12% in the case of one room and to over 15% in the other. For this purpose the contract was given to the General Electricity Co., and a three-phase A.C. generator, of a capacity of 500 KW., was laid down, being driven by engine No. 2, a grooved rope pulley, with 17 ropes, being used, while the exciter was directly coupled to the main shaft. The switchboard was mounted on a level with the first platform of the main engine, and was fitted with maximum type circuit breakers, voltmeter and ammeter for the alternator, exciter panel and a triple-pole circuit breaker and ammeter

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for each motor. A separate three-core cable was run from the switchboard to each motor. There are six of these motors: three of a capacity of 120 H.P. each, and three of 90 H.P. each. They are fitted with triple-pole switches and starting switches, having pilot lamps to indicate the E.M.F. These pilot lamps are controlled from the engine, where, close to the stop valve, is placed a voltmeter and a subsidiary shunt resistance in the exciter circuit, the voltmeter being connected across to the main alternator leads. Under the voltmeter are seven switches, each operating a bell in the electrically equipped rooms, so the signal of full voltage is conveyed by means of both sound and sight. The cables are of the three-core bitumen insulated, armoured type, and are, as far as possible, carried outside the building, being taken through the wall at the back of the switchboard, and run in where necessary to the motors. The electric drive is adopted in the twist room, spinning cellar, winding room, two spinning rooms, and frame room. In two of the rooms the motors are placed in separate rooms, entirely cut off from the spinning rooms, the line shaft being extended through the walls and the starting switches placed inside the spinning rooms. In two other cases, the motors are fixed against the walls, and in the two remaining are elevated on girders. The switches are of the ironclad type, with plate glass front, and are placed high up near the ceiling, being operated by means of a lever with steel rope. The whole of the automatic no-volt release gear forms part of the starting switch, and thus in this way the control is from the switch, with the result that the slip-rings of the rotor are never short-circuited, so that the machine runs continuously without getting unduly heated. For purposes of complying with the Home Office regulations, a triple-pole quick-break switch has been placed on the main circuit close to each motor, but these are enclosed in lock-up iron boxes, the keys being placed in a separate box adjoining, and which is provided with a thinnish glass panel. Another safety device is the compressed air equipment, used for blowing fluff out of the motors once a week, the pressure used being 60 lbs. per square inch. Now, as to results: there has been a slight increase in the power used. Against this we have to put an increase of 6% of output from the electrically-driven spindles, the yarn, too, being of a better quality. There has been "practical extinction of repairs to machinery." A length of horizontal shafting, two vertical shafts, and a large number of bevel wheels have been put out of commission, to the saving of expense on lubrication and repairs. As regards the increase of power used, it is only fair to say that this has nothing to do with the electrification, but must be put down to the addition of 5,928 ring spindles and 505 looms in the weaving shed. It is altogether a noteworthy case, for these mills are splendidly equipped, have been kept up-to-date, and turned out work satisfactorily as to quantity and quality, but, even so, partial electrification has rendered notable service both as regards economy in management and in increase of turnover and improvement of quality.

CORRESPONDENCE.

All communications intended for the Editor should be addressed "THE EDITOR, 149, Fleet Street, London, E.C." Anonymous communications will not be noticed. Letters should reach the Editor not later than Tuesday afternoon to be included in that week's issue of the Journal.

The Editor is not responsible for, nor does he necessarily endorse opinions advanced by correspondents.

STREET LIGHTING.

Sir,—In view of the recent prominence that has been given to the question of street lighting, it may be of interest to you to know that we have recently installed two metallic filament (Osram) lamps (400 c.p.) on an elevated arc lamp post in Westbourne-terrace, Paddington. Specially designed brackets and globes have been used, in order to produce the best effect, which, in our opinion, is so successful, that we venture to suggest that it would be worth while for your representative to inspect them some evening after dark. We think that you will agree that these lamps compare very favourably with arcs, though, of course, the candle-power is far less, and it may be stated that, although they have been in use for a month, the globes have not once been cleaned.

The post is situated at the Bayswater-road end of Westbourne-terrace, and I may add that at the other end of the terrace, on the bridge crossing the Great Western Railway, we have installed three ordinary street gas pillars with 100 c.p. Osram lamps, also in special globes, which your representative might also like to see at the same time.—Yours, etc.,

E. CUNLIFFE OWEN, Secretary.

The Metropolitan Electric Supply Co., Ltd.,
16, Stratford-place, W.,
London, April 29, 1910.

FREE TRADE v. PROTECTION.

Sir,—With reference to the meeting which this Association is convening on May 23 next at Caxton Hall, to consider the effect of Free Trade or Protection on the electrical industry, I have received many communications regarding this, and should be glad if you can intimate to your readers that the meeting will be a ticket meeting, and that tickets will be sent by this Association to all its members, also to all the members, associate members, and associates of the Inst.E.E.—Yours, etc.,

F. B. O. HAWES, Secretary.

The National Electrical Manufacturers' Association
(Incorporated),
Balfour House, Finsbury-pavement,
London, E.C., April 29, 1910.

ELECTRICAL PUMPS DISPUTE.

Reserved judgment was delivered by Mr. Pollock, in the Official Referee's Court, on Saturday, in the action brought by the Electrical Co. of London against Messrs. O. H. Thomas, Son & Co., of the Llynvi Valley Colliery, near Neath. The claim was for £1,150, alleged to be the balance due for electrical pumping machinery and plant supplied. The defendants counterclaimed for £32,000 damages for losses, which they alleged had been sustained owing to the defects and breakdown of the machinery.

The hearing of the case has occupied 40 days—the longest hearing in the Official Referee's Court for 20 years. The costs have been estimated at over £10,000, including 4,000 guineas for counsels' fees. The joint costs worked out at £273 per day, or 18s. 3d. for every minute. One of the witnesses occupied the box for 14 days.

Mr. Pollock's judgment occupied exactly three hours. The case, he said, had lasted longer than any other he had tried, and it was, perhaps, appropriate that it referred to a flooded mine. He did not think that the time the case had occupied was justified, and it was wholly due to the way in which the defendants had put their case. Practically the whole of the time had been devoted to the defendant's counterclaim, which, he considered, had been grossly exaggerated. He came to the conclusion that the plaintiff's case was right; but awarded the defendants £50 on the counterclaim. Judgment was entered for the plaintiffs for £1,105, with costs, on the claim and counterclaim.

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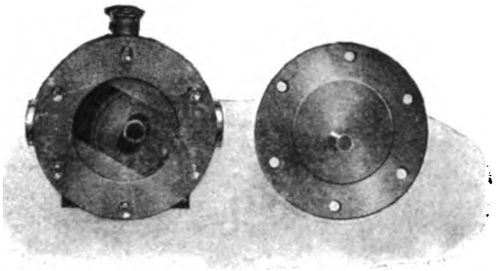
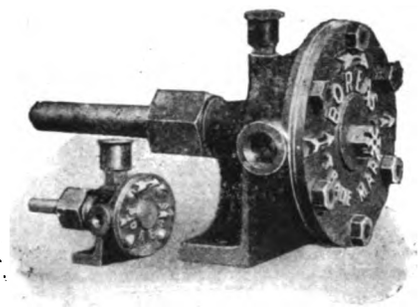
PUBLICITY.

In this Section of "The Electrical Engineer" we give Publicity to New Inventions and Specialities.

"BOREAS" ROTARY PUMPS.

In the "Boreas" rotary pump, which is at present made in six standard sizes, with capacities of from 10 to 1,000 gals. per hour, valves are entirely dispensed with and no gears or vanes of any kind are used, thus eliminating elements of failure. It has only two mechanically-operated parts and two bearings, and is extremely simple and reliable in action. It will raise liquids from any practical depth and force them against any reasonable pressure. It is eminently suitable for circulating water, forcing lubricants, raising and pumping chemicals, wines, spirits, and, in fact, liquids of every description. These pumps are manufactured in standard sizes up to 1,000 gals. capacity, but larger sizes can be made to order. They can be mounted on a portable stand and fitted with a





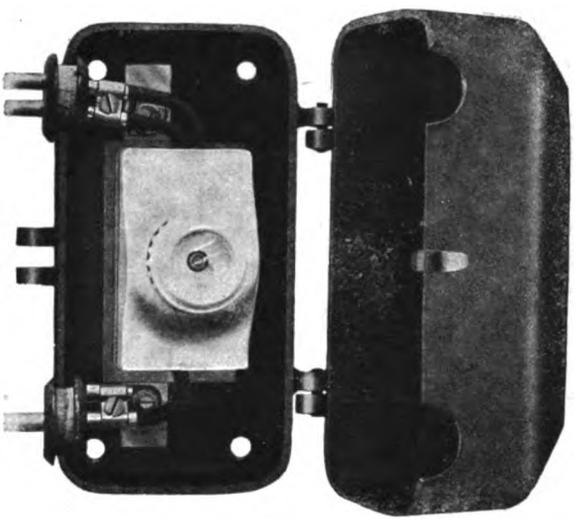
petrol engine drive of the electric motor. Fitted up in this manner, a remarkably useful and very economical machine is secured, which can be used for a variety of purposes, such as supplying water to public and private buildings, gardens, farms, and golf courses; also for spraying trees, bushes, etc. It also makes a compact and reliable fire engine for country houses.

The machine weighs only 210 lbs., and has a capacity of 1,500 gals. per hour, and will work against a pressure of 100 ft. The company will be pleased to send our readers copies of their catalogue on receipt of a trade card. It is manufactured and stocked in various patterns, by Messrs. Lacy-Hulbert & Co., Ltd., of 91, Victoria-street, Westminster, S.W.

CONCENTRIC WIRING ON THE O.S. SYSTEM.

We have received from Messrs. Siemens Bros. & Co., Ltd., Caxton House, Westminster, S.W., a copy of their new Catalogue No. A 517 (supplementary to Catalogue No. 517), in which the advantages of the O.S. Wiring System for concentric purposes are set forth. It is pointed out in the introduction that whilst concentric wiring is not new, various systems having been in use for a good many years, the special fittings which were required rendered it actually no less expensive, and in some cases dearer, than the two-wire system, and it had, therefore, fallen considerably into abeyance. Messrs. Siemens Bros., in advocating the claims of the O.S. Wiring System for concentric work, have, as a matter of fact, found that so little is known on the subject that they have decided to publish the catalogue in question, which deals, in general, with the application of the O.S. Wiring System to concentric work, and in particular, with certain accessories, such as double-wound transformers, "Tantalum" lamps and "Stannos" House fuse boxes, which have been standardised for the purpose in question. It is claimed that the essential reasons why the O.S. Wiring System, when used for concentric work, is less expensive than any other system, are because special wires or tubes have not to be manufactured, nor are special fittings or jointing devices required; because standard accessories can be employed; because it can be erected rapidly and inexpensively; and, finally, because its electrical conductivity and continuity are absolutely reliable.

Kalkos conduit, when used as an earthed return conductor, requires only half the amount of wire to be drawn into it, and, consequently, smaller conduits may be employed than would be necessary with a two-wire system.



In the case of "Stannos" wires, when the sheathing is used as an earthed return conductor, *i.e.*, when it is in series with the inner conductor, the drop in volts for a given length of sheathing plus inner conductor is less than that of the inner conductors of two separate wires, owing to the section of the sheathing. Consequently, a "Stannos" wire used concentrically may carry more current than two separate wires on the two-wire system. Hence not only is one wire used instead of two, but that wire may be smaller, and, as the same fittings are employed in either case, it is clear that about half the amount of material is saved in comparison with the two-wire system.

Messrs. Siemens Bros. claim, therefore, that the O.S. system, when employed for concentric wiring in any combination of its two component parts, effects a saving in the cost of materials and labour, which may be as much as 40%.

The advantages of low voltage are also explained. It is shown how the consumer can save in current and outlay on lamps by using low voltage "Tantalum" lamps, and, in connection with alternating current supplies, by installing a double-wound transformer. The latter apparatus are listed in a very convenient form and sizes, from 250–

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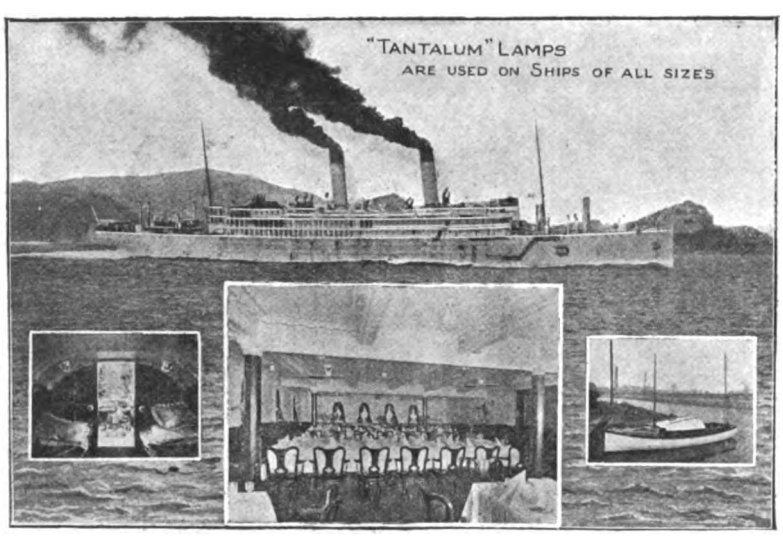
5,000 watts, and for secondary pressures from 20–230 volts; the approximate number of "Tantalum" lamps of various candle-powers being shown, which can be connected to various listed pressures.

A novelty is the "Stannos" house fuse box, which is employed where "Stannos" wires, run on the concentric system, are used for the purpose of supplying separate houses, outbuildings, etc. (as in the case of the Fixed Price Light Co.'s system). The box consists of a small cast iron case with hinged lid, containing a Siemens "Zed" cartridge fuse with non-interchangeable cartridge, and the sheathings of the "Stannos" wires are clamped at each entry to the iron case, the two clamps being bonded together. A small window is provided in the lid of the box, in order that the fuse may be inspected without unsealing the case.

In addition, of course, the catalogue contains prices and particulars of "Stannos" wires for concentric purposes, "Tantalum" lamps, and general instructions for concentric wiring on the O.S. System. It may be of interest at this juncture to point out that Messrs. Siemens Bros. & Co. are now making "Stannos" wires in the following sizes: 1-18th, 1-16th, 3-20ths, 7-20ths, 7-18ths and 7-16ths.

"TANTALUM" LAMPS FOR SHIP LIGHTING.

"Tantalum" lamps are used for all classes of ship lighting, from the man-of-war to the ferry boat. The accompanying illustration shows an Atlantic liner on which over 1,000 "Tantalum" lamps are installed, in comparison with a pleasure motor yacht. The extraordinary strength



of the lamp enables it to withstand all the severe vibration which is experienced on board ship, and accounts for its wide adoption by shipping firms. The centre inset shows one of the palatial interiors which are now to be found on the larger types of vessel, whilst on either side of it is an illustration of the small private yacht in which the owner seeks pleasure in the summer months. Thus it seems that the private owner realises the advantages of "Tantalum" lamps, and appreciates them quite as materially as the large shipping companies who are out for making dividends. Messrs. Siemens Bros., the manufacturers of the "Tantalum" lamp, also make a speciality of electric light fittings for ship, yacht and train lighting, and all who are interested in that class of work should obtain particulars and prices of same when considering new installations.

INDUSTRIAL ELECTRIC DRIVE.

At a meeting of the University of Bristol Engineering Society, a paper was read by Mr. Holbrooke on "The Advantages of Electric Driving." He pointed out the various advantages, and said that under these conditions factories would be much more cool and pleasant to work in. During the lecture Mr. Holbrooke gave several illustrations with the aid of a lantern.

INSTITUTION OF MINING ELECTRICAL ENGINEERS.

South Wales Branch.

A meeting of the South Wales Branch of the Institution of Mining Electrical Engineers was held at Barry's Hotel, Cardiff, on Saturday evening, April 30th. Mr. Sydney F. Walker, the local president, was in the chair, and Mr. W. J. Richards, of Maesteg, read a paper on "Colliery Cables." A discussion followed, and Mr. T. Schronthiel, M.I.E.E., exhibited a joint box and fittings, showing how the cable was inserted in the box, and the box filled with bitumen to ensure sound insulation. The peculiar feature was the earth bonding.

The first annual dinner of the branch was afterwards held, Mr. Sydney F. Walker, M.I.E.E., presiding, supported by Mr. Sam Allen, M.I.Mech.E., who was the guest of the evening, and Mr. Geo. Humphry (secretary). After the toast of "The King," proposed by the president, Mr. McCoy proposed "The Industries of South Wales," to which Mr. L. Watkins responded in a neat speech. "The Institution of Mining Electrical Engineers" was proposed by Mr. Schronthiel, who spoke of the advantages of the institution, and wished it long life and success in its endeavours. Mr. Fokes responded. Mr. Geo. Humphry proposed "The Press," indicating how much they were indebted to the Press for the present status of the engineer generally; Mr. Sam Allen responded. The toast of "The President" concluded a most enjoyable evening. One of the pleasant surprises of the evening was the souvenir *menu* card, which was set out rather alarmingly in technical terms as follows:—

Menu: Soup—Clear Network, Short Circuits; Fish—Boiled Armature Coils, Magnetic Sauce; Fried Coils of Fields, Non-Inductive Sauce; Entrees—Earthy Cutlets, Leakage Indicator Sauce, Time Limit Relays, Automatic Cut-outs; Joints—Armoured Cable, Bitumen, Roast Insulation, Megger Sauce; Poultry—Ammeters and Voltmeters; Sweets—Duplicate Sets, Turbine Pudding, Kilowatts, B.o.T.U., Stewed Batteries and Sal Ammoniac. Energy. Work. On the cover was an excellent pictorial representation of the various phases of mining activity.

Messrs. Thorpe, Allen, and Ward entertained the members with a selection of music.

ELECTRICAL ENGINEERS TERRITORIALS (London Division)—Orders for week ending May 14: Monday, May 9, "A" Company, Recruits' Infantry Drill, 6 to 6.45 p.m.: Company Drill, 7 to 9.30 p.m.; Tuesday, May 10, "B" Company, Company Drill, 7 to 9.30 p.m.; Wednesday, May 11, Gymnasium, 6 to 9.30 p.m.; Thursday, May 12, "C" Company, Recruits' Infantry Drill, 6 to 6.45 p.m.: Company Drill, 7 to 8 p.m.: Technical Drill, 8.45 to 9.45 p.m.; Friday, May 13, "D" Company, Recruits' Infantry Drill, 6 to 6.45 p.m.: Company Drill, 7 to 8.30 p.m.: Technical Drill, 8.45 to 9.45 p.m. (Signed) J. H. S. Phillips, Capt., Act. Adjutant.

STANDARD ELECTRICAL WORKS.

ARC LAMPS, ELECTRIC. By J. ZEIDLER and J. LUSTGARTEN, M.Sc. Demy 8vo. Profusely illustrated. 5s. net; 5s. 4d. post free. [611]

ATLANTIC CABLE, THE STORY OF THE. By CHARLES BRIGHT, F.R.S.E., M.I.E.E. 220 pp. 45 Illustrations. 1s.

CONTINUOUS-CURRENT ARMATURES. By C KINZBRUNNER, A.M.I.E.E. Demy 8vo. Illustrated. 3s. 6d. net; 3s. 9d. post free. [622]

CONTINUOUS-CURRENT MACHINE DESIGN. By WILLIAM CRAMP, M.I.E.E. Demy 8vo. Illustrated. [626]

DISEASES OF ELECTRIC MACHINERY. By C. KINZBRUNNER, A.M.I.E.E. Limp cloth. 1s. 6d. net; 1s. 8d. post free. [619]

The ELECTRICAL ENGINEER, 149 Fleet Sreet, LONDON, E.C.

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Electrical Contractors' Section.

A Survey of New Things and Business Prospects.

NOTICE.

Contract and Miscellaneous Advertisements should reach this Office by Mid-day on Wednesday. For rates apply to the Manager, 149, Fleet Street, London, E.C.

CONTRACTS.

CITY AND COUNTY BOROUGH OF BELFAST.

TRAMWAYS AND ELECTRICITY DEPARTMENT.

The TRAMWAYS and ELECTRICITY COMMITTEE of the BELFAST CORPORATION are prepared to receive TENDERS for the following Plant:—

Specification No. J. 7. Motor Boosters and Switchgear.

Specification No. J. 8. Extension of Lighting Switchboard.

Specifications, with form of Contract, may be obtained from the undersigned, on payment of one guinea each, which will be refunded, provided a *bona fide* Tender has been sent in, and not withdrawn.

Extra copies may be obtained at 10s. each Specification, which is not returnable.

Sealed Tenders, endorsed "Tender for Motor Boosters" or "Tender for Lighting Switchboard," shall be lodged with the Town Clerk, City Hall, Belfast, not later than 11 a.m. on Monday, May 23, 1910.

The Council do not bind themselves to accept the lowest or any tender.

THOMAS W. BLOXAM, M.Inst.E.E.,
City Electrical Engineer.

East Bridge-street, Belfast.

BOROUGH OF FAVERSHAM.

ELECTRIC WORKS.

The ELECTRIC LIGHTING COMMITTEE of the TOWN COUNCIL of the BOROUGH of FAVERSHAM invite TENDERS for the SUPPLY and INSTALLATION of a SYSTEM OF FORCED LUBRICATION TO A VERTICAL GAS ENGINE at the ELECTRIC LIGHT WORKS, FAVERSHAM.

Specification and Plans may be seen at the Electrical Engineer's Office at the Works.

Sealed Tenders, endorsed "Tenders for Forced Lubrication," to be delivered to the undersigned at 20, West-street, Faversham, at or before noon on Friday, May 13, 1910.

The Committee do not bind themselves to accept the lowest or any Tender.

By Order,
GUY TASSELL,
Town Clerk.

BOROUGH OF SCARBOROUGH.

TO CONTRACTORS FOR ELECTRICAL LIGHTING.

The TOWN COUNCIL of the BOROUGH OF SCARBOROUGH is prepared to receive TENDERS for the work in connection with the Electric Lighting of the following:

No. 1. Pavilion, Alexandra Gardens.
No. 2. Alexandra Gardens.
No. 3. Marine Driver Shelter and Toll-houses.

Plans and Specification may be seen and Form of Tender and Schedule obtained on application to the undersigned on and after Monday, May 2, 1910.

Sealed Tenders, in an envelope provided for the purpose, to be delivered at the Office of the Town Clerk (D. Arthur Nicholl, Esq.), not later than 12 noon on Monday, May 9, 1910.

A deposit of £1 1s. is to be made with the Borough Accountant before any particulars or Form of Tender can be supplied, which sum will be returned to those whose Tenders are not accepted, but it will be forfeited if the person whose Tender is accepted does not carry out his Tender.

The lowest or any Tender will not necessarily be accepted.

HARRY W. SMITH, A.M.I.C.E.,
Borough Engineer and Surveyor.

Town Hall, Scarborough,
April 29, 1910.

CONTRACTS OPEN.

HOME.

Belfast.—Corporation invite tenders for supply of motor boosters and switchgear and for extension of lighting switchgear. Particulars from Mr. T. W. Bloxam, City Electrical Engineer. May 23.

Dublin.—Technical Education Committee invite tenders for the installation of electric light in the Bolton-street Technical Schools. Particulars from the City Electricity Engineers, Dublin. May 11.

Eccles.—Electricity Committee invite tenders from British cable makers for supply and delivery of 2,000 yards of high tension concentric paper-insulated cable. Particulars from Borough Electrical Engineer. May 12.

Faversham.—Electric Lighting Committee invite tenders for supply and installation of a system of forced lubrication to a vertical gas engine at the electric light works. Particulars from Town Clerk. May 13.

Hoylake and West Kirby.—District Council invite tenders for the supply of coal for the electricity works to June 30, 1911. Class of coal, "Peas and Beans," and also lower grade. Quantity, 3,000 tons. Particulars from Mr. C. J. Turner, electrical engineer. May 17.

London.—Metropolitan Asylums Board invite tenders for (1) engineers' ironmongery, (2) electrical accessories. Particulars from Clerk to the Board, Victoria-embankment, London, E.C. May 11.

London.—L.C.C. Tramways. Tenders invited for the road-work and platelaying required for the reconstruction, on the underground conduit system of electric traction, of the Council's existing horse tramways in Tooley-street, Bermondsey; Dock-head, Parker's-row, Jamaica-road, Union-road and Evelyn-street, Deptford; and the construction on the same system, of the authorised tramway in Creek-road, Bridge-street and Church-street, from the terminus of the existing horse tramway in Evelyn-street to a junction with the existing conduit tramway in Nelson-street, Greenwich; also for the paving works of the street widenings on the above route. About 8·16 miles of single track. Specifications from the Chief Engineer of the Council, County Hall, Spring-gardens, S.W. May 31.

Perth.—Town Council invite tenders for the supply of 3,500 tons of small coal during the period ending May 15, 1911, delivered free at their electric lighting station. Forms of tenders from Mr. J. Lambert, Borough Electrical Engineer, Perth. May 11.

Scarborough.—Corporation invite tenders for the electric light wiring of (1) The Pavilion, Alexandra Gardens; (2) Alexandra Gardens; (3) Marine Drive shelter and toll houses. Particulars from Mr. H. W. Smith, Borough Engineer. May 9.

OVERSEAS.

Antwerp.—Lower Scheldt Works.—Electric lift for vehicles on floating pier. Dep., £320. Specification No. 19, 2d., plans 1s. 5d., Direction du Service Spécial de l'Escaut Maritime. June 16.

Antwerp.—The Municipal Authorities invite tenders for the supply of electrical appliances for the town workshop at the new North Docks. Tenders must be sent in sealed envelopes to the Burgomaster, Hôtel-de-Ville, Antwerp, to arrive not later than May 9. Copies of the *cahier des charges* may be obtained (price 50 centimes) at the Hôtel-de-Ville, Antwerp.

Budapest.—H.M. Consul-General at Budapest (Mr. Esme Howard, C.V.O., C.M.G.) reports that tenders are invited by the Municipality of Pécs for the building and working of an electric railway in that town. Tenders will be received up to noon on June 6, by the "Pécs varos gazdasagi tanacsnokanak, Varosi Székhaz," Pécs, Hungary, from whom also detailed conditions and forms of tender may be obtained at a cost of 2 kronen (1s. 8d.). The plans and other documents can be examined on personal application at the Engineering Office of the town of Pécs.

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CONTRACTS—continued.

BOROUGH OF ECCLES.

The ELECTRICITY COMMITTEE invite TENDERS from British Cable Makers for the SUPPLY and DELIVERY of 2,000 yards of High-tension, Concentric PAPER INSULATED CABLE.

For further particulars apply to the Borough Electrical Engineer, Electricity Works, Cawdor-street, Patricroft.

Sealed Tenders, endorsed "Tender for Cable," to be delivered to the undersigned not later than 10 a.m. on Thursday, May 12, 1910.

The Corporation do not bind themselves to accept the lowest or any Tender.

EDWIN PARKES, Town Clerk.

Town Hall, Eccles,
April 28, 1910.

THE METROPOLITAN ASYLUMS BOARD invite TENDERS for the SUPPLY of ENGINEERS' IRONMONGERY, BUILDERS' IRONMONGERY, PLUMBERS' and GASFITTERS' IRONMONGERY, ELECTRICAL ACCESSORIES, and MISCELLANEOUS STORES.

Forms of Tender (upon which alone Tenders will be received), giving all particulars, can be obtained at the office of the Board, Embankment, London, E.C., where Tenders duly filled up must be delivered not later than 10 a.m. on Wednesday, May 11, 1910. Those whose Tenders are accepted will be informed accordingly in due course.

The Board do not bind themselves to accept the lowest or any Tender, and reserve to themselves the right to accept the whole or any part of a Tender.

By Order,
T. DUNCOMBE MANN,
Clerk to the Board.

April 28, 1910.

PATENTS.

S. SOKAL, Chartered Patent Agent,
AND
Certified Austrian Patent Attorney (Patentanwalt), Specialist for German Patents and Patent Litigation.

55, CHANCERY LANE, LONDON, W.C.

THE OWNERS of BRITISH PATENT No. 9637 of 1907 entitled "A process for increasing the Durability of Carbon and Graphite Electrodes in Aqueous Solutions," granted to The Chemische Fabrik Buckau, are desirous of disposing of the patent or entering into a working arrangement under license with firms likely to be interested in the same. In the alternative, the owners would be open to consider proposals to carry out the process to fill any requirements of the market in Great Britain on terms to be arranged.

The patent covers an invention interesting to the Electro-Chemical industry.

Detailed information as to the invention will be found in the patent specification, of which a copy will be supplied to any interested party on request.

Full particulars can be obtained from and offers made (for transmission to the owners) to MARKS & CLERK, 57 and 58, Lincoln's Inn Fields, London, W.C.

THE PROPRIETORS of the PATENTS, Nos. 9413 of 1906, 9418 of 1906, 9423 of 1906, 9424 of 1906, for "Improvements in Pneumatic Tube Systems" and "Improvements in Governing Mechanism for Pneumatic Tube Systems," are desirous of entering into arrangements by way of license and otherwise on reasonable terms for the purpose of exploiting the same and ensuring their full development and practical working in this country. All communications should be addressed in the first instance to HASELTINE, LAKE, and Co., Chartered Patent Agents and Consulting Engineers, 7 and 8, Southampton-buildings, Chancery-lane, London, W.C.

THE ELECTRICAL ENGINEER REPRINTS.

New Series No. 1.

JUST PUBLISHED.

"LIGHTNING CONDUCTORS,"

By ALFRED HANDS, F.R.Met.S.

Author of "Scientific Protection," "A Guide to the proper Application of Lightning Conductors," "Lightning and the Churches," etc.

PRICE THREEPENCE.

Post free, Threepence Half-penny.

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The Latest and Most Novel Patterns.

The Best and Cheapest in the End.

For Lists and Particulars apply to

The Leysner Electrical Instrument Coy.,
12, Lime St., LONDON, E.C.

CONSTANTINOPLE.—Public Works Department.—Distribution of electric current in the European part of Constantinople and suburbs, except that required for telegraph, telephone and public traction purposes. Prov., £E10,000. May 28.

MELBOURNE.—H.M. Trade Commissioner for Australia (Mr. C. Hamilton Wickes) reports that tenders will be received at the office of the Deputy Postmaster-General, Melbourne, for the supply of the following:—(1) 581 steel date stamps (Schedule No. 305); tenders will be received up to 3 p.m. on May 31. (2) 100 common battery wall telephone sets and 10 common battery table telephone sets for party line working (Schedule No. 280); tenders will be received up to 3 p.m. on June 14. (3) 100 common battery telephone extension switches (Schedule No. 281); tenders will be received up to 3 p.m. on June 14. (4) 3,000 telephone protectors (Schedule No. 282); tenders will be received up to 3 p.m. on June 14. Tenders will also be received at the office of the Deputy Postmaster-General, Perth, Western Australia, up to 3 p.m. on June 7, for the supply of one main distributing frame for the Cottesloe Telephone Exchange, in accordance with Schedule 66. Tenders, marked "Tender for Main Distributing Frame," should be addressed to the Deputy Postmaster-General, Perth, Western Australia. A deposit will be required with each tender. Local representation is necessary. Tender forms, specifications, etc., for each of the above contracts (except that for the supply of date stamps) may be obtained, and preliminary deposits paid, at the offices of the High Commissioner in London for the Commonwealth of Australia, 72, Victoria-street, S.W.

WELLINGTON, NEW ZEALAND.—H.M. Trade Commissioner for New Zealand (Mr. G. H. F. Rolleston) reports that a Wellington firm desire to obtain quotations from British manufacturers for solid drawn steel conduit and fittings, screwed with standard gas thread; also for insulated cable of the make of the Associated Makers or equal thereto. Manufacturers interested should send catalogues, with the latest discounts and trade terms, quoting preferably c.i.f. and e. Mr. Rolleston also reports that another Wellington firm wish to get into touch with manufacturers of electric cable of all descriptions. Communications regarding both the foregoing enquiries should be addressed to H.M. Trade Commissioner, 9, Grey-street, Wellington, New Zealand.

TENDERS ACCEPTED.

DUBLIN.—British Insulated & Helsby Cables, Ltd., £17,532 for supply of extra high-pressure and low-pressure cables—delivery open a period of two years.

LONDON.—St. Pancras Borough Council tenders for the supply of arc lamp carbons during the ensuing year:—The Sloan Electrical Co., Ltd. (accepted), £687 15s.; William Geipel & Co., £744 2s. 6d.; H. G. Mayer & Co., £756; Crompton & Co., Ltd., £763 14s. 9d.; Ship Carbons, Ltd., £774 10s. 3d.; G. Baulik, £813 15s.; the General Electrical Co., Ltd., £922 18s.; Siemens Bros., Ltd., £1,279 8s. 11d.; Sirus-Werke, £1,386.

GLOUCESTER.—The Electricity Supply Committee resolved that the tender of Messrs. W. M. Geipel & Co. (the lowest), amounting to £111 16s. 7d., be accepted for the supply of carbons.

Continental Expert in the manufacturing process of Wolfram-Metal and Wolfram Filaments for Glow-lamps

is ready to teach and train responsible gentleman in the best methods of establishing plants in the U.K. and render such services as may be necessary for the successful conducting of this marvellous, highly profitable business. Charges reasonable. Negotiations through—**Alfred Schellhese, 290, Old-st, E.C.**

PLANT FOR SALE.

Advertisements under this heading: Twenty-four words, 1s. per insertion; three insertions for 2s. 6d.; or each additional line of eight words, 4d.

FOR SALE, 2 ELECTRICAL OVERHEAD CRANES, 15 and 20 tons, 37½ feet span, by Sunderland Forge Co.; 1 Pintel and Scarfing Machine; 1 48in. Iron Saw; 1 20-ton Steam Forge Crane; 2 50-horse motors; 1 4½ Carter Disintegrator; 1 Special Steam Hammer for Sternframes.—Apply, ALEXANDER, Iron Merchant, Sunderland.

ELECTRIC MOTORS (10, 5, 2½-h.p.), in stock.—GEO. DIXON, Electrical Engineer, Popham-street, Canal-street, Nottingham.

EIGHTY MOTORS AND DYNAMOS for sale or hire.—MARTIN, 320, Witton-road, Birmingham.

FOR SALE, 20 h.p. Suction Gas Plant and 14 b.h.p. Engine; also 10 h.p. Vertical Boiler and 6 h.p. Vertical Steam Engine.—Box C.E., c/o THE ELECTRICAL ENGINEER, 149, Fleet-street, London, E.C.

ELECTRIC MOTORS.—Two 15 h.p., 500 volts; one 20 h.p., 100 volts; one 10 h.p., 460 volts; tramway controllers.—Box W.G., c/o THE ELECTRICAL ENGINEER, 149, Fleet-street, London, E.C.

FOR SALE, Three Generating Sets, 100 kw. 125 volts.—THOMAS JOHNSON, Prescott-street, Wigan.

FOR SALE, Two Willan's Three-crank Triple Expansion Engines, 825 I.H.P., 180 lbs. press., 270 revs.; only run about 1,000 hours; work triple or compound; bargains.—THOMAS JOHNSON, Prescott-street, Wigan.

PLANT WANTED.

PLATINUM UTENSILS, SCRAP, LAMP TOPS.—Best prices given by DERBY AND CO., LTD., 44, Clerkenwell-road, London, E.C. N.B.—Platinum Sold.

WANTED.—A small, Second-hand, Electric Motor Pump, in good condition, about 2½ h.p., 210 volts direct.—Apply stating price to J. MARCHAM, Ranelagh Club, Barnes, S.W.

SECOND-HAND 5 H.P. ELECTRIC MOTOR, 440 volts, slow speed preferred.—Particulars to WHITING, LIMITED, 334, Euston-road, London, N.W.

SITUATIONS VACANT.

SHIFT ENGINEER, with experience in a Central Station and accustomed to taking an eight-hour shift on a three-wire system, wanted at once. Salary to commence, 25s. Applications, stating age, and giving full particulars of previous experience, together with copies of not more than three testimonials, to Box No. S.E., c/o THE ELECTRICAL ENGINEER, 149, Fleet-street, London, E.C.

SITUATIONS WANTED.

ELECTRICAL and GENERAL ENGINEER requires situation, station or private plant.—W. WINTERBURN, 192, High-street, Harlesden, N.W.

FOREMAN WANTS SITUATION with Arc Lamp firm; well up in Theory and Practice of Mechanics and Electricity; 32 years of age, and 17 years' practical experience.—Box W. E., c/o THE ELECTRICAL ENGINEER, 149, Fleet-street, E.C.

ELECTRICAL ENGINEER desires berth in Central Station, or charge of private installation.—Box C., c/o THE ELECTRICAL ENGINEER, 149, Fleet-street, London, E.C.

NOTES.

Potteries Contractors.

Business is brisk in the Potteries, and certainly electricity is more than making headway in all the towns, and not least so in Burslem, thanks at once to the enterprise of the Corporation Electricity Works and to the private contracting firms. Two of these have built up more than local reputations. Messrs. E. M. Evans & Son, of Swan-square, have had many big contracts in hand lately for the Government, corporation, railway company, and private persons. Among those may be mentioned the wiring and supply of 1,000 lamps at Chell Workhouse, the lighting of a church at Sneyd, and the equipment (lighting and power) of the Acme New Mills, Pendlebury, the first cotton factors in the Potteries to adopt electrification. Another go-a-head firm are Barnett & Hyde, of Waterloo-road, Burslem, who, among other work, are fitting up the new Skating Rink and the local Hippodrome with electric lighting. They make rather a speciality of country house illumination, supplying petrol or power gas plant for working electric plant.

D.P. Battery Foreign Agents.

The D.P. Battery Co., Ltd., have appointed representatives in Argentina and in Turkey. In the first-named country, Messrs. Milne, Makein y Cia., of Suiphaca 88, Buenos Aires, represent thom; and the firm of Messrs. Wm. Sprowson & Son, of Constantinople, has accepted their agency for Turkey, Greece and the Balkans.

M.S. Metal Filament Lamp.

Messrs. D. H. Bonnella & Son, Ltd., have taken over the agency for the M. S. metal filament lamps, and will keep a stock at their depôt, 58 and 60, Mortimer-street.

Carriage Tariff.

Messrs. Neale & Wilkinson, Ltd., of 32, St. Mary-axe, London, E.C., have brought out a new edition of their "A. B. C. Tariffs of Rates," for the conveyance of goods and parcels to all parts of the world. It has been enlarged and revised and brought right up-to-date. There are many new features and it includes rates to places abroad, recently brought into prominence by the rubber boom. A copy of the handbook may be had post free on application.

Change of Address.

The British Westinghouse Electric and Manufacturing Co., Ltd., advise us that their Supply Department (offices, showroom, and stores) for the London district has been removed from 27, Chancery-lane, London, W.C., to larger and more commodious premises at 3, West-street, and 30, Litchfield-street, Charing Cross-road, W.C., at which address they will be pleased to show anyone interested, the Westinghouse-Bremer patent "Arcturus" flame arc lamps, various forms of enclosed arc lamps, their latest magazine flame lamps for street lighting, as well as to demonstrate the saving to be effected by the Westinghouse patent "Auriga" metal filament lamps.

Thousand-Day Electric Clocks.

The Eureka Clock Co., Ltd., of City-road, have completed an order for 188 clocks for the Carlton Hotel, Biarritz. The Eureka is a noiseless clock with watch movements, so it will go and keep time in whatever position it may be placed. It contains a small dry battery, and only requires winding and new battery about once in three years. It may be mentioned that the King has ordered one of these clocks for Buckingham, the chairman of the company, Mr. Sigismund Kutnow, having had the honour of showing one to His Majesty while at Biarritz.

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SITUATIONS WANTED—continued.

ELECTRICIAN, young, requires situation; could take charge of small plant.—Box H., c/o THE ELECTRICAL ENGINEER, 149, Fleet-street, London, E.C.

MEN OUT OF EMPLOYMENT in all branches of the Electrical Trade should write to Box No. 20, c/o THE ELECTRICAL ENGINEER, 149, Fleet-street, London, E.C.

TRAVELLERS calling upon Electrical firms, Electrical Engineers and Manufacturers and Dealers can earn additional commission. No samples to carry.—Address Box 40, c/o THE ELECTRICAL ENGINEER, 149, Fleet-street, E.C.

LATE TORPEDO INSTRUCTOR (R.N.), abstainer (27), seeks sit. (electrical). Used care and maintenance of switchboards, dynamos, motors, lighting, bells and telephones; also testing, balancing and fault finding. Home or abroad. Trial solicited.—Address, C. H., 16, Elm-road, Winchester.

CONTRACTS WORTH WATCHING:—

Barrow-in-Furness.—Borough Engineer. Manual Instruction Centre.

Brighton.—Mr. Hugo Talbot, Town Clerk, Brighton. Overground lavatory and tram shelter.

Chelmsford.—Mr. W. Stunt, Clerk to the Governors, 71, Duke-street, Chelmsford. Alterations and additions to the Grammar School.

Coventry.—Education Offices, Priory-road. Elementary School for 1,254 children.

Darlaston.—Mr. Graham Balfour, Director of Education, Stafford. School for 304 infants.

Deptford.—Messrs. Cooke & Warren, architects, Talbot House, Arundel-street, London, W.C. Branch Library.

Epsom.—Mr. A. G. Ebbutt, Clerk to the Union, "Gynsdale," Waterloo-road, Epsom. Nurses' Home, and additions to Girls' Home.

Glasgow.—Messrs. Walker & Ramsey, architects, 123, Wellington-street, Glasgow. Industrial Hall and Offices.

Heanor.—Mr. G. H. Widdows, architect, St. Mary's-gate, Derby. Secondary School for 250 boys.

Millstreet, Co. Cork.—Mr. J. S. O'Connor, Clerk to the Rural District Council, Millstreet, Co. Cork. Free Library.

Newcastle-on-Tyne.—Messrs. Shewbrooks & Hodges, 24, Grainger-street, Newcastle. Home for Incurable Children.

Pontypridd.—Messrs. A. L. Thomas and G. S. Morgan, architects, Pontypridd. Three large shops and offices.

SCHILOWSKY MONO-RAILWAY.

Demonstration of the System in London.

Many representatives of the technical and general Press were present at the *Westminster Palace Hotel*, London, on Wednesday afternoon, when His Excellency Mons. Pierre Schilowsky gave a demonstration with working models of his mono-railway system.

The Schilowsky mono-rail is kept in equilibrium by a single gyroscope, as distinguished from the Brennan system, which employs two. The gyroscope is pivoted on a horizontal axis in a frame, which, in turn, is pivoted at a point below the centre line of the gyroscope. As demonstrated by models, it is driven by steam and has a pendulum, which, directly the car tends to fall to one side, brings into gear a small quadrant with a constantly running steam engine. The quadrant is coupled up to the gyroscopic frame to which it transmits a series of oscillations or shocks, which have the effect of keeping the car properly balanced.

The author claims that his system, which can easily be adapted for electrical operation, will ensure safe and rapid transit, and economy in working expenses.

FARADAY HOUSE.—Major O'Meara, late R.E., C.M.G., will deliver a lecture on May 20th to the Third Year Students upon "Depreciation."

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SPECIALISTS
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F. CARSON & EVANS.
34 Fenchurch Buildings
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19 & 70, LOMBARD STREET, LONDON, E.C.
Total Funds exceed - £13,000,000
Claims Paid exceed - £70,000,000
Chairman: RT. HON. LORD GEORGE HAMILTON, G.C.S.I.
The Company transacts all the principal classes of Insurance business on advantageous terms, including
FIRE - LIFE - ACCIDENT
Loss of Profits following fire, Workmen's Compensation, Fidelity, Guarantee, Burglary, also undertakes the duties of Trustee and Executor.
ELECTRIC LIGHTING.
The Company has always encouraged the development of Electricity, and the well-known "Phœnix Fire Office" Rules for Electrical Installations are in use throughout the world. Copies will be supplied free on application to the Head Office.
G. H. RYAN, General Manager.

ONTARIO HYDRO-ELECTRIC LAW.

An Ottawa correspondent announces that, after mature consideration of the question, the Dominion Government has reached a definite decision not to disallow the Hydro-Electric legislation of the Ontario Government. Application for disallowance was made last summer by a number of companies interested in electrical development in the Niagara District, and the matter has been under consideration at intervals since that time. Those who were opposed to the legislation took the ground that it constituted an unfair and unconstitutional infringement of vested rights involving millions of dollars; and that Canada would be seriously injured as a field of investment for foreign capital if provincial governments are to supplant industries of this kind in which so much capital had been invested by works of their own.

The Minister of Justice, in recommending to his colleagues that the legislation of the Ontario Government should not be disallowed, took the view to which he had already given expression in the House in connection with similar legislation, viz.: That whatever may be the opinion of the federal authorities as to the wisdom or unwisdom, of such legislation, the matter is one which affects the province only, and is one on which the voters of the province should be allowed to decide for themselves. The minister further says that no valid reason has been advanced to show that the legislation complained of has affected the credit of the Dominion as a field for foreign investment.

In this connection, it was urged by the opponents of the legislation that hundreds of thousands of dollars' worth of bonds of the private companies now established in the Niagara district are held by American and other financial institutions.

Mr. Aylesworth says that a complaint as to this would lie more properly with the provincial government, which has established the opposition to the private power schemes.

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PUBLICATIONS.

We must congratulate Mr. G. A. Sekon on the first issue of his new magazine, *The Railway and Travel Monthly*. It is admirably edited, illustrated and printed, and contains 88 pages of interesting matter. The first article, on "The World's Most Luxurious Railway Coach," has eight illustrations in colour, and there is also a coloured plate of the three-cylinder compound express locomotive "Lady Henderson." Among the outstanding features are an article on "British Express Trains and Locomotives (1900–1910)," and "The Most Modern Locomotive Works." This last describes the Eastleigh works of the London and South-Western Railway. We are told that the "gas is not provided, except in the dining hall, for the purpose of supplying the cooking stoves, and in the paint shop for burning off paint, etc.

"With the exception of the general offices, all departments are now fully occupied and in actual working order, and the old workshops at Nine Elms have been closed.

"What strikes a visitor perhaps more than anything else is the magnificent proportions of the erecting shop, which consists of four bays, each 765 ft. long and 56 ft. wide, giving a total width of 224 ft. Each bay is provided with three sets of rails, so that the extreme length of railway contained in this shop alone amounts to no less than 3,060 yards, or about 1¾ miles. The outside pair of rails in each bay are provided with pits throughout their entire length, while the centre road, which is intended for moving the engines from one point to another in the shop, contains beneath it a chamber, in which are situated the drains and pipes conveying the rain water from the roof, etc. In each bay two 30-ton overhead electrically-driven cranes are placed.

"The machine and fitting shops adjoin the erecting shop, with no party wall division, so that a most spacious shop is provided, 765 ft. long by 90 ft. in width. Placed transversely at the end of these shops is the boiler and wheel shop, 405 ft. in length, with a width of 117 ft. The smiths' shop runs parallel with the machine shop, and measures 360 ft. by 90 ft. In this building a splendid system is in vogue of placing the blast and smoke exhaust flues underground. A description of the various tools and appliances with which these workshops are equipped will be given later on.

"The western end of the bay, containing the smithy, is devoted to the coppersmiths' shop (135 ft. by 45 ft.), the paint shop (360 ft. by 45 ft.), paint stores, etc. The paint shop is provided with three lines of rails throughout, the centre line having a pit for its entire length. Between this shop and the machine shop are the dispensing stores, a building measuring 270 ft. by 45 ft., and equipped with movable and fixed cranes for expeditiously dealing with material.

"At the extreme end of the shops, and adjoining the wheel shop, is the power house, with a total length of 150 ft., divided into three portions, the first containing the boilers, the centre portion the electric engines and dynamos, and the third the hydraulic engines. About 60 ft. away is the chimney shaft, a remarkably fine piece of brickwork, 120 ft. high and 4 ft. 6 in. diameter inside, taking the smoke and fumes from the boiler house, etc.

"The foundries, forge, pattern shop, etc., are contained in separate buildings about 120 ft. south of the main shops. The iron foundry is a building of two spans, each 49 ft. 8 in. wide by 35 ft. high, and 250 ft. long. The roof of the foundry is formed from the ironwork recovered from the foundry at the Nine Elms Works. In a 'lean-to' adjoining are the cupolas, core stoves, brick arches, and bins, etc. Next to this is the pattern makers' shop and stores, 100 ft. square, and at the end the brass foundry, 100 ft. by 50 ft., with air furnaces. The wrought iron chimney is placed outside the walls.

"The whole of the tools, cranes and plant in the new workshops are electrically driven, and to provide for this the power house is equipped with two high-speed vertical engines, driving two sets of 600 kw.'s direct current generators, constructed by the British Westinghouse Co. One set of these is sufficient to produce all the power required for driving the plant, the second set having been installed as a stand-by for use in cases of breakdown or other necessity. In addition to these there are also four sets of 75 kw. engines, used for producing the current for lighting, etc., and one 40 kw. engine. The steam for driving the generators is supplied by a set of five locomotive type boilers of 160 lbs. pressure, each constructed at the company's workshops at Nine Elms. The hydraulic engines and accumulators and pneumatic power plant is also situated in the power house. While on the subject of driving power, we may mention that all the larger machine tools are provided with individual motor drive of varying power. The smaller tools are operated by motors on the group principle. Wherever practicable the motors are equipped with Vickers & Maxim's system of reversing.

"In the boiler machine shop we find a set of 12-ft. vertical bending rolls for bending plates of all descriptions, driven by a motor supplied by the British Westinghouse Electric & Manufacturing Co., of 25 b.h.p. This machine was supplied by Messrs. Thomas Shanks & Co., of Johnstone, Glasgow, and, in addition to this is another very fine tool—a 30-ft. plate edge planing machine, constructed by Messrs. Hugh Smith & Co., of Glasgow. This machine is also driven by a separate electric motor of Vicker's design, working at 30 b.h.p. These motors, with others, are specially equipped with the Vicker's design of reversing motor, the change in speed on the forward and return stroke being effected by means of resistances. On reversal the motors do not operate the tools at a higher speed than 100 ft. per minute. Other tools in this shop are referred to later on.

"In the machine shop some of the machines are operated by separate electric motors, but in many cases they are driven on the group principle, the number varying from two to six or seven, according to the size and description of the tools.

"An exhaust fan and blower has been set up here capable of exhausting smoke from 40 smiths' fires through a main flue of 36 in. diameter, working at 1,000 r.p.m., driven by a 75 h.p. motor. This fan, etc., is the work of the Electric & Ordnance Accessories Co., Ltd., of Aston, Birmingham.

"The smithy blower is driven by a powerful motor of 30 b.h.p., supplied by Messrs. Vickers, Sons & Maxim.

"The motors driving the several tools are of different brake horse-powers, varying from 5 to 60 h.p., and are all of the very latest design.

"It has already been stated that the power for driving the plant is derived from two remarkably fine sets of 600 kw.'s engines and dynamos, delivered to the company by Messrs. Belliss & Morcom, Ltd., running at 270 r.p.m. at 230 volts, with standard D.C. frame generators by the British Westinghouse Co. The air compressors in the power house are driven by three 30 b.h.p. motors, and a hand-power crane is installed, working on the overhead principle for facilitating the removal of any portions of the machines when necessary.

"The switchboard fittings were supplied by various well-known firms, who make a speciality of electric fittings, such as Kelvin & White, British Thomson-Houston, and the British Westinghouse Co. The switchboard itself was put together by the London and South-Western Railway's electricians, and is surmounted by a handsome clock."

It will be seen that the magazine is at once readable and practical.

The South Wales Wages Agreement is the title of "Coal Trade Pamphlets" No. 6, issued by the *Colliery Guardian* at 1d.

We have received from the Hill Publishing Co., Ltd., their Catalogue of Technical and Scientific Books. It covers a wide range of subjects, and is specially strong in the Electrical Section, wherein works of recognised value will be found in practically all branches.

LIENS REGISTERED.

HINDHEAD AND DISTRICT ELECTRIC LIGHT CO., LTD.—Issues from March 7 to April 9, 1910, of £950 Debentures, part of a series of which particulars have already been filed.

PAIGNTON ELECTRIC LIGHT AND POWER CO., LTD.—Issue on April 13 of £400 Debentures, part of a series of which particulars have already been filed.

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ELECTRICITY IN COLLIERIES.

Mr. Wood on Earthing v. Insulation.

LONDON DISCUSSION.

Before the Institution of Electrical Engineers, London, on Thursday, the 28th ult., Mr. W. Wellesley Wood, A.M.I.E.E., read his paper on "Earthed *v.* Insulated Neutrals in Colliery Installations," an abstract of which appeared in our last issue.

Mr. J. G. Wilson, in opening the discussion, remarked that the keynote of the paper was that each case should be considered on its own merits. There was, however, a tendency in the paper to lean towards an insulated neutral, or, at any rate, to avoid a general practice of earthing the neutral. The author's qualifications rather cut down the conclusions, because portable tools were generally supplied with electricity underground, and cables underground were as much as any liable to mechanical damage. He (the speaker) advocated the general practice of earthing the neutral, and, further, that, whether the supply to the pit was transformed down to the system or generated locally, all underground cables should be armoured, and the armouring should form a continuous electrical connection, both to earth and to the neutral point of the system. He questioned very much whether the damage from shocks was reduced by the insulated neutral. A more important matter than that of shocks was the danger from explosion by ignition of gas or coal dust underground. Now, assuming that the installation was a good one, and all the switchgear underground was of the modern enclosed type, there was still the possibility of the roof in the workings falling on to the cable. If the cable were thoroughly well armoured, it would stand a great deal, but if damage occurred to the insulation, it was of first importance that the supply should be cut off, and, he thought, that was the gist of the whole matter. The advantage of instantaneous cut-off of the supply was, in his opinion, conclusively in favour of earthing the neutral point of the system. Reliability of supply to a colliery was most important in the departments of winding and blowing, both of which were done at bank, and neither of which, if the supply were properly arranged, would be affected by the cutting-off by tripping of an automatic switch in circuit with the underground cables. Temporary cutting off of the supply underground from haulages, or even pumps, while exceedingly objectionable, should not be considered where it was a question of actual danger to the mine by explosion. Concerning flashing to the casing of switchgear, he thought it was really a question of design, the importance of which it was impossible to over-rate. He was in favour of earthing the neutral in all cases of three-phase supply to mines.

Mr. H. W. Clothier held that any system which allowed a damaged circuit to exist was unsatisfactory. After criticising some of the observations and figures shown by the author, he insisted on sound, metallic, continuous armouring throughout the system, and that they should earth the neutral point in order to obtain, or if only for the fact that they might obtain, thereby a better and safer system of automatic protection. He went on to explain that his remarks referred mainly to the low tension connections in mines.

Mr. W. H. Patchell considered that, wherever possible, the conductor should be metallic and thoroughly well earthed. If people spent less on little fancy contrivances and more money on skilled attention, they would not get so much trouble with installations. Much had been said with regard to faults due to falls of roofing, but it was very hard to instance a case where there had been a flash due to a fall in a mine. It certainly was something they must avoid, but what the risk was, it was almost impossible to say. They must look the earthing matter fairly in the face.

Mr. W. C. Mountain attributed 99% of the breakdowns to the system not being earthed. He did not think that protective gear was at all likely to promote the safety of the miner underground. To his mind, installations in collieries should be put up as strongly and as simply as possible. It was his firm belief that armouring should be used where possible. Everything of a metallic character, which contained electricity, such as the motor frame, switchgear, etc., should be as permanently and satisfactorily earthed as possible. In his 22 years' experience of colliery work, he did not know of a single case of an armoured cable being cut by a fall of roof. The whole danger and the scare which existed at the present time was absolutely unwarranted, if only they had men to look after the machinery properly.

Mr. J. F. C. Snell intimated that, after the very careful investigation which Mr. Patchell, himself, and a few others made on behalf of the Institution in connection with the new Coal Mines Regulation Act, he felt that it was imperative that the neutral of the three-phase system should be earthed. He did not think it would interfere in any way with the simplicity of the system. Coupling with it a complete system of armouring, they got a thoroughly good distribution system, and one which protected the employé from danger of shock, and, what was much more important, minimised the risk of explosion, either of gas or coal dust. The cables must be completely armoured, and he suggested that all the joints should be thoroughly bonded, and the frames of all fixed machines should be bonded to the armouring. Thus they would get a completely armoured and protected system. It would be a great mistake if armouring were not made compulsory. If a thoroughly armoured system were regarded as the standard system of distribution, it would go a long way towards meeting the adverse criticism now offered by managers of collieries regarding electricity in mines. If the first cost were greater, it would give a system immune from the dangers which occasionally arose. He thought it would do the industry a great deal of good and bring about a feeling of security among colliery people, and redound to the credit of electrical engineers.

Mr. E. B. Wedmore expressed himself in entire agreement with the views of the previous speaker. He favoured the use of continuous metallic covering, earthed at one or more points. If that were granted, there were good arguments for the use of leakage devices referred to.

Mr. H. M. Sayers declared himself to be on the side of the earth neutral. The scare about electricity in mines, he said, was the scare of the electrically ignorant man, who came up against something which he did not know had dangers, and got killed or badly hurt.

Mr. H. Brazil believed it was now generally recognised that earthing through a resistance was advisable.

Mr. C. H. Wordingham said he was brought up in the school of Mr. Ferranti, who was the pioneer of earthing, as in so many other things. He strongly endorsed what had been said by previous speakers as to the safety of earthing. He advocated direct earthing and not through resistances.

Mr. S. Z. de Ferranti said that he thought in the present case most emphatically it was desirable not only to thoroughly well earth the neutral point, but to substantially cover and enclose the rest of the parts carrying a potential high enough to do any damage. The great point was to do the work thoroughly.

Mr. S. Evershed (who presided) agreed with those who would earth the neutral and who would, at all events, endeavour to enclose effectively all parts in metallic sheath armouring, not only on the cables, but on the gear.

Mr. Wood (replying to the discussion) appreciated that if armouring could be relied upon to keep good, nothing could afford greater protection; but it could not always be depended upon in collieries. With an earthed neutral, they had to rely on one set of insulation to prevent trouble and danger, while with an insulated system there were two sets of insulation in series. He went on to observe that if a man was killed by a fall of roof, little comment was offered, but if the accident were attributed to an electrical cause, a great fuss ensued. Electricity was now very extensively used in collieries, and he maintained that 1% of the total deaths which were attributed to it, was pretty satisfactory. Still, they should try to reduce the number of accidents.

A vote of thanks to Mr. Wood concluded the proceedings.

NEWCASTLE-ON-TYNE DISCUSSION.

Professor Thornton thought that the reason that it was common practice in America to use delta and not star

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winding was because of cheapness and not to save life. He referred to the large oscillatory currents between generators earthed in parallel, and gave results of oscillograph tests showing a heavy cross-current due to difference of wave form unless excitations was the same in each machine in parallel. He referred to the subject of insulating strata, and thought that such strata must extend over the whole area of a coal field without any fault to obtain heavy potential differences due to leaks, but he marvelled that ordinary earth is such a good conductor underground. He thought low voltage metal filament lamps—say, 25 or 50 volts—were the best for underground lighting. With regard to earthing the neutral, in a case in which he had adjudicated, and in which the contractor objected to earthing, a compromise was made by putting a switch in the earth connection, closed only during tests, which were made several times a day. He thought it advisable to earth at every seam, and to arrange for as many earths as possible. It was well to note that fresh water was an insulator; it was only the salts in the earth which rendered conductivity of moist ground so good.

Mr. Holbrow asked whether or not there was a more severe flash or shock from an earthed than an unearthed neutral.

Mr. Turnbull suggested the use of rubber mats around electrically-driven machinery in mines.

Mr. Wilson thought that the point that with an insulated neutral the danger of shock was less required modification. Where the system was extended, or there were a large number of motors, it was practically certain that there would be sufficient leakage on one pole or the other to make it dangerous to touch the wires. The danger would be variable on different days, which was itself a disadvantage. As regards explosions, it would be more definite to discuss the question of earthing, or not earthing, if the subject were limited to cases where armoured cables were used. Where three-phase supply was given and armoured cables were used, there was a strong argument for earthing the neutral, as the most frequent cause of cable damage was the falling of a roof, and the first effect would probably be the bringing of a phase into contact with the armouring. If this were unearthed and there was a discontinuity of armouring, there was no certainty that a circuit breaker would operate, while in the alternative case the supply would be cut off instantaneously.

Mr. Clothier strongly advocated earthing the neutral. He thought a damaged circuit should be instantly cut out, so that one of the advantages claimed for not earthing was dangerous. Advantages of earthing were that one need not have a leakage detector which outweighed the saving on one trip coil mentioned in the paper. It saved earthing devices at other portions of the circuit. From the paper he took it that the author was in favour of earthing the neutral in large undertakings, such as large collieries operating their own generating plant. Earthing the neutral facilitated the use of 25 or 50 volt lamps, as these can be connected across autotransformers with a common terminal, whereas ordinary static transformers require earthing devices on their secondaries. He thought that for colliery work a sound metallic armouring from generator to load was the keynote of safety. He thought the diagram (Fig. 4) was misleading, as in order to show a protected system such as the Merz-Price, the armouring should be shown, and this also must be discontinuous to render the trip gear unoperative. Danger from a broken earth wire would be present in an unearthed-neutral system, as phase-leakages and currents through leakage detectors would be sufficient to give a shock. He agreed that earth-plates should be installed down a pit as well as at the surface.

Mr. F. O. Hunt said the severity of shock in an insulated system depended largely on its size due to capacity effect. The question of limitation of voltage for safety was not easily settled, as a friend of his had found that, under favourable conditions, it was impossible for men to release themselves from 30 volts circuits owing to muscular fixation, though there was much variation in this. He thought that the point made in the paper that, with an earthed neutral the failure of one phase to earth was practically certain to produce a flash was a very important one. With all automatic devices, their mechanical inertia would be sufficient to give a flash time to do damage. He thought that it would be possible (although not yet accomplished) to arrange leakage trips to operate on circuits with insulated neutrals. With reference to the increased stresses on insulation, he referred to M. B. Field's researches on condenser effects in cables, which showed that an efficient anchorage of potential to earth, similar to earthing through a fairly high resistance, was given. He described another method of indicating want of balance in phases to that of the Price arrangement, consisting of a transformer round the cable passing current to a trip coil when lack of balance occurred. He thought that a leakage indicator, if good, was valuable in showing that insulation was failing before the absolute breakdown occurred, which might involve a stop of work.

Mr. Vesey Brown thought that earthing was a very good fault-finding arrangement. If the installation were a bad one, the earth became a bad master. He personally always earthed wherever possible, but it was difficult to find a good earth. In one case, he earthed into a lake having a river running into and out of it, but a blue brick wall was sufficient to insulate the water of the lake from land inside the wall.

Mr. Porter said that the proposition that the resistance of the earth was equal to that of the conductor in one phase only held good when metallic sheathing of the cables was adopted. He thought with reference to the earthing of generators in parallel, that Mr. Rider's step-by-step switch was complicated. If only one machine is earthed, the whole of the shock of an earth is thrown upon that machine, the intensity of the shock depending on the position of the fault and the resistance of the earth return. To equalise this as much as possible, the earth plate should be at the centre of the system, the neutral point at the station being connected to this by a transformer system. Leakage trips were not suitable to be used in series with one another—a fault on a branch main might trip not only the device on the branch, but that on a main distributor. The shape of the earth-plate curves referred to in the paper was probably due to the area of cross-section of the conducting earth in the neighbourhood of the earth plates, which was restricted compared to the area at the middle of the distance between the plates.

Mr. Wood, in reply, said that earthing or not earthing the neutral had very little difference as to the intensity of the flash, but if in an insulated system two earths occur, the flash has a double chance of being a weak one, as one of the earths may only be partial. He thought putting an earth plate down the pit was preferable to using rubber mats. The paper had not championed either earthing or insulating the neutral, but had emphasised that the conditions were so varied, that each case had to be considered on its own merits. He thought that high tension cables should be armoured, probably in all cases. He thought with Mr. Wilson that danger from shock existed in an insulated-neutral system owing to leakage, but his claim was that there was less danger than with an earthed neutral. Mr. Hunt was correct as to the killing effect of capacity, but this capacity would have to be large. One was not legally compelled to put in leakage indicators on earthed-neutral system, but it was considered good practice to do so. Referring to Mr. Clothier's remarks, it was possible to have an interrupted armouring due to corrosion or carelessness. In such a case a leakage trip would not operate under the conditions shown diagrammatically in the figure, *i.e.*, of a motor in foundations with a broken earth wire. If the earth is good, there would be no shock, whether there was a leakage trip in circuit or not. It was simpler to rely on a good earth and good maintenance than on automatic devices. The danger of stress on insulation was not that of puncturing, but of creeping or flashing.

INSTITUTION OF ELECTRICAL ENGINEERS (Yorkshire Local Section).—At the annual general meeting of this section the following gentlemen were elected as officers for the ensuing session: *Chairman*—T. Harding Churton; *Vice-Chairman*—Wilson Hartnell; *Committee*—J. D. Bailie, Dr. R. Pohl, H. H. Wright, S. D. Schofield, W. B. Woodhouse, J. W. Hame, E. A. Barker, G. Wilkinson, A. J. Cridge, A. B. Mountain, W. Emmott, J. McFall Smyth.

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Electrical Progress at Home & Abroad.

A Review by our Special Correspondents.

TYNESIDE.

NEWCASTLE-ON-TYNE.

In order to inaugurate the opening of his large electrical engineering showrooms in the Cloth Market, Newcastle, Mr. J. Parmley Graham has been holding a week of "morning coffees" for all engineers who cared to call and inspect the large line of apparatus which he holds. The chief line which Mr. Graham is showing is a collection of Messrs. J. H. Holmes & Co.'s manufactures, and some of the switchgear, in particular, is of especial interest. A main switchboard illustrates various types of switches, fuses, ammeters, circuit breakers, etc., for general supply purposes, while there are switch panels for colliery work having automatic relay gear for motor starting and pump work, interlocked switch and fuse gear of the oil immersed type for three-phase work, and free-handle switchgear for three-phase work, provided with overload and no load features, intended for such purposes as the operation of squirrel cage motors on heavy starting torques. In addition, is a searchlight, operated by a dynamo driven from a Holmes motor, a haulage gear electrically operated, and a pumping plant. The showroom is lit by flame and enclosed arc lamps of the Davy type, while Venner signs figure both in the showroom and on the facia of the shop front. The latter is a very striking feature of the frontage and is the second of its type in the North of England. One of the features of this exhibition is that the apparatus is capable of actual operation in position, the wiring being carried out by means of Credenda conduits. The Western Electric telephones also deserve mention.

Turbine Installations in the North of England.

Some important work is now in progress in the north-eastern area in connection with the installation of exhaust and mixed-pressure steam turbines for electric generating plant, chiefly in connection with colliery work. An instance of this is to be found at the Thornleigh and Wingate Grange collieries of the Weardale Coal and Coke Co., Ltd., where two turbo-generator sets supplied by the British Thomson-Houston Co., Ltd., are being put down. Another example is in the installation of a further turbo-generating set at Middlesborough in connection with the waste heat generating plant attached to the works of Sir B. Samuelson & Co., Ltd., This addition is an indication of the satisfactory performance of the original installation. Yet another example is the equipment ordered by the owners of the North Walbottle Colliery of a turbo-generator set, the turbine being of the Rateau type and of British Westinghouse construction, driving a Brown-Boveri alternator of 250 kw. capacity.

A Unique Installation.

Perhaps one of the most unique of this type of installations is one which is shortly to be erected at the New Brancepeth Colliery of Messrs. Cochrane & Co. This colliery was originally operated on a 250 volt direct current system, but owing to extensions of power becoming necessary the system was adapted to a three-wire installation (probably the only three-wire colliery installation in Great Britain), and the larger motors operated at 500 volts across the outers. To give power to this supply, the British Westinghouse Co., Ltd., are supplying a 300 kw. mixed pressure turbine running at 3,000 r.p.m. and driving two generators in tandem on the 500 volt supply. A feature of these generators is the commutator, which is of the radial type. The commutator has a series of square grooves against the sides of which press carbon brushes, greatly increasing the contact surface in proportion to the length of commutator and eliminating the troubles found with cylindrical commutators running at high speed. In connection with this plant a Westinghouse-Leblanc condenser and a Blæsburg cooling tower are being installed.

Pole Line Work.

The work of extending the pole-line installations for colliery and other installations, chiefly in connection with the operations of the power-in-bulk supply companies operating in this area, is proceeding rapidly. The British Insulated and Helsby Cable Co., Ltd., are at present engaged in erecting a 6,000 volt pole-line from Benton to Seghill *viâ* Backworth and Holywell, together with another for the same pressure between Birtley and Harraton, while a very important supply to the West Stanley Colliery at 11,000 volts is shortly to be given. An interesting point in connection with this company's work is that they have joined the ranks of the metal filament lamp makers, and are now supplying in this area their "B.I." lamp, which is a tungsten lamp suitable for all voltages.

A Correction.

In my notes for last week I referred inadvertently to Messrs. Reyrolle's wall plug as being made for the purpose of complying with the Home Office requirements for colliery work. This should have referred to the Workshops and Factories Regulations, and although plugs of this type have been installed for surface work in collieries, their chief purpose has been in connection with general factory equipment.

THE MIDLANDS.

BIRMINGHAM.

At the meeting of the Birmingham Section of the Institution of Electrical Engineers last week, great interest was shown in Mr. G. W. Worrall's paper on "Commutation Phenomena and Magnetic Oscillations Occurring in Direct-Current Machines." The personal way in which Mr. Worrall had brought home many interesting points in his researches was referred to by the President (Mr. R. K. Morcom), who said that the intricacy of the subject was evident to anyone who had watched dynamos going through their tests and had seen the very empirical way in which many representatives of electrical firms set to work to try to cure the heating of brushes and sparking. He supposed they always took the temperature very close to the brushes. He did not know whether they did it at the positive brush, but after what Mr. Worrall had said, he expected that they would do so, unless inspecting engineers insisted upon having it taken near the negative.

Points for Designers.

In the course of his criticism of the technical points in the paper, Dr. Kloss suggested that it might be possible to eliminate the oscillations due to the teeth of the armature and so get more accurately the result of the oscillations due to the commutation only. He also suggested that there would be an advantage in using a four pole armature lap-wound instead of carrying out the experiments solely with a two pole machine. Again, Mr. Worrall had assumed the brush width to be equal to one segment including the insulation, but such a brush was not used in practical work, and he wished to know if Mr. Worrall had studied the subject from the point of view of what would happen with a brush covering more than one segment. He agreed with Mr. Worrall that satisfactory commutation did not depend so much upon the total surface of the brush available as upon the proper distribution of the resistance and the current densities. In fact, Mr. Worrall had improved not only the commutation, but also the whole performance of the machine by cutting down the actual contact surface of the brush. These and other results obtained by Mr. Worrall showed that restrictive figures such as it was customary to put into specifications, were inadvisable. The designer should be left to choose the figure which was compatible with the progress of manufacture and not be bound down to obsolete conditions.

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Temperature and Ventilation.

Following up Mr. Worrall's observations with regard to the manner in which contact was made uneven owing to expansion resulting from increased temperature in the brush, Dr. Kloss stated that Siemens had introduced a special ventilated commutator which had enabled them to put forward D.C. machines which gave perfect commutations and had proved a very great success. The commutator was ventilated by channels through the segments and these took away the heat not only from both ends but also from the middle. This principle had also been applied to high speed generators and other machines requiring very long commutators, the commutators for which were supplied in two halves. He had also found a great improvement effected in commutation by cutting slits in the way Mr. Worral had illustrated, with a view to the avoidance of sparking.

Self-Induction.

Self-induction in relation to resistance was discussed by Mr. G. J. Wall, who said that it was evident that as the self-induction or the apparent self-induction of the coil was diminished, the resistance was increased. In every good commutation high resistance was combined with low self-induction, and it would be interesting to find out whether it was possible to exclude sparking by altering the self-induction and the resistance. It seemed to him quite possible that by opening ducts to alter the resistance sparking might be excluded.

Reply.

Owing to the shortness of the time available for discussion, other members, who had given in their names as speakers, were asked to communicate their observations in writing. The President announced that communications had already been received from Professor G. Arnold (Karlsrubi), Professor E. W. Marchant (Liverpool), Professor D. Robertson (Bristol), Mr. H. G. Stephens (Leicester), and Mr. W. Armstead (Wolverhampton). The lecturer was also asked to give his reply in writing. Mr. Moffett mentioned a case in which he thought Mr. Worrall's paper threw some light. It was that of a heavy current machine, the brushes of which were a mixture of copper and carbon. It was found that the brushes ran quite satisfactorily on the positive pole, but that on the negative there was tremendous heating. The whole of the copper was actually carried away and the brushes were left simply showing a surface of carbon. That looked to him as if there were electrolytic action. Mr. Worrall, while reserving his full reply for a written communication, referred to one or two points. In reply to Dr. Kloss, he said that he had found it desirable to follow Professor Thompson's advice against having too many segments, as it was highly important in experiments of this character to avoid complication. He therefore had thought it advisable not to make use at the present stage of a multi-pole machine. He wished he could have had longer time for this work. It really took twelve months to arrive at proper research conditions, and he had only had six months in which to do the work, and as the money for the work had ceased he had to cease also.

Mining Switchgear.

Safety of mining machinery was discussed in various aspects at a meeting held on Saturday last in Birmingham, by the Warwickshire and South Staffordshire Branch of the Institution of Mining Electrical Engineers. The President, Mr. Arthur Hall, contributed some notes on "Mining Switchgear." He said that substantial make and design should be the first consideration in buying. "Cut" and cheap designs might turn out death-traps. Then, plant and gear otherwise suitable, might frequently be a source of trouble for lack of the appointment of a thoroughly competent mining electrical engineer. The switchgear too often received limited attention in a colliery. Such gear should be subjected to regular periodical inspection to see that the covers were properly fixed, the cable bushes maintained in an efficient condition, accumulation of dust inside the case prevented, and in switches of the oil type the oil maintained at the proper level. It was imperative to see that the framings of all switches and switchboards were efficiently earthed. Switchgear of the ironclad type should be totally enclosed, having no slots for handles, etc., or other openings, except, perhaps, in the case of large starting and regulating resistances where a considerable amount of heat was to be dissipated. Here it was only necessary to see that dust did not accumulate sufficiently to short circuit the installation between the resistance and the frame. It was impossible to exclude gas entirely and the box must be strong enough to resist internal pressure due to explosion, and the joints should have relatively wide metal-to-metal machined surfaces which would serve to cool the joints and so prevent ignition of the gas outside. These heavy boxes were unnecessary in non-fiery mines, though in all cases the joints should be sufficiently close to prevent dust from entering in any quantity. Handles should not operate through a slot in the cover, but by means of a spindle passing through a boss in the case of controllers of the A.C. type throughout the magnetic blow-outs, or in that of switchgears without quick breaks or other means of extinguishing the arc, the switches should be immersed in oil. The immersion of switches and controllers in oil, provided the oil level was maintained, was a good means of ensuring against ignition of gases. It was also serviceable in keeping the contacts of switchgear clean and free from dust and in maintaining good insulation. Starting resistances could also with advantage be immersed in oil together with their switches. This made the apparatus compact and comparatively cheap, since the heat absorbing capacity of the oil admitted of the resistance material being reduced. In non-fiery mines, liquid starters when kept in good order and furnished with properly designed short circuiting contact, gave very good results, and enabled a very even acceleration of the motor to be obtained. They required, however, a good deal of attention to prevent damage arising through unexpected temperatures. Mr. Hall mentioned a case in which a haulage motor and its starting and controlling gear worked inefficiently, and the user proposed to put in a larger, but on following the advice to replace the liquid controller by an oil type controller with metallic resistance, all trouble in starting and controlling disappeared, and the motor was found to be of ample capacity.

Standardisation of Switchboards.

In the discussion which followed, stress was laid by Mr. Handley and others upon the importance of standardisation in colliery switchboards, and upon the desirability of strength in any apparatus subjected to the usage customary in collieries. To make it electrically efficient, Mr. Handley said, was a very much easier matter if they had something mechanically strong to start with. He suggested that the institution should endeavour to formulate a standard for switchgear which would embody all the good points of the various gears now in use, and which should satisfy commercial requirements as to price. Too often manufacturers introduced special points, the utility of which was not apparent. A very important thing also to his mind was the standardisation of fuses. Too often the fuse wire was fitted in such a way that it was absolutely no protection. Fuses for different capacities should have different centres, and then they would not have a fuse of 100 amperes put into a 50 ampere fuse box. Mr. Handley promised a paper on the subject from the manufacturer's point of view, and his offer was readily accepted. The inconvenient arrangement of switch boxes, which led to the cables being bent into all sorts of shapes in order to be got in and caused them often to make dangerous contact with bolts, was dwelt upon by Mr. Power, who said that the man who put the cables in was on this account often wrongly blamed for jerry-work. The President concurred as to the importance of standardisation of fuses.

Earthing Coal-Cutters.

An interesting series of tests with regard to the earthing of coal-cutters was reported on by Mr. J. R. English (Walsall Wood). The tests had not been completed, but as far as they had gone, Mr. English thought they showed clearly that under normal conditions of working, when the insulation was good everywhere else, no serious shock would be received from a coal-cutter working at 440 volts D.C., if its insulation should break down. Another test showed the machine itself made a very good earth connection, and with a fairly good conductor for the leakage

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current, the total resistance between positive and negative lines through the frame and 300 yards of earth being only 22 ohms. No doubt a very unpleasant shock would be received by any person touching the machine under those conditions, but he scarcely thought it could be fatal unless to a person with a weak heart.

SCOTLAND.

GLASGOW.

Signs of reviving trade all over the Clyde increase and become more tangible every week. We hear of one shipbuilding firm with 14 berths all occupied, and other orders on hand. The Glasgow Labour Exchange, placing 700 men per week in employment, hopes soon to increase this number to 1,000 per week for the summer months. In this respect it is said to stand at the head of such concerns in this country. So far as electrical contracting work is concerned, however, the flowing tide of trade has not yet shown any appreciable effect. In Glasgow most of the principal contractors still complain bitterly of dearth of house-wiring work, and although the May terms (which is the time of house-removals in Scotland) will no doubt bring a number of small jobs, it is unlikely that much will be done now till the autumn. In connection with ship work there is a very great deal of work in hands and in prospect. The Fairfield Shipbuilding Co., Messrs. John Brown & Co., and Messrs. Wm. Beardmore & Co., are all busied with admiralty work. Messrs. Brown and the Fairfield Co. have got two battleships to build for the Australian Commonwealth. The cable contract on one of these boats alone runs to some £6,000. In connection with the recently launched *Collosses*, it was Callender's cable which was used throughout.

Burgh Extensions.

The Town Council of Motherwell have just completed arrangements for installing one 1,000 kw. exhaust steam turbine, to drive D.C. dynamos. It has not yet been definitely decided where the order is to go, but the present indications are that a well-known English firm will get it, and the generating plant is also likely to be of English make. The extension includes two miles of 1 sq. in. triple concentric cable by Messrs. Callender. The demand of Messrs. Hirst, Nelson & Co., wagon builders, Motherwell, is likely to be sufficient to keep this cable fully loaded.

After much cogitation, the Falkirk Town Council have now decided on a considerable extension to their plant and mains. For some time it looked as if the Scottish Central Co. were to step in here, but the negotiations have fallen through for some reason, and the Town Council are to put down fresh plant of their own to the specifications of their own engineer, Mr. McMillan.

The Alloa Town Council have also been turning their attention for some time to the further development of their undertaking, and on the advice of a Glasgow consultant, they are to transfer their generating plant from the old station to the gas works, where it will be under the immediate control of the gas manager. It is hoped that the changes now being effected will be instrumental in considerably increasing both the lighting and power loads.

A Coast Town Installation.

An interesting little development is that which is taking place at Skelmorlie, a small residential town on the west coast of Scotland. The station was first put down for the supply of energy for light, power, and medical purposes to the local hydropathic owned by Dr. Philp. Some time ago, however, a few of the neighbouring residenters asked for and obtained a supply for their houses. The number of these applicants increased until some 12 fairly large houses were lit, equivalent to a demand of over 1,200 lamps of 8 c.p. The plant in the station consists of two Crossley gas engines of 90 and 50 h.p. respectively, and one National gas engine of 100 h.p. These drive by belt on to direct current generators for three-wire supply at 460 volts across the outers. A balancer is provided for balancing the three-wire supply, and a booster for cell charging. Provision is made for a storage battery to be put down later. The present load is being supplied by Crossley gas producers, but Farrenham impr[illegible]as producers will be used instead of these in the near future; in fact, they are now being erected. The Farrenham producer is adapted for use with bituminous coal, thus considerably reducing the cost of running. Dr. Philp and Mr. Farrenham have now obtained Parliamentary powers to supply the neighbourhood, and they have already entered into an arrangement with the local County Council to light the roads. Some parts of these have been lit for fully 12 months, and it is expected that the remainder will be lit so soon as the necessary cable is laid. Messrs. Callender's Cable & Construction Co. have entered into a contract with Messrs. Philp and Farrenham to supply and lay all the cable in connection with the job. It is expected that the price for supplying and laying the cable will ultimately run to a total of some £6,000.

Corporation Contracts.

The Electricity Department of the Glasgow Corporation have now fixed up their annual contracts for supplies of cables, meters and other stores. The only item which remains to be dealt with is the extra high tension cable. The following are among the offers which have been accepted: Low tension cables and flexibles—Callender's Cable & Construction Co., Ltd; rubber covered cables—Craigpark Electric Cable Co.; meters—Chamberlain & Hookham, Ferranti, Ltd., British Thomson-Houston Co.; carbons—Sloan Electrical Co., Ltd.

Wiring Rules and Regulations.

A new edition of the Terms and Conditions of Supply and General Rules for the Prevention of Fire and other risks in connection with the supply of electrical energy, referred to in the last issue, is, in several respects, an improvement on its predecessors. All the conditions relating to any one thing are put under one clause or main heading, instead of being referred to in several clauses under different headings, and the very complete index on the last two pages greatly facilitates reference to any particular regulation. The stipulations embodied in the new Home Office Regulations, and the conditions to be complied with as regards the Factory Acts, so far as these refer to power supplies of electrical energy, are covered, which brings the new issue thoroughly up-to-date. The following alterations and additions are worth noting: Under the heading "Flexible Cord Conductors," there is this additional clause: "The insulating material used as the dielectric should be either pure and vulcanised rubber of the best quality, of the same standard as that specified in Clause 32, or pure rubber of best quality. Dielectrics composed of vulcanised rubber only are not recommended, and will only be allowed if a layer of cotton or similar material is placed between the conductors and the rubber." Under "Main Fuses," the following has been added: "Main fuses are to be fixed on the supply side of the main switch, and in order to comply with Home Office requirements they must be so constructed that they can be replaced without danger; preferably they should be of the replacement type, with a bridge carrying the fuse metal in the form of a handle, which can be withdrawn wholly from the terminal contacts while replacements are being made."

GERMANY.

BERLIN.

Dr. Guggenheim, of Zurich, has issued a long report on researches on alloys of iron with silicon, and with silicon and nickel. Some of the main points are as follow:—The usual assertion that silicon lowers the permeability while nickel increases, is true only for very high inductions. With ordinary inductions the permeability increases. with the percentage of silicon in the alloy, and the amount of nickel present is of small importance. Aysteresis losses increase with increased quantities of silicon up to 1·8% of the alloy. On still further increasing the percentage of silicon, they diminish. first quickly and then slowly, and with 4·5% of silicon they are very small. They are inversely proportional to the permeability of the iron. In all cases the silicon must be kept below 5%, or the iron becomes too brittle to be of any service.

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Air Ozonisation.

It has been found that ozonised air, which can, of course, be prepared by electrical means only, is of great importance at large public baths and wash-houses. It affords a means of disinfecting the air, constantly being filled with particles of dust and spray from dirty water, besides other impurities, in a manner as yet unequalled for efficiency and cheapness of execution. Large scale experiments at the big establishments at Heidelberg have led to nothing but results that are satisfactory in every way. It must be remembered that draughts must be avoided in bathing establishments, and in many cases it is difficult to get proper ventilation without draughts, and as the outer air must be introduced in large quantities, the maintenance of temperature is a great expense. The ozoniser in use at Heidelberg is worked by an alternating current, and the air of a room of 3,600 cubic metres can be kept permanently ozonised by an expenditure of about 0·2 kw. per hour, at a cost of 4 pfennig, or rather less than ½d. per hour.

Electric Cookers or Heaters.

It is high time that the requisites for this class of apparatus were known to the public, as much misapprehension exists on the subject, of which makers of unreliable apparatus are only too prompt to take advantage. The matter has recently been taken in hand seriously both here and in Switzerland, and the conclusions arrived at worthy of all acceptation, and ought to be carefully borne in mind by all users of apparatus which generate heat by offering resistance to the passage of a current of electricity, whether the heat is required for cooking or simply for warming purposes. The resistance coils must be simple in construction, and easily taken out and easily repaired. The surroundings of the coils must insulate them, and at the same time allow a ready escape of variations of current which are specially liable to occur with these appliances, and also proof against oxidation by the air. If the surface becomes tarnished, the insulating material is damaged, and the heat developed has much difficulty in escaping for use. The whole heater should be constructed so as to resist the entrance of even moist air, to say nothing of water. Few appliances combine all these requisites, but, nevertheless, electric foot warmers are coming into use here in Berlin, and on Alpine railways.

Electric Blast Furnaces.

Experiments on a large scale have conclusively demonstrated that where fuel is expensive, and water power abundant and cheap, pig-iron can be made from the ore in the electric furnace on an economic basis. It is interesting to note that the blast furnace has held its own later than most of the other kinds of plant used in the iron manufacturing trade, although it is the oldest of the types now existing in civilised countries. A few figures as regards the relative cost of working ordinary and electric blast furnaces will be of interest. We may, however, say here that the electric blast furnace is not a gigantic structure 80 or 100 ft. high, so that to begin with there is a saving in the erection of the furnace. The average consumption of coke in an ordinary blast furnace is ton per ton of the pig-iron obtained. The cost for coke in Germany is about 15 marks per ton of pig. In the electric furnace coke is wanted at the rate of 3 tons only per 10 tons of pig, while the electric cost is measured by about 20,000 kw. hours. Thus we have 4½ marks for coke, and if the process is to pay, the power must cost less than 10 marks per ton. Hence the electric blast furnace must be driven by water power, whereby, however, a cost considerably less than 10 marks per ton is incurred. It must also be remembered that an enormous advantage is secured by dispensing with the blast. At the same time, however, the water gases from the electric furnace cannot be utilised to anything like the same extent as those from the ordinary blast furnace. In Sweden, where Grönwall, Lindblad & Stalhane's process is, there is a saving of 16% on the cost of producing the pig.

Cheapening Metallic Filament Lamps.

We in Berlin have taken fright at the cheapening of metallic filament lamps, especially those of the more recent kinds, which has lately been advertised so largely. This cheapening seems to depend mainly on supplying lamps of inferior quality. A writer in the *Elektrotechnische Zeitschrift* (April 14, 1910, p. 375) states openly that he knows an installation bureau of the A. E. G. which offers metallic filament lamps now at prices below two marks, without regard to the size of the order, but just to gain customers. That one should be distrustful of the quality of the lamps under such conditions is easily understandable. A good metallic filament lamp is not an article for warehousing, and quality must be preferred, even at a reasonable extra cost.

Automatic Telephony.

We Germans seem to be in too great a hurry in this matter. Friends in Munich are loud in their complaints. They say that they are greatly hampered in talking to us here in Berlin. They could do it quicker if they could catch hold of the receiver in the good old way. It may seem strange to talk about the common or garden telephone as an old-fashioned instrument, but at the same time, the automatic devices do not yet quite seem to be able to entirely replace the human hands.

Company Notices.

The Deutsche Atlantische Telegraphengesellschaft, of Cologne, made a net profit of 445,421 marks for the last financial year, as against 424,072 for the year preceding. The dividend is 7%, as for last year.

The net profit of the Deutsche Kabelwerke A.G. Berlin-Rummelsburg rose from 402,158 marks in 1908–9 to 474,244 marks in 1909–10, so that the dividend has been increased from 6 to 7%.

UNITED STATES.

NEW YORK.

Probably no phase of electrical development has been more marked in this country than that of the electrically-driven automobile. The great progress of this industry has been the subject of frequent comment in these Notes for some months past, but some figures which have just been issued give fresh point to the criticism, often previously made, that in this, as in so many other directions, cities like New York and Chicago are far ahead of London, Paris or Berlin. Both for pleasure and for business the electric vehicle is gradually superseding the gasoline (petrol) driven car, and wherever it has once been used, the other type has been promptly discarded. The old complaints that the electric automobile was uncertain in its action, expensive in upkeep and tiresome to charge, have all ceased under the influence of modern developments. New types of accumulators have been evolved, central stations have especially equipped themselves for the accommodation of the electric vehicle, aud manufacturers have been quick to seize upon every possible improvement, with the result that at the present moment the electric car is making extraordinary progress in public favour. There are nearly 7,000 of these cars in use for pleasure purposes in New York, as compared with as many hundred a few years ago, and upwards of 3,000 are in use in Chicago, where not long since this type of vehicle was regarded as an extraordinary novelty.

The Central Station's Opportunity.

The extent to which the electric automobile and the electric wagon have grown in popular favour can be gauged to some extent by a glance at the advertisements in the daily newspapers, and still more, perhaps, by the announcements in the electrical journals. Here is a typical advertisement addressed to the Central Station manager: "There will be 10,000 electric vehicles sold this year. The electrical energy required annually for these new cars alone will be over 67,000,000 kw.h. How much of this are you going to furnish? The Electric Vehicle offers the Central Station a big opportunity for increased business. Just think—an "Electric" consumes annually from 2,000 to 11,500 kw.h.—as much as 10 arc lamps or 450 incandescent lamps. The present perfected types of Electric Vehicles, both pleasure and commercial cars, have made wonderful strides in popularity. The sales of "Electrics" for 1910 alone promise to exceed many times the sales

of any previous year. The public now realizes the many advantages of the Electric Vehicle. The electric pleasure car is best adapted to meet the requirements of an automobile for city and suburban use. It is unquestionably the car for the busy business man, for ladies' or even children's use. It is easily operated, the height of simplicity, absolutely safe in every way, clean and convenient. In the commercial field, electric wagons and trucks have conclusively demonstrated their superiority over horse-drawn vehicles. The electric truck carries greater loads, at greater speed, is more durable, more dependable, and more economical than the horse and wagon." This is extracted from the page advertisement of The Electric Storage Battery Company, of Philadelphia, which finds it pays to spend the equivalent of £100 a week in pushing its specialized business.

The Commercial Electric.

The General Vehicle Company, of Long Island City, is among the numerous firms addressing themselves particularly to the manufacture of electric wagons. They point out in their announcement (and support the statement in a booklet full of proved facts) that the electric commercial vehicle of to-day is 30% cheaper to operate, and travels 30% faster and farther than the earlier type. " As much relative improvement," they point out, " has been made in storage batteries and vehicle efficiency as has marked the development of all other motor cars. Don't overlook the significance of this fact to the central station and its customers. Under all but extraordinary and unusual service conditions the electric commercial vehicles manufactured by this company *can be demonstrated* to be *cheaper to operate*, year in and year out, than any other known vehicle for the trackless transportation of merchandise. The signal advantages of the electric in simplicity and ease of operation, reliability, durability, flexibility of control, silence, cleanliness, absence of all danger from fire, are obtained *in addition* to *economy*—not at any sacrifice of economy either in cost of operation or maintenance. And this emphatic statement we are prepared to reinforce with a service and maintenance guarantee." These advertisements are typical of many, and are only cited to indicate the wonderful strides which have been made in this particular industry in the past few years. Of this progress I have been able to observe no indication whatever in the technical journals of England, or even of Germany. Why this should be so is a problem which English manufacturers might be asked to solve.

New Insulation System.

A new system of insulation for high potential electric conductors, which is claimed to be a new departure in the development of insulator systems, has recently been patented by Mr. L. Steinberger, of Brooklyn, and is described in the technical journals of the current week. The insulators are a combination of thimble-type and rod-type insulators, the former being alternated with the latter so as to form a flexible chain capable of indefinite extension. The under surface of the thimble-type insulators will remain at all times comparatively dry; each thimble-type insulator acts like an umbrella, covering the upper end of the rod-type insulator below it, and connected therewith, thereby keeping it dry under the most unfavourable conditions (as, for instance, when all of the insulators are subjected to the action of a driving rain), hence the group of insulators must always afford adequate insulation for all practical purposes. The insulator will practically prevent leakage and undesirable grounding of the circuit either from conductors or from supporting structures for the same. The various parts of the insulator may be detached and replaced by other parts, and the total number of parts may be increased or diminished at will after the original structure is built, this feature being especially important in instances where, after the installation of a conductor, the voltage is to be increased. The voltage may be increased to any desired extent, the various mechanical parts which are employed being of comparatively small size, light weight and low cost. An important feature is the flexibility of the chain of units; the structure as a whole, when in operation, is under spring tension, thereby insuring more or less resiliency, so that the complete structure is relieved in all of its parts, as well as in its entirety, from the effects of sudden and abrupt accidental strains.

$55,000,000 for Brooklyn Monorail.

In connection with the Brooklyn mono-rail project, to which reference has already been made in these Notes, it is announced that Mr. G. G. Schroeder, of Washington (District of Columbia), has incorporated the International Elevated Railroad Company with a capital of $50,000,000, and the Universal Motor Company with a capital of $5,000,000. The object of these incorporations is the construction of a mono-rail line through the city of Brooklyn. The road is to be an elevated single rail, and the type of car is known as the " saddlebag " construction. The car is much the same as that designed by F. B. Behr, of England, who exhibited at the Brussels Exposition a three-mile line which was successfully operated. It will be remembered that Mr. Behr had a model in operation at the St. Louis Exposition, and that he spent many months in New York endeavouring to obtain a franchise from the old Rapid Transit Board for a line from Atlantic Ferry to Coney Island. He was unsuccessful because the members of the board were neither convinced of the success of the plan nor that he would be able to finance it to the point of operation.

Treating Sulphated Storage Cells.

An ingenious method of restoring sulphated storage cells is expounded by Mr. J. O. Hamilton, of the Kansas State Agricultural College, in a communication to the *Electrical World* of this city. He points out that in the ordinary course of events, the hard, white sulphate having once formed at the positive plate, can be removed only at the expense of much time and energy, and describes the following method, which has been used with success at Kansas State College. When a cell is brought to the laboratory for treatment, the operator first examines the contacts of the cell, as the formation of an oxide covering the lugs and binding posts is often found to be the real seat of trouble in a defective cell; all nuts, washers and binding posts are removed and given a thorough cleaning, scraping or filing to be sure of metallic contact. The cell is charged until gassing starts, after which it is discharged at the usual rate to 1·8 volts, and again charged to its rated amp-hours, observing the current and time of charge, and is finally discharged, observing the amp-hours output and calculating the efficiency. Under these conditions, if the acid is of nearly usual strength, the plates, having been previously examined to be sure that no short-circuits exist, and if the efficiency falls to 50, 40, 30%, or lower, the cell may be taken as one slightly or badly sulphated, as the efficiency test may show. In treating the sulphated cell, the acid solution is siphoned off in the case of a large cell, or poured off in the case of a small one that can be easily handled, and the plates thoroughly rinsed or soaked in distilled water, or rain water, which is again drained off. A solution of caustic soda (NaOH) of a strength running from 2 to 5% by weight is poured into the cell, using enough to cover the plates and the battery put on charge, charging in the usual direction and at the same rate. If at any time the solution gives an acid reaction on litmus paper, and the sulphate at the positive plate has not disappeared, add caustic to the solution until a positive alkaline reaction is given, and continue the charge until the plate has the usual chocolate appearance. Draw off the solution, rinse the plates, pour back the sulphuric acid solution, and continue the charge until gassing starts or until the drop shows that the cell is fully charged. If one is certain that the cell is sulphated, start at once with the caustic treatment. The preliminary steps were given only that the user might test for himself the efficiency of the method by testing the capacity of cell before and after the treatment.

Electric Signal Economy.

The substitution of electricity for oil in the signal lamps of the Baltimore and Ohio Railroad has effected a marked saving in expenditure. Mr. Patenall, the signal engineer, in his report on the change, states that on the Washington branch, between Baltimore and Washington, 69 electric lamps were lighted and extinguished 1,259,250 times,

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while on the Metropolitan branch, between Washington and Germantown, Md., 38 electric lamps were lighted and extinguished 208,050 times. During this period there were but nine failures, four being caused by lightning and five by filaments burning out. When burning the lamps consumed approximately ½ amp. of current, and on the Washington branch, where 50 trains are running in each direction daily, each lamp burns 1 hour and 40 minutes each 24 hours, the lamps lighting upon the approach of trains both day and night. The entire expense of maintaining the 107 signals during the year, including labour, was $10,786. It is interesting to note that 32·4 lb. of blue vitriol were used per signal per month. The current for lighting the lamps was obtained from the same source as that for operating the signalling motor, namely, six cells of storage battery charged by 18 cells of gravity battery for each pair of signals. At interlocking plants, where frequently four signals are operated from the battery, seven cells of storage battery are used, charged by 21 cells of gravity battery. In conclusion, it is reported that the system not only operated more satisfactorily than the oil system, but with higher economy, the wages of five lamp men, equivalent to $225 a month, having been saved since the system was put in operation.

"Agent Defies Death."

Under this thrilling caption, the New York newspapers print a remarkable report from Bridgeport, Connecticut. A coroner's jury had brought a verdict of criminal negligence against the Metallic Cartridge Company in a case in which a servant of the company was alleged to have been killed by a live wire carrying a current of 450 volts. In the presence of the coroner and jury, G. S. Lawler, representing a factory insurance company, successfully withstood a shock of electricity from the same live wire, which had been alleged to have brought instant death to the employee. It was Lawler's purpose to demonstrate that the current was not dangerous, and that the employee's death must have been due to some physical defect. When the current passed through Lawler he stiffened out for a second, but managed to keep a smile on his face.

New Transmission Circuit.

The 44,000 volt steel-tower aluminium transmission line of the Sanitary District of Chicago from the hydro-electric generating station at Lockport, Ill., to the Western Avenue terminal station, Chicago, is being augmented by the addition of a third three-phase circuit of aluminium stranded conductors, equivalent to No. 3 copper. This additional transmission capacity, says the *Electrical World*, follows the completion of the full generating capacity of the station. 24,000 kw., all six of the 4,000 kw. machines being now in place. The original design called for a duplication of the existing 60-ft. steel-tower pole line, with two circuits to each line of towers, but this plan has since been modified, rendering three circuits available by hanging suspension-type insulators from the lower cross-arm, and replacing the present ground wire carried at the pole tops by an additional transmission cable. As first installed, a stranded steel ground cable was carried from pole to pole on saddles at the apex of each. The upper 12-ft. steel cross-arm carried the upper wires of each circuit, an 18-ft. arm below supporting the lower four. By an ingenious arrangement this construction has been modified for the accommodation of three circuits. Insulators will be installed on the pole peaks for the top wire of the top circuit, which is completed by the pair of wires on the upper cross-arm. By hanging suspension-type insulators on the lower arm, one on each side midway between each of the present pairs of insulators, two additional circuits become available. A pair of ground wires will be installed outside and above the three circuits, as the efficacy of this device, or at least its preventive value in many instances, is still firmly believed in by the Sanitary District's engineers. The present work of adding a third circuit on the steel poles has been going on while the 44,000-volt lines are live, and has involved some interesting methods devised by the local construction staff.

Power Developments.

The Southern California Edison Power Company is planning to construct an immense power plant at Slide Lake, on Bear Creek. It is estimated that the expense in connection with this new plant will reach $600,000. The plant will supply electric energy for the entire San Bernardino valley, thus relieving the demands upon the big plants on Kern River. The company proposes to divert its water supply for the new power plant from Filaree Flats, where the New Bear Valley Mutual Water Company plans to impound the water. The Salt Lake City Light and Railway Company's electrical construction department has begun the erection of 43 towers between Devil's Gate and the main transmission line between Ogden and Salt Lake, 4·1 miles. These towers are being located 600 ft. apart, to carry the high voltage lines transmitting 4,000 h.p., as well as telephone wires. The towers were made by Milliken & Company, of New York, and the value of the improvement is put at $20,500. The new power plant going up at Devil's Gate will supply the power, the entire plant to be ready early in May. The Washington Power Company will probably spend $1,000,000 in the development of a 40,000 h.p. plant at the Spokane Falls of the Spokane River. The company has two plans under consideration, one of them calling for the sinking of a shaft from the crest of the upper falls to bedrock in the river, a depth of 135 ft., and connecting with a tunnel to the Post-street plant. The second plan is to construct a pipe line from the upper falls to the converting plant and erect a dam at the beginning of the falls. Both projects will drain the stream for a distance of five blocks in the heart of the business district. The Escanaba Traction Company's plans for a dam on the Escanaba River are progressing rapidly, and it is expected that the construction work will be under way by June 1. The dam will be located at Groos, near the Bichler quarry, and it will have a 30-ft. head of water. This will be sufficient to develop 2,000 h.p. —nearly double the power developed at the Flat Rock dam, from which the company is now getting its current.

Drawn Tungsten Wire.

The *Journal of Electricity* of San Francisco, observes editorially: "The announcement that it is now possible to produce ductile metallic tungsten in the electric furnace means much for the tungsten lamp, which has heretofore been hampered by its filament fragility. Under present methods of manufacture tungsten particles have been welded into a continuous filament by passing an electric current through a binding material containing the metallic particles and driven off by the high heat. By this new method the metallic tungsten can be drawn into fine wire much stronger and more rugged than the sintered filament. It is expected that the incandescent lamp made with these new filaments will not only have a longer life, but also be even more efficient than the present tungsten lamps." An account of the new process was transmitted to the ELECTRICAL ENGINEER some five weeks ago.

DIARY.

MONDAY, MAY 9.

INSTITUTION OF MECHANICAL ENGINEERS (Graduates' Association).—At 8 p.m., "Some Notes on Materials under Combined Stresses," by Mr. Ernest W. Moss.

TUESDAY, MAY 10.

NATIONAL ELECTRICAL MANUFACTURERS' ASSOCIATION (Incorporated).—Committee meeting at 8.30 p.m. in the Association's Offices.

JUNIOR INSTITUTION OF ENGINEERS.—At 7.30 p.m., at the Royal United Service Institution, Whitehall, Mr. J. M. Newton, B.Sc., on "High-speed Steam Turbine Rotor Design and Construction."

WEDNESDAY, MAY 11.

JUNIOR INSTITUTION OF ENGINEERS.—At 7 30 p.m., at the Royal United Service Institution, Whitehall, paper on "Notes on the Running of an Electricity Works," by Mr. Lauret N. Jockel.

THURSDAY, MAY 12.

INSTITUTION OF ELECTRICAL ENGINEERS.—Ordinary General Meeting at the Royal Society of Arts, John-street, Adelphi, W.C., at 8 p.m., "Street Lighting by Modern Electric Lamps," by Mr. H. T. Harrison.

FRIDAY, MAY 13.

ROYAL INSTITUTION OF GREAT BRITAIN, Albemarle-street, W. —At 9 p.m., Professor W. H. Bragg, F.R.S., on "Radioactivity as a Kinetic Theory of a Fourth State of Matter."

WEDNESDAY, MAY 25.

INSTITUTION OF ELECTRICAL ENGINEERS (Birmingham Local Section).—Annual general meeting at the University, Bournbrook, when a paper, "Standardisation of Fuses," by H. W. Kefford, will be read.

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Business Notes and News.

LIGHTING AND GENERAL—Home.

BRIDLINGTON.—The profit on the Council's electricity undertaking is £437 on the past year's trading, although £92 was spent on new offices, stores and workshops, and £169 on meters, out of revenue. The Council have decided to push forward the improvements at works, which will involve an expenditure of £3,000, in spite of a warning from the Local Government Board that if they did so, and the Board for any reason declined to sanction the loan of £3,000, they would have to defray the amounts involved out of revenue.

BURTON-ON-TRENT.—Mr. P. J. Pringle, the Borough Electrical Engineer, is to be congratulated on the result of the past year's trading. The result shows a surplus of £1,473, to which should rightly be added a sum of £190 rebate on income tax. This surplus is to be disposed of by placing £165 to capital cost of meters, £128 to stock meters, £23 to capital cost of instruments at power station, and £1,155 (plus the £190 of returned income tax) to renewals fund, which now stands at £4,440, or 5·3% of the total capital cost. There has been a marked reduction in the cost of fuel. In fact now, thanks to good management, practically only "smudge" is burnt. The total cost of production per unit is now down to the excellent figure of 0·918d. The gross profits amount to 7·92% on capital outlay, as against 7·1d. of last year. As regards revenue, it is to be noted that the lighting has produced less than it did seven years ago, in spite of the increase of connections from 23,703 to 34,829. This is, of course, partly due to the better efficiency of lamps, and partly to the reduction in charges. On the other hand, the increased revenue from motor units amounts to £2,162, in spite of the low mean price of 0·953d. per unit. The "restricted hour supply" for motors seems to have answered well. The percentages of total h.p. and units sold on this system amount to 80 and 79 respectively.

CHELTENHAM.—At a Local Government Board inquiry into an application for sanction to borrow £4,000 for purposes of the electrical undertaking, the inspector reduced the amount for meters—£1,000—to half.

DERBY.—The Midland Railway Co. have decided to extend their electrical generating station at Derby, and have placed an order for two 1,250 kw. Willans "Impulse Disc and Drum" type turbines with Messrs. Willans & Robinson, Ltd., of Rugby.

GLOUCESTER.—The Engineer reported that special terms had been arranged for supplying electricity to Messrs. Priday, Metford & Co., Ltd., and the Gloucester Ice Co., Ltd. It was recommended that the agreements be approved. After considering a letter from the manager of the local branch of Electric Theatres (1908), Ltd., the Council were recommended to approve a special form of agreement with him for supplying electricity to the Theatre de Luxe, Northgate-street.

HEBEN BRIDGE.—The Council have adopted the following scale of reductions as from March 31:—Lighting—2½% on all accounts of 5s. and over (if not otherwise discounted) if paid within one month of demand; 5% for accounts on consumption of over 150 units and under 300 per quarter; 7½% for accounts on consumption of over 300 and under 500 per quarter; 10% for accounts on consumption of over 500 units and under 1,000 per quarter; 15% for accounts on consumption of over 1,000 units per quarter. Power—2½% on all accounts of 5s. and over (if not otherwise discounted) if paid within one month of demand; 5% for over 400 units and under 800 per quarter; 10% for over 800 and under 1,200; 15% for over 1,200 and under 1,600; 20% for over 1,600 and under 2,000; 25% for over 2,000 units per quarter.

LLANELLY.—The Llanelly and District Electric Light and Traction Co. have commenced to erect the generating station, and the work is to be pushed forward with all haste.

LONDON.—The County Council have conditionally sanctioned the laying down of mains in the following streets: Kensington and Knightsbridge Electric Lighting Co., in Thurloe-mews; Notting-hill Electric Lighting Co., in Peel-street, Peel-passage and Capden-street; South Metropolitan Electric Light & Power Co., in Xenner-road; Westminster Electric Supply Corporation, in Grosvenor-road; St. Pancras Metropolitan Borough, in South Villas. The following bodies have given notice of their intention to lay mains, but for which the sanction of the County Council is not necessary: Battersea Metropolitan Borough Council, in Kyrle-road; Battersea Metropolitan Borough Council, in Ethelburga-street; Hampstead Metropolitan Borough Council, in Greville-road, Mortimer-road, Mortimer-crescent, Bolton-road, Holtham-road, St. George's-road, Priory-road, Abbotts-road, West End-lane, Birchington-road, Acol-road, Abbey-road, Kilburn-priory, Wavel-mews, Goldsmith-place, Bell-terrace, Springfield-gardens, Manchester-mews, and Mutrix-road; Stepney Metropolitan Borough Council, in Shepherd-street and Great Hermitage-street; and in Juniper-street.

PENDLEBURY.—A contract for electrical power and lighting supply has been concluded between the Acme Mill Spinning Co., at Pendlebury, and the Lancashire Electric Power Co. The contract began on May 1, and includes a portion of the Albion Mill, which adjoins the Acme. It is for a long term of years. The Acme is one of the few large spinning mills in England without a chimney.

WEDNESBURY.—The annual report of the Borough Electricity Department shows that the number of new consumers obtained during the year was 83, which is a greater number than any previous year. The figures regarding the sales of electricity show an increase for lighting of 52,015 units, and for power of 156,542 units. The net surplus on the year's work amounted to £142, which, together with a sum of £184 brought forward from last year, provides a total of £326. The amount received from rates during the year has not been touched, and an amount of £725 is carried forward. The new system of generation has justified its claims for reliability and economy.

LIGHTING AND GENERAL—Overseas.

BAHIA.—The Brazilian Ministry of Communications and Public Works has opened a credit of 830,000 milreis (about £52,000) to meet the expenses of the construction of the telegraph line from the State of Matto Grosso to the State of Amazonas.

BUENOS AIRES.—The principal residents of General Belgrano, Province of Buenos Aires, have, at the invitation of Messrs. Matta and Fuente, held a meeting with a view of forming an electric light company; the idea has been vigorously taken up.

HOBART, TASMANIA.—The Complex Ores Co., Ltd., proposes to establish near here works for the treatment of zinc and other ores. The scheme includes the production of aluminium, of steel, of various forms of iron, and extends to the manufacture of calcium carbide and of cinamide for the fixation of nitrogen for the treatment of soils. These works will possess a large power station, the current being generated by water from the Great Lake. The company proposes to supply electricity for lighting and power purposes to the city of Hobart and its suburbs.

MATYASFOLD, HUNGARY.—The Landlord Association have decided to establish works for the supply to the town of water and electric light. The cost of the work is estimated at 281,000 kronen (£11,700), which amount is to be advanced by the President of the Association, Mr. Josef Paulheim.

TRACTION—Home.

GREENOCK.—With an increase of 6% on the number of passengers carried, the corporation tramways made a surplus revenue of £6,765 on the past year's trading.

SHIPLEY.—The Urban Council are considering tenders for the supply of steel girder tram rails and fish-plates.

TRACTION—Overseas.

GOUDA.—The communal authorities have granted to J. H. Müller, The Hague, a concession for the construction and working of electric tramways between Gouda, Haastrecht, Oudewater, Montfoort and Utrecht, and between Gouda and Rotterdam.

SPEZIA.—An electric tramway is shortly to be laid down between Spezia and Cadimare. The British Vice-Consul states that there is little likelihood of an immediate opening for the supply of rails or wires, and probably not for cars.

STOCKHOLM.—The following particulars are given in the report by H.M. Legation at Stockholm on the Swedish Budget for 1911 (Foreign Office, Annual Series, No. 4,414) respecting additional expenditure provided for, to be met by loan, viz.: Electric works at Trollhättan, £80,000; Venersborg-Gothenburg canal (see *Board of Trade Journal* of May 27, 1909, p. 419), £111,000; railway rolling stock, £113,000; railway construction, £425,500; total, £729,500. The new lines on which work is to be begun or continued are the following: Gothenburg—Skee, Bastutrask — Skellefteo — Kallholmsfjord, Ostersund — Ulriksfors—Strömsund, Jarna—Vagnharad—Lunda—Norrköping.

COMPANIES' MEETINGS AND REPORTS.

RANGOON ELECTRIC TRAMWAYS SUPPLY.

The net profit for last year, after allowing for depreciation, debenture interest, etc., was £22,848. A sum of £383 was brought forward. A dividend of 3% is recommended

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on the Ordinary shares, £621 being carried forward. Debenture stock issued during last year was £18,198, and the present amount outstanding is £164,948.

BRITISH WESTINGHOUSE ELECTRIC.

In their report for the year 1909 the directors of the British Westinghouse Electric and Manufacturing Co., Ltd., state the company's financial position continues sound and satisfactory. Shareholders will hardly feel inclined to endorse that opinion, seeing that a debit balance of £798 is the result of the year's operations, the total deficit at the end of 1909 being £7,319. Interest on the 6% Prior Lien Debentures and 4% Debenture stock has been met. It is stated that orders to date are substantially in advance of those for the corresponding period of 1909.

EASTERN TELEGRAPH.

The directors announce that, subject to final audit, the accounts for 1909 show that after making a contribution to the general reserve fund, payment of interest on the 4% Mortgage Debenture stock, dividend on the 3½% Preference stock and three interim dividends of £1 5s. per cent. each on the Ordinary stock to September 30 last, there is a balance available out of which the directors recommend the payment of a final dividend of £1 5s. per cent. and a bonus of £2 per cent., both free of income-tax, making a total distribution of 7% on the Ordinary stock for the year.

AUCKLAND ELECTRIC TRAMWAYS.

The report for 1909 states that the total revenue was £182,594. The traffic receipts amounted to £180,386, an increase of £16,539 over the previous year. After deducting expenses chargeable to revenue, including £16,454 for debenture interest, the rental and percentage of profits payable to the Auckland City Council amounting to £3,992, and setting aside £15,000, compared with £12,500 last year, to the depreciation account, there is a surplus of £35,124, making, with £3,920 brought forward, £39,044. The directors place £11,500 to reserve, and recommend a dividend on the ordinary shares at the rate of 6% per annum, carrying forward £3,544.

SINGAPORE ELECTRIC TRAMWAYS.

The directors, in their report for the year ended December 31 last, state that the accounts show an excess of revenue over expenditure of £28,511, against which has been charged debenture interest, depreciation, and royalty, amounting to £28,376, leaving a profit for the year of £134. As compared with 1908 the tramway revenue shows an increase of $17,194·53, the passengers carried an increase of 13,806, and the car-miles run an increase of 193,354. The passengers carried per car-mile have fallen from 6·54 in 1908 to 5·96, but the directors report that up to April 16 in the present year this ratio has recovered to 6·17. Notwithstanding the increased car-mileage the tramway working expenses show a decrease of $5,258·23.

SUBMARINE CABLES' TRUST.

The trustees, in their report for the year ended April 15 last, state that the revenue amounted to £25,259 and the expenses to £1,160, leaving a balance of £24,099, to which is added the sum of £228 brought forward from the last account, making an available balance of £24,328. After providing £17,952 to meet payment of the coupons, the sum of £6,201 has been transferred to the redemption fund, leaving a balance of £175 to be carried forward to the next account. During the year 52 certificates were redeemed by purchase in the open market, with the surplus funds of the trust, costing £6,201, as above. £11,000 Anglo-American Telegraph Co.'s preferred stock has been sold during the year, the proceeds having been invested in shares of the Great Northern and Western Telegraph Cos. The certificate-holders will be asked, in accordance with the terms of the trust deed, to confirm such re-investment.

CUBA SUBMARINE TELEGRAPH.

At the 77th ordinary general meeting, Mr. George Keith presided, and said that the half-year's traffics compared very favourably as a whole with those of the same period of 1908. The improvements shown might be attributed partly to the more active state of business following a good harvest, and partly to an increase in the Press and other traffic in consequence of the exceptional storms and floods which took place in Cuba and the West Indies during the half-year. Bad weather in Cuba interfered with the working of the land lines, especially in the western portion of the island, and led to a larger use of the company's cables along the south coast for local business. As regarded the current year, business generally was good and active. Cuba continued very prosperous under its own government, new industries were springing up, and works were going on in connection with railway extension. It was expected that the yield of the sugar crop now being cut and ground would be one of the largest on record. The report was adopted.

ELECTRIC SUPPLY CORPORATION.

The annual report for the year ended December 31 shows the gross earnings of the year amounted to £23,801, an increase of £2,561 upon that of the previous 12 months, whilst the sum taken into net revenue account for the same period amounts to £9,300, made up as to £8,834 from the company's working, and as to £466 from dividends on its holding in the Dumbarton Tramways Co. Preference shares, as compared with £6,566 made up as to £6,335 and £230 respectively, as shown in the directors' report for 1908. After paying interest upon Debenture stock and temporary loans there remains a surplus of £3,780, as against £2,397 in 1908. The company received full dividends upon its Dumbarton Burgh & County Tramways Co., Ltd., 6% Preference shares, and the directors are pleased to again report that continued and excellent progress has been made during the year by the Hendon Electric Supply Co., Ltd., the total number of lamps taking supply at December 31 last being rather over 23,000, compared with 12,600 of the previous year.

EASTERN EXTENSION TELEGRAPH.

The directors of the Eastern Extension Australasia and China Telegraph Co., in their report for the half-year ended December 31 last, state that the gross receipts amounted to £315,034, against £306,889 for the corresponding half-year of 1908. The working expenses, including £17,997 for maintenance of cables, totalled £143,674 against £151,507 for the corresponding period of 1908, leaving a balance of £171,360. From this is deducted £3,841 for income-tax payable in England, and £15,048 for interest on Debenture stock, leaving, as the net profit for the half-year, £152,471. After adding £58,844 brought forward from the previous half-year, there is an available balance of £211,315. One quarterly interim dividend of 1¼% has been paid for the half-year, and it is now proposed to distribute another of like amount on May 11, making, with the interim dividends paid for the first half-year, a total dividend of 5%. It is also proposed to pay a bonus of 4s. per share, or 2%, making a total distribution of 7% for the year 1909. The sum of £50,000 has been transferred to the general reserve fund, and the balance of £26,315 carried forward.

SOUTH METROPOLITAN ELECTRIC TRAMWAYS AND LIGHTING.

Presiding at the general meeting, Mr. Tegetmeier said that the company was dependent upon a class of traffic which was directly influenced by weather conditions, and the decrease which had taken place in the receipts instead of the continued increase that they had hoped for, was to be attributed to the adverse climatic conditions of the past year. There had been a falling off on the Crystal Palace and Tooting section, where the decrease was £860, but that had been partially made up by an increase on the Sutton section owing to the growth of the ordinary traffic. The electric lighting part of the business showed a satisfactory increase, which was distinctly favourable in view of the conditions in which electric lighting companies had been carrying on their business in the last year or two. He alluded to the growing use of metallic filament lamps which used less current, and said that the altered conditions had received the careful consideration of the

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directors, and they determined last year to increase their standard charge for light current by one halfpenny per unit. The increased rate came into force on October 1. The higher price was only a trifling advance compared with the economy to be effected by the use of these lamps. He felt that on the whole they were justified in taking a hopeful view of the future and the prospective dividend-earning capacity of the company. The tramway undertaking had not so far fulfilled their expectations, but they entertained no doubt that they possessed an improving property, and the lighting business was also capable of great expansion. The report was adopted.

BRISBANE ELECTRIC TRAMWAYS INVESTMENT.

At the ninth annual meeting, Mr. H. R. Beeton presided. After expressing great regret at the death of his predecessor, Sir Malcolm McEacharn, he stated that the anticipations of continued prosperity upon which he ventured last year had been fulfilled, and, thanks to the progress of Queensland, they had again to congratulate themselves on results which surpassed those of any previous year in the company's history. The total receipts for 1909 amounted to £199,335, showing an increase of £20,733 over those of the previous year. On the other hand, the expenses exhibited an increase of £8,326, so that there had been an increase in net profits of £12,407 over those of 1908. A further sum of £18,000 had been placed to renewals, and the directors proposed to set aside a further sum of £1,000 to accidents insurance, bringing the total of that fund up to £3,000. The balance of net profits then available, after satisfying their debenture stock interest and Preference share dividend, enabled them to recommend a balance dividend on the Ordinary shares of 4s. 6d. per share, tax free, making with the interim dividend of 3s. 6d. per share a total dividend on those shares of 8% for the year. The aggregate of renewals and reserve funds and undivided profits would then amount to £96,690.

As he anticipated when he last addressed them, the receipts of the company during the past year were assisted by the celebration in Brisbane in August last of the 50th anniversary of the birth of Queensland as a separate State. It said much for the admirable way in which the exceptional traffic was handled that everything passed off satisfactorily. The car mileage receipts averaged 13·6d. for the first six months and 15·03d. for the second six months, being an increase of 1·3d. and 2·05d. per car mile respectively over the corresponding periods of the previous year. The proceeds of sale of power had increased by £1,008, and there was every prospect of considerable extension in that branch of their business. There had been a slight all-round increase on nearly every item entering into tramway operations, owing largely to the effects of the Wages Board Act, but the bulk of their additional expenditure was due to their increased wages bill consequent on the "determination" of the Wages Board, which was gazetted on June 16 and came into force on July 1 last. The receipts for the first quarter of the current year showed an increase of £5,704, with average car mile receipts of 14·93d. They had no reasons to apprehend any abatement in the measure of prosperity which they were at present enjoying, and which was, as ever, largely due to the energy and ability of their manager, Mr. Badger, and to the loyalty of the staff and employees. He concluded by moving the adoption of the report and accounts.

Mr. J. B. Concanon seconded the motion, which was adopted; and resolutions were afterwards passed declaring the dividends recommended and re-electing the retiring directors and auditors.

INDO-EUROPEAN TELEGRAPH.

The 43rd ordinary general meeting was held at the company's offices, Old Broad-street, Mr. J. Herbert Tritton presiding.

The Chairman, in the course of his remarks, said:—Gentlemen, the year under review has been an uneventful one. Persia has reverted to a more or less normal condition from the telegraph point of view, and our lines over the great portions of the continents of Europe and Asia traversed by the company's system have been subject to even less interruption than in former years. Strange to say, our troubles this year have been nearer home. The difficulty of the interruption of submarine cables, owing to damage done by the trawls of the fishing fleets round the coasts of Great Britain, is one that has seriously affected most of the companies having cables touching these shores. Both the cables across the North Sea in which the company has leased wires were totally interrupted, the one for 79 days and the other for 66 days, of which 49 days were concurrent. The effect of this on the company's business may well be imagined, particularly as the Postmaster-General found himself unable, owing to the requirements of his own traffic, to give us the use of relief wires except for a very small portion of the time. Under the above circumstances the directors have been forced to look for additional cable accommodation between England and Germany, if possible, in a direction removed from fishing operations, if such is to be found.

Whilst tariffs show a consistent tendency to fall, traffics have, the directors are pleased to report, shown a gratifying rise during the year. There is only one way to deal with increasing traffics, and that is the attainment and maintenance of perfect methods of transmission with the highest class of instruments and apparatus of all kinds obtainable. We have no fear of reproach on the above grounds. The directors have set aside £15,000 out of profits for the year towards the cost of the additional land wire found necessary, and hope to provide a considerable further amount for the same purpose out of profits for the coming year. The cost of additional cable accommodation is, of course, a much heavier one, and the question is still engaging the attention of the directors. I have often congratulated the shareholders on the financial position of this company. Its large liquid assets enable the directors to meet at a moment's notice commitments such as these, which might, ordinarily speaking, be almost heavy enough to necessitate the raising of fresh capital.

The daily direct working between London and Karachi is of the greatest assistance in dealing rapidly and accurately with the traffic, and the directors are constantly endeavouring to better the company's own reputation in this respect. Yet we cannot keep pace with the demands of our customers, who expect their code words to be carried 7,000 miles to India without the failure of a single letter, the failure of one letter only having, apparently, the most disastrous results upon the sense of their telegram. This carries us back to the vexed question of pronounceable, or, rather, unpronounceable, combinations. No improvement is visible in the construction of these codes. The practical effect on the working as a whole is that our lines, and others doubtless also, are choked with telegrams of repetition, which in our case amount to 40% of the original telegrams transmitted. Many of these repetitions are in respect of an error of one single letter. The merchant, we think, is defeating his own object by the abuse of the pronounceable combination system. It is sincerely to be hoped that the International Committee provided for the censorship of codes submitted to it may be the means of standardising pronounceable combination codes on a more reasonable basis.

Turning to the accounts, the revenue from message receipts and other sources shows a satisfactory increase of £12.766 13s. 1d. The combined commercial and maintenance expenses show an increase of £2,562 7s. 8d., due to an item of expenditure on maintenance account of a non-recurring nature. The balance-sheet shows no variation from last year calling for remark. The directors propose the usual final dividend, which absorbs £14,875, and bonus of 20s. per share, which accounts for a further £17,000, and have again decided to recommend a special distribution out of interest upon certain investments and advance accounts of 15s. per share, free of tax in each case. There remains a sufficient surplus to enable the directors to propose the allocation of £15,000 towards the cost of increasing the carrying capacity of the system (which will, of course, ultimately amount to a considerably larger sum) and of a further sum of £5,000 to the trustees of the retirement trust fund, carrying forward £7,978 1s. 11d. to the credit of 1910. With regard to our prospects for 1910, traffics have for the months up to date been quite unprecedented, so that, provided our business is not dislocated by Channel cable interruptions or any of those bolts from the blue to which undertakings such as ours are at all times exposed,

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we may hope for a prosperous outcome of the year 1910. (Cheers.) He concluded by moving a resolution adopting the report and approving the proposal therein as to dividend, etc.

Mr. Charles Holland seconded the motion, which was at once carried unanimously without discussion; and resolutions were afterwards passed re-electing the retiring directors and auditors.

ORIENTAL TELEPHONE AND ELECTRIC.

The 16th ordinary general meeting of the Oriental Telephone and Electric Co., Ltd., was held at the Great Eastern Hotel, Bishopsgate, E.C., Mr. Benjamin St. John Ackers presiding.

The Chairman said: The board is pleased to be able to present a favourable report of the results of the company's affairs for the past year. Those of you who have studied the figures of the report will, I trust, be satisfied with the progress we have made since we met here a year ago. Whilst we think it wise to be content to continue to pay an 8% dividend, we have made, as you will see, substantial increases to both reserve and the amount carried forward, and it is in that direction that the progress of the past year is indicated. There can be no doubt that the sums set aside from time to time have been most usefully employed in the business, and have largely helped in placing the company in its present strong position, by assisting the development of our revenues in the various centres without having to rely solely on our share and debenture capital. This development continues to go steadily forward, and the prospects are encouraging. Both your share and debenture capital are, as you are aware, very moderate, but your directors will not hesitate to take advantage of any promising opportunities which may present themselves to add to the importance and usefulness of the company, both to the Governments and the public of the countries which it serves, and come before you with any plans they may have in connection therewith. Steady development is also apparent in our subsidiary companies, one of which—the Bombay Company—pays a higher dividend for the year 1909. The Bengal Co. would also have been justified in increasing its dividend but for having had to face a further pressing demand for opening up fresh districts to the north and south of Calcutta, requiring further large outlays, towards which some of their surplus profits are being applied. The negotiations between that company and the Indian Government for taking over the latter's telephone system are occupying this board's attention, and we entertain every hope that they will lead to a satisfactory reply, by which the Bengal Co.'s position will not only be further strengthened, but their general revenues benefited.

To secure this object your company has undertaken to lend their financial assistance as far as possible, and your interest in the Bengal Co. may therefore become second only to that you own at present in the Telephone Co. of Egypt. In Egypt the progress did not equal, in proportion, that made during the years immediately preceding the recent crisis, from the effects of which that country has not as yet entirely recovered. Nevertheless, a satisfactory increase in revenue has been recorded for the past year, and has continued since, according to our latest advices. The China and Japan Co. is again able to report satisfactory developments at Hongkong, and that company is husbanding its resources with a view to meeting such expenditure as it may be called upon to make in the near future for the extension and consolidation of its interests. The progress made by their branch in Kowloon is equally marked. The railway from that place to Canton, which has been under construction during several years past by English engineers and with English capital, is now reported to have been completed and will be ready for traffic in July next. This will render Kowloon a place of great importance, and the China Co. expect to derive very considerable benefits from the increased commercial activity which is, by general assent, anticipated. The negotiations which your directors have carried on for a very considerable time with the Government of Mauritius for the purpose of extending telephone facilities as far as practicable all over the island, have now been nearly concluded, and a final settlement of that question is likely to be reached within the next few months. The expenditure involved will, however, be moderate. In conclusion, I have great pleasure in bearing testimony once again to the efficiency of our staff both at home and abroad, to whose zeal and loyalty the satisfactory results obtained during the past year are, in so great a measure, due. I have now to move "That the directors' report and the statement of accounts for the year ended 31st December, 1909, as presented to the shareholders, be received and adopted." I will call upon Mr. Lloyd to second this. But before I put the resolution, if any shareholder wishes to make any remark, will he do so now.

Mr. Thomas Lloyd seconded the resolution.

Mr. H. R. Sibson said that he would like to take the opportunity of saying how gratified and eminently satisfied the shareholders were with the report submitted. It was perfectly clear from the account that the directors could have declared a dividend of 10% and then have carried forward a reasonable amount. He approved of the manner in which the reserve account was set out in the balance-sheet. He fully appreciated the satisfactory report presented, but in view of the fact that the revenue account showed an increase of nearly 22%, that the net revenue account was some £10,000 better, and that they had been able to add £5,000 more to the reserve, and carry forward £5,000 more than last year, he thought they had every reason to look forward to an increase in the dividend.

The Chairman, in reply, said that the question regarding an increase in the dividend had already been answered by the previous speaker. The feeling of the board was that it was far better to pay an absolutely safe and steady dividend of 8% from year to year than to pay a higher one, with the possible risk of having to make it lower at some future time. With regard to the point raised in the auditors' certificate as to the value of their investments in subsidiary companies, they had always endeavoured to under-estimate rather than over-estimate the value of these shares. As a matter of fact, the Bengal Telephone Co.'s shares, which some time ago stood at 80, were now at par, while those of the Bombay Co., taken at 25, were at the present value of 32, so that they would see that the value put upon them was well below their market value.

The report was unanimously adopted.

The Chairman then proposed (1) "That a final dividend of 3% be paid on the Preference shares issued, less income tax; (2) a final dividend of 5% on the Ordinary shares issued, free of income tax, payable on May 2, 1910, and that the balance of profits be applied as recommended in the report."

Mr. H. Grewing seconded the resolution, which was unanimously adopted.

COMPANIES REGISTERED.

Express Cable Inventions.—£50,000 (£1). To acquire from H. Knudsen his patents and other rights in certain inventions for transmitting and receiving photographs and printed and typewritten messages by wireless telegraphy and over cables and land lines, etc. First directors (not less than two nor more than 10) are Colonel H. S. Fitzgerald, C.B., H. C. Hall, and T. E. L. Oakley (all permanent), 10 shares. Remuneration (except managing director, if any), £500 per annum, divisible. 29a, Charing-cross-road, W.C.

Harpin & Co. (Ltd.), Electric Light Engineers.—£2,500, in £1 shares (1,500 6% Cumulative Preference.) 47, Temple-row, Birmingham.

W. F. Peare, Ltd.—Capital, £10,000, in £1 shares Objects: To acquire the business of an electrical engineer carried on by W. F. Peare, Catherine-street, Waterford. Private company. The number of directors is not to be less than two nor more than four. The first are Sir W. G. D. Goff and H. W. D. Goff. Registered office, 3, Catherine-street, Waterford, Ireland.

FINANCIAL NOTES.

City of Buenos Ayres Tramways Co.—Dividend of 1s. 3d. per share, less tax, for the three months ended March 31.

Colombo Electric Tramways and Lighting Co.—Six per cent., tax free, for the year 1909. The sum of

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£7,300 has been transferred to reserve, and £2,200 carried forward.

DUDLEY, STOURBRIDGE ELECTRIC TRACTION.—The directors of the Dudley, Stourbridge and District Electric Traction Co., Ltd., after placing £2,000 to renewals account and £998 to depreciation account, have declared a dividend of 2% (2s. per share) on the Ordinary shares for the year to December 31, carrying forward a balance of £12.

EASTERN TELEGRAPH CO.—Final of £1 5s. per cent. and a bonus of £2 per cent., tax free, making 7% for the year ended December 31.

WEST INDIA AND PANAMA TELEGRAPH CO.—Dividend of 6s. per share on the first preference for the six months to December 31, and 9s. per share on the second preference on account of dividends accrued to December 31.

PERSONAL.

The employees at the Aberdeen Electrical Engineering Co., Ltd., met last month to make a presentation to Mr. Albert Auer on the occasion of his leaving the firm to take up practice in Aberdeen as a consulting electrical engineer. Mr. Batting, the manager, in making the presentation, spoke of Mr. Auer's excellent college training and the practical experience he had gained during his nine and a half years' stay with the firm, during which he had been engaged in many large contracts, including Kingseat Asylum and the Waldorf Hotel, London, and also in the installation of complete generating plants in steam suction, gas, oil and water-power, in all of which he had shown marked ability, and that he was thoroughly well qualified to act as a consulting electrical engineer. Mr. Batting then presented Mr. Auer with a handsome oak office cabinet on behalf of the employees. Mr. Auer, in a few well chosen words, acknowledged the gift and thanked Mr. Batting and the workers for the consideration and support he had always received during his stay with the firm.

Mr. C. E. Smith, Chief Engineer of the Rosario Electric Co., has been appointed Chief Engineer of the Compañia de Electricidad de la Provincia de Buenos Aires.

Mr. H. F. Payne, of the Weymouth Borough Electricity Department, on leaving to take up a position with the Carlisle Corporation, was made the recipient of a presentation from his colleagues.

CATALOGUES AND PRICE LISTS.

The St. Helens Cable & Rubber Co., Ltd., have just issued a quaint illustrated "Summary Catalogue" for hanging up. It is a good reminder.

A new pamphlet from Messrs. Ferranti, Ltd., deals with their "two-rate" meters—meters which record "day load" and lighting consumption.

Messrs. Crompton & Co.'s Catalogue U.21 deals with "Moving Coil Electrical Instruments for Continuous Current Circuits." It is a bulky pamphlet, well illustrated, and containing a mass of carefully digested information.

The fifth edition of The Edison & Swan United Electric Light Co., Ltd., Catalogue Section II. (wholesale and export) is concerned with ship, factory, colliery, street and traction fittings.

Messrs. G. M. Boddy & Co. have brought out a striking price list of their lamps in the form of a *facsimile* typewritten letter, and giving a useful diagram showing the life curve of a Boddy "Metalik" lamp.

Mr. F. J. Dunn, in a series of leaflets, describes the merits of the "Gear Shield" (now used by 115 electrical tramway and railway systems, 256 collieries, shipyards and works, and 200 other engineering works); an ingenious machine for cutting rails, girders, angles and pipes; Guy Anthers' and other specialities connected with electrical engineering and tramway equipment.

The Braulik Engineering Co.'s latest publications consist of price list of "Eclipse" Type D., D.C. Dynamos and Motors, and price list of Motor Starters, Regulators and Controllers. Both of these give a wealth of information of great service to would-be purchasers. The motors described, by the way, are of this year's patterns, and embody the latest improvements, so the list is worth filing.

STANDARD ELECTRICAL WORKS.

ABSOLUTE MEASUREMENTS IN ELECTRICITY AND MAGNETISM. By PROF. A. GRAY, F.R.S. 5s. 6d. [515]

ABSOLUTE MEASUREMENTS IN ELECTRICITY AND MAGNETISM, THE THEORY AND PRACTICE OF. By PROF. A. GRAY, F.R.S. Two vols. Vol. I., 12s 6d.; Vol. II., in two parts, 25s. [514]

ALTERNATING CURRENTS, THE ELEMENTS OF. By W. S. FRANKLIN and R. B. WILLIAMSON. 8vo, 10s. net. [513]

ALTERNATING CURRENTS AND ALTERNATING CURRENT MACHINERY. By PROF. D. C. JACKSON. 14s. net. [518]

ALTERNATING CURRENTS. By ALFRED HAY, D.Sc., M.I.E.E. Demy 8vo. Profusely illustrated. 6s. net; 6s. 5d. post free. [613]

ALTERNATING-CURRENT WINDINGS. By C. KINZBRUNNER, A.M.I.E.E. Demy 8vo. Illustrated. 3s. 6d. net; 3s. 9d. post free. [623]

ALTERNATING CURRENT MACHINES, TESTING OF. By C. KINZBRUNNER, A.M.I.E.E. Demy 8vo. Illustrated. 4s. 6d. net; 4s. 10d. post free. [618]

THE ELECTRICAL ENGINEER, 149, FLEET STREET, LONDON, E.C.

PATENTS.

Electric Accumulator Sub-Stations Fed from Alternating-Current Systems.

2147—1909. A. M. TAYLOR, King's Heath. The primary object is the neutralisation of the lagging current, caused by the induction motor cables on an alternating current system, in a more economical way than hitherto possible. A further object is the neutralisation of the reactance in the overhead line itself, and the consequent reduction in the size of generator required for supplying current through the line when it is very long, or the amount of energy transmitted is considerable. The first object is attained by utilising one of the battery charging units to perform the junction of a capacity connected in parallel with the alternating current load. The battery is caused to operate in this manner by over-exciting the field. The battery charging unit is kept continually loaded to such a degree as to make it work economically, no matter how large or how small the capacity current required from it may be, by allowing it to discharge current into its battery unit. In order to attain the second object one of the battery charging units is inserted in the form of a capacity in series with the overhead line to the sub-station or to the load, instead of putting the capacity in parallel with the load. By this arrangement the reactance of the overhead transmission line is neutralised from the generating station without increasing the total amount of current going through that line. At the same time, the rotary converter or other synchronous battery charging unit is economically loaded by providing a load for it in the form of a charge delivery into the battery unit, which charge is available at the time of the peak of the load for assisting the main station.

Rendering Constant the Voltage of Dynamos.

7058—1909. O. M. SHEPHERD, Hanwell. A disc is fixed upon the armature shaft of the dynamo and to the periphery of one end of the disc a spring is fastened. On the other end of the spring is a contact block. Mounted concentrically with relation to the disc is a fixed contact ring and the parts are so arranged that upon a given speed being reached by the armature of the dynamo, the contact block will recede from the disc and make contact with the fixed contact ring. A regulating coil of a material having a high temperature coefficient is employed in connection with this automatic cut in and cut out. This is inserted in series with the armature circuit or may be used in other parts of the winding. As the speed of the machine increases there is a rise of temperature in the regulating coil, and consequently a correct proportionate increase in resistance, which keeps the voltage constant.

Connections for Electric Cables.

7576—1909. THOMAS & BETTS CO., New York. The connection comprises a collar to embrace the ends of the cables. The collar is provided with one or more rotatable members mounted in oppositely disposed circular aperatures. Each member carries a binding member adapted by the rotation of its corresponding rotatable member to be travelled upon so as to bite into the covering of the cable and firmly grip the cable between the binding member and the rotating member.

Electric Storage Battery Plates.

27221.—1909. ACCUMULATOREN FABRIK A.G., Berlin. The plate consists of two elements, each having ribs which do not coincide, but form a chequered plate of small thickness.

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Diaphragm Condensers for Wireless Telephony.

7906—1909. Dr. W. Burstyn, Berlin. According to this invention the diaphragm of the condensers used in telephony is influenced indirectly not by magnetic but by electrostatic forces, which are brought into action by means of a microphone actuated by sound.

Electrical Distributing System.

8165—1909. A. Spencer, London, E.C. This is an improvement in systems in which it is desired to distribute electrical energy alternatively to different translating devices from an earthed source with control from two or more points distant from each other. The object is to provide an arrangement whereby, in the act of completing the circuit of the required translating device to earth from any one point of control, the circuit will be automatically completed to earth at another point. In this way conductors of reduced cross sectional area can be employed, thus rendering it possible to economically distribute energy to each of a number of sets of parallel translating devices or alternative use from a separate source of current.

Electric Coal-Cutting Machine.

8694—1909. T. Thomson, Hamilton, N.B. Hitherto, the cutter bars of coal cutting machines have been caused to act through moving the machine otherwise than for cutting the coal, and many serious and fatal accidents have resulted. In order to prevent the bars from moving during movement of the machine they are adapted to be thrown out of gear by the special arrangement of the bevel gearing.

Outgoing Telegraph Signal Records.

9686—1909. A. W. Sharman, London, S.W. A pivoted lever is connected by a tie rod to an arm attached to the Morse key. The movements of one end of the lever are communicated to the stylo of a recording apparatus. An accurate record of all signal impulses transmitted by the operator is automatically recorded, whereby errors in manipulation may be checked and a permanent record of all messages transmitted may be kept.

Shade Holders for Electric Incandescent Lamps.

9812—1909. W. R. Mackay, Ilford. The shade holder comprises a collar provided with slots for the passage of projections on the lamp holder. Seatings in the collar on one side receive the projections and a helical spring on the other side is attached at one end to the collar, while the other end bears against the shade.

Electric Time Switches.

10940—1909. H. H. S. Marsh, Soho, W. The switch arm is rotated by a motor controlled by a clock train. A spring on the clock hands causes the locking device engaging with it to be disengaged immediately upon the release of the switch arm.

Production and Maintenance of Long Electric Arcs for Effecting Reaction Between Gases.

11060—1909. Chemische Fabrik Griesheim Elektron, Frankfort, a. Main. Long stable arcs may be obtained between the electrodes by the continuous supply of gases to the arc over its whole length by means of a system of slits arranged after the manner of louvres through which the gases issue in constant amount and at a constant acute angle against the electric arc.

Insulating Electric Cables.

11135—1909. British Insulated & Helsby Cables, Ltd., Warrington. The insulating covering consists of a layer of vulcanised bitumen combined with a layer of vulcanised rubber, juxtaposed on each side of the layer of bitumen. The rubber protection is calculated to greatly increase the mechanical strength and flexibility of the dielectric.

Electrical Device for Transmitting Angular Movements to a Distance.

11338—1909. F. Spalazzi, Rome. The invention consists in a special arrangement of rotor and switch constructions which provide for a comparatively large number of angular positions of adjustment of the rotor whilst providing that this shall be always under current, that is, there shall be no point at which the circuit through the rotor is broken.

Electric Arc Lamps.

15880—1909. H. J. J. Jaburg, Amsterdam. This is an improvement in lamps with obliquely arranged electrodes arranged in parallel planes. Current is fed to the two main electrodes, through an auxiliary electrode located obliquely to one of the main electrodes. The current is automatically interrupted in the burning away of the electrode supports or in event of the electrodes becoming suspended.

Electric Fly Switches.

17561—1909. C. J. Baker, Balham, S.W. The switch comprises two contacts arranged in approximately the same plane, a brush moving at right angles to the plane of the contacts and adapted to join them, and an operating toggle connected on the one hand to the tumbler and on the other hand to the centre of the brush.

Rectifying Alternating Currents.

17742—1909. E. Giglio, London, S.W. This is an improvement in alternating current rectifiers of the type in which the alternating current acts electro-magnetically to cause an oscillating armature working in conjunction with a stationary magnet to move synchronously with the alteration of the current and to make and break the connections for supplying the rectified current to its circuit. The contact devices actuated by the oscillating armature are arranged in such a way that they will change over the connections of the rectified current circuit for each half wave period so that all the alternating current waves are sent in the same direction through the rectified current circuit.

Wireless Operation of Switches by Sound Waves.

17932—1909. Ma. Karolyi, E. Klupathy & C. Berger, Budapest. In apparatus for wireless operation of switches at a distance in which, owing to a fall of current taking place in a microphone circuit, a relay releases its armature, which effects the switching operation, an arrangement is made whereby the relay armature is held fast by its electro-magnet in the position of rest of the microphone. The conditions in the microphone circuit as well as the size of the counter force acting on the relay armature, are calculated so that the strength of the current circulating in the microphone circuit when the microphone is at rest, is not sufficient for again attracting the armature pulled away, which is returned by a separate device.

Safety Electric Connector Plug.

18228—1909. J. F. & E. S. Conradi, London, E.C. The plug is provided with a handle with a shield, and a cover through which the cable passes out at right angles to the long axis of the pins and away from the operator. The arrangement protects the hand of the operator from injury due to any fault in the electrical circuits.

Abstracting Moisture from Insulated Electric Cables.

19368—1909. J. E. Dane, Melbourne, Australia. The cable is wound direct on to a drying drum, which is heated internally by hot air. The heat passes through the wall of the drum and dries the cable. An outer jacket is provided to conserve the heat.

Rectifiers for High Tension Alternating Electric Current.

26466—1909. Siemens Bros. & Co., Ltd., Westminster, S.W. This rectifier for alternating currents has a shaft on which are two pairs of wipers consisting of diametrically opposite rods parallel to the shaft of the machine, mounted at an angle of 90° to each other. The wipers move between three parallel pairs of fixed diametrically opposite stationary single contacts. The stationary middle contacts are connected with the terminals of the source of current or the current consuming apparatus. The pairs of diagonally opposite outside stationary contacts are connected accordingly with the current consuming apparatus or the source of current.

Electrical Switches.

25551—1909. J. P. Jakobsen & H. F. Jensen, Copenhagen. The switch has a contact arm which is rotatable about the centre of the base of the switch and parallel to the plane. The arm is connected by a spring to the free end of a handle lever, which is rotatable in a plane perpendicular to the contact arm in such a manner that when this lever is shifted from either of its extreme positions to the other one, the contact arm will also be thrown over and both members will remain in the new position under the action of the spring.

Electrical Transmission of Photographs.

229—1910. H. Carbonelle, Uccle. The transmitting stylo and the original are continually moistened with non-conducting liquid in order to avoid the wearing of the stylo and original by friction and sparks. The stylo has a resilent plate which prevents its being lowered into the deep depression of certain original blocks.

Commutators of Dynamo Electric Machines.

1292—1910. Siemens Schuckert Werke G.m.b.H., Berlin. In this commutator, the main insulating material is omitted between the adjacent segments for any desired distance along the segments and for a radial depth, which corresponds to the radial wearing depth of the segments. The insulation between adjacent segments over areas corresponding to the omitted main insulation is obtained by varnishing or painting the sides of the segments, or thin plates of insulating material may be inserted between the segments.

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TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns per week. Ending	1909-10.	1908-9.	Increase or decrease. Week.	Current year.	Miles of track open. 1909.	1908.	Accounts for past year. Ending	Total receipts.	Passengers carried.	Car miles run.	Receipts per Passenger.	Car mile.	Mile of track.	Car
		£	£	£	£				£						
Aberdeen Corporation	April 27	1,189	1,254	— 65	— 827	27½	27½	May 31	71,930	17,517,304	1,566,119	·98	11·02	4,940	
Ayr Corporation	Sept. 18	671	562	+ 108	—	8	8	—	—	—	—	—	—	—	
Baker Street and Waterloo Ry.	Nov.	8,141	6,070	+2,071	—	4·25	—	—	—	—	—	—	—	—	
Birkenhead Corporation	April 24	1,014	1,033	— 19	— 289	24·003	13·52	—	—	—	—	—	—	—	
Birmingham Corporation	April 23	6,673	6,390	+ 283	—	56·792	58·52	—	—	—	—	—	—	—	
Blackburn Corporation	Oct. 6	1,100	1,293	— 173	— 1,036	24·53	28·3	—	—	—	—	—	—	—	
Blackpool Corporation	Aug. 26	2,152	2,050	+ 102	+ 732	—	—	—	—	—	—	—	—	—	
Blackpool-Fleetwood Trams	„ 8	2,304	2,309	— 24	—	—	—	—	—	—	—	—	—	—	
Bolton Corporation	Oct. 10	2,416	2,337	+ 79	— 259	42	42	Mar. 31	117,799	25,492,902	2,492,147	1·1	11·34	2,804	
Bournemouth Corporation	July 21	1,681	1,723	— 42	— 23	29½	29½	„ 31	86,225	13,991,328	1,766,068	1·47	11·71	2,912	
Bradford Corporation	April 23	4,753	4,629	+ 124	— 1,923	98	54·81	„ 31	235,258	47,839,569	5,331,007	1·17	10·59	2,378	
Brighton Corporation	May 1	835	844	— 9	— 694	9·5	—	—	—	—	—	—	—	—	
Bristol Tramway Company	April 29	5,429	5,159	+ 270	—	57	51½	Dec. 31	265,362	46,652,389	5,756,842	—	—	—	
Burnley Corporation	April 30	1,183	1,225	— 42	—	19½	19½	Mar. 31	64,261	12,355,958	1,202,330	1·23	12·83	5,971	
Burton Corporation	May 1	258	253	+ 5	— 70	6½	6½	„ 31	14,918	3,221,595	430,913	1·04	8·30	1,460	
Cardiff Corporation	April 8	2,000	1,957	+ 43	—	—	—	„ 31	109,979	25,058,146	2,497,169	—	10·57	—	
Carlisle Tramways Company	June 19	170	175	— 5	— 89	—	—	—	—	—	—	—	—	—	
Central London Railway	April 30	5,647	5,575	+ 72	+ 372	6·32	6·32	Dec. 31	350,150	41,898,373	1,456,781	2·01	5·769	55,404	
Charing X, Euston, & Hamp. Ry.	Nov.	6,822	6,092	+ 730	—	7·75	—	—	—	—	—	—	—	—	
City and South London Railway	May 1	3,226	3,163	+ 63	— 392	7·26	7·26	—	—	—	—	—	—	—	
Colchester Corporation	July 14	200	219	— 39	—	8	—	Mar. 31	10,983	2,308,721	349,539	1·09	7·74	1,477	
Cork E. T. and L. Company	April 28	451	396	+ 55	+ 301	9·89	9·89	Dec. 31	24,044	5,737,478	896,945	—	6·43	—	
Croydon Corporation	April 15	1,593	1,774	— 181	— 437	11½	—	Mar. 31	74,132	16,277,418	1,884,137	1·06	9·56	3,705	
Darwen Corporation	Oct. 1	239	256	— 17	— 201	7·23	7·23	„ 31	13,899	2,557,654	245,584	1·30	13·68	1,922	
Dover Corporation	Sept. 18	230	252	— 22	— 395	7	—	„ 31	11,593	2,697,672	316,754	·98	8·78	—	
Dublin and Lucan Electric Ry.	April 29	125	128	— 3	+ 24	7	7	—	—	—	—	—	—	—	
Dublin U.T.	April 29	5,061	5,256	— 195	+ 2,950	54½	54½	—	—	—	—	—	—	—	
Dundee City Tramways	Oct. 6	1,332	1,305	— 27	— 569	—	26½	May 15	60,573	16,367,911	1,281,552	·875	1·9	2,371	
East Ham Corporation	April 30	976	1,001	— 25	— 154	15	15	Mar. 31	47,430	15,355,703	1,091,586	·73	10·26	—	
Glasgow Corporation	April 23	17,826	17,357	+ 469	+ 2,437	192½	185	May 31	907,494	226,948,290	20,766,722	·96	10·49	5,080	
Gloucester Corporation	Oct. 6	395	425	— 30	+ 535	15	—	—	—	—	—	—	—	—	
G.N., Piccadilly and Brompton	Nov.	13,429	9,354	+4,075	—	9·25	—	—	—	—	—	—	—	—	
Halifax Corporation	—	—	—	—	—	52·574	37	Mar. 31	81,872	20,378,672	1,786,390	11·40	11·13	1,528	
Huddersfield Corporation	Dec. 4	1,613	1,357	+ 256	+ 2,663	28	28½	„ 31	84,704	16,200,020	1,960,329	1·29	10·37	2,421	
Hull Corporation	April 30	2,585	2,462	+ 122	+ 179	29	26	„ 31	128,722	30,964,254	3,022,844	1·	10·22	—	
Ilford Corporation	Feb. 12	451	391	+ 60	+ 1,969	10	10½	„ 31	25,328	6,385,466	634,446	·87	9·58	2,066	
Ilkeston Corporation	April 27	112	122	— 10	— 93	4	4	„ 31	7,214	1,968,850	198,415	9·1	7·9	1,803	
Kirkcaldy Corporation	Sept. 8	259	266	— 7	—	7½	7½	May 15	14,993	4,874,199	459,066	·711	7·838	1,856	
Lancashire United Tramways	April 27	1,176	1,205	— 29	— 82	39	39	Dec. 31	68,904	12,554,593	2,244,344	—	—	—	
Leeds Corporation	Sept. 18	6,896	6,624	+ 272	+ 3,662	108	96½	Mar. 31	340,368	75,734,083	7,694,989	1·06	10·62	3,527	
Leicester Corporation	Sept. 11	2,162	2,130	+ 32	—	—	—	—	—	—	—	—	—	—	
Liverpool Corporation	Nov. 19	10,803	10,687	+ 116	— 1 977	109	104	Dec. 31	572,822	124,043,239	12,231,799	1·108	11·24	5,508	
Liverpool Overhead Railway	April 24	1,300	1,343	— 43	+ 25	6·65	2·40	June 30	79,004	11,171,515	1,106,386	—	—	—	
London County Council	April 16	39,766	36,867	+ 2,899	+ 8,041	132½	123½	Mar. 31	1,274,660	279 166,461	25,591,028	1·08	11·74	—	
Lowestoft Corporation	Dec. 11	155	150	+ 5	+ 30	3½	—	Sept. 30	11,399	2,645,206	370,320	1·03	7·36	2,279	
Maidstone Corporation	Mar. 6	157	100	+ 57	—	7·4	—	—	—	—	—	—	—	—	
Manchester Corporation	Sept. 11	15,631	15,297	+ 334	— 2,871	183	181	—	—	—	—	—	—	—	
Metropolitan District Railway	April 30	10,782	10,144	+ 638	+18,316	24	24	—	—	—	—	—	—	—	
Metropolitan Railway	May 1	16,553	16,292	+ 261	+ 9,601	24½	24½	June 30	680,357	99,846,735	—	1·46	—	—	
Nelson Corporation	Oct. 16	151	131	+ 20	+ 7	2½	2½	Mar. 31	7,362	2,060,712	204,740	·85	8·63	1,907	
Newcastle-on-Tyne Corporation	April 23	3,643	3,647	— 3	— 1,762	60½	59½	„ 31	211,085	46,203,164	4,411,745	1·10	11·48	3,504	
Newport (Mon.) Corporation	Oct. 9	663	638	+ 25	— 211	14½	14½	„ 31	35,531	8,174,003	798,029	1·04	9·89	2,450	
Oldham Corporation	Jan. 24	1,778	1,516	+ 262	— 386	—	—	—	—	—	—	—	—	—	
Portsmouth Corporation	Oct. 10	2,046	1,809	+ 237	—	28½	28½	Mar. 31	97,741	21,247,048	2,309,489	1·10	10·15	—	
Reading Corporation	April 28	556	577	— 21	— 186	13½	13½	„ 31	32,769	7,933,572	915,481	—	8·93	—	
Rochdale Corporation	Dec. 26	1,240	1,126	+ 114	+ 746	20·9	20·93	„ 31	56,558	10,196,148	1,252,925	1·32	10·83	2,693	
Rotherham Corporation	Feb. 4	555	587	— 32	—	—	—	—	—	—	—	—	—	—	
Salford Corporation	Sept. 27	4,096	4,662	— 66	— 3,326	78	74½	Mar. 31	244,065	45,771,611	5,486,150	1·25	10·67	3,185	
Scarborough Tramways Co.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
Sheffield Corporation	April 24	5,758	5,436	+ 322	+ 659	39½	37	Mar. 25	289,745	17,568,686	7,065,380	·896	9·842	4,225	
Southampton Corporation	April 20	1,015	1,003	+ 12	— 169	18	18	„ 25	52,647	10,121,887	1,157,451	1·25	11·33	—	
Southend-on-Sea Corporation	Aug 21	995	557	+ 438	+ 1,483	—	—	—	—	—	—	—	—	—	
Stockport Corporation	—	—	—	—	—	25	25	Mar. 31	52,004	9,155,172	1,335,911	1·34	9·342	1,830	
Sunderland Corporation	Jan. 27	1,310	1,336	— 26	— 7,984	—	—	—	—	—	—	—	—	—	
Swindon Corporation	April 20	126	121	— 5	—	—	—	—	—	—	—	—	—	—	
Torquay Tramways	Aug 26	630	647	— 30	—	8·41	—	Dec. 31	15,065	2,880,420	353,297	1·40	1·023	—	
Wallasey U.D.C.	April 30	840	855	— 15	— 569	12·68	12·45	Mar. 31	43,823	8,331,038	891,540	1·2	11·79	3,453	
Warrington Corporation	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
West Ham Corporation	April 21	2,300	2,223	+ 77	— 547	27	14·7	Mar. 31	122,881	35,502,836	2,556,854	·789	10·95	4,417	
Wolverhampton Corporation	Nov. 3	841	823	+ 18	— 206	21¾	—	„ 31	44,432	9,440,369	975,714	—	10·929	2,190	

a Train Miles. *h* Half-year's figures.

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THE
Electrical Engineer.
An Illustrated Record and Review of Electrical Progress.
WITH WHICH IS INCORPORATED "ELECTRIC LIGHT."

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Owing to the sudden and lamented death of King Edward VII., many public and semi-public functions have been postponed. The Tramways Congress to be held at Dublin has been postponed until further notice. So, too, have the meeting of the Institution of Electrical Engineers fixed for May 12th, and the Lectures and Weekly Meetings of the Royal Institution.

NOTES.

Theory and Practice.

In his address before the Iron and Steel Institute, the President dwelt largely upon the relation between the men of science and the practical manufacturer, once more giving voice to the suggestion that the Presidents should be alternately chosen from the ranks of the scientific and practical members. But subsequently he went on to lay stress upon the necessity of combining scientific knowledge with practical experience. His words apply equally well to electrical engineering, and are well worth recording. He said: "I would strongly submit to members that, to be of service, scientific knowledge must be combined with practical experience, and in making this statement I would remind them of the words of Dr. Percy in his admirable address in 1885, when he said: 'The best men are those who have been technically educated and trained in works on a large scale; that a trained mind crammed with theoretical principles is worthless'; and of Sir R. Hadfield's statement in 1905, 'Remember always that nothing, not even the highest natural ability, will take the place of persistent hard work.' With these words I entirely agree. What is wanted is a judicious combination of scientific and practical experience coupled with a plodding determination to succeed. Then failure is impossible."

Causes of Failure.

He went on to point out that most of those present could recall instances of men who had been highly educated in science, yet in practice were absolute failures—exactly from what cause it would not be easy to determine; but some men highly trained in science—having left the practical side probably until too late—upon entering the works failed to properly grasp the situation and apply themselves to the work. Hence many others who may have been indifferently educated, and by hard plodding and determination succeeded in occupying the chief positions in the country. "Undoubtedly," he concluded, "it is by a combination of theory and practice alone that success can be achieved, and it is to an institute of this nature, with a cosmopolitan membership such as this institute enjoys, that we must look in the future, as we have done in the past, for their guidance and information, without which no industry can hope permanently to prosper."

Faults in Underground Mains.

In a short communication prepared for the annual meeting of the Glasgow Local Section of the Institution of Electrical Engineers, Mr. W. A. Toppin discusses the vexed question of localisation of faults on underground mains. His contention is that cable makers have brought their art to such a degree of perfection that cables ought to last for years if only properly looked after. Practically, he pleaded for testing as a daily routine, so that faults could be at once tested and steps taken to remedy them. Many will agree with him when he says that small earth-leakages often go on for a long time, and then suddenly result in a "burn-out" and a consequent breakdown. Such accidents could be prevented if the leakage was detected in time. And after all, the essential duty of those in charge of supply stations is to see that everything runs smoothly, and, so far as may be, not a single consumer is incommoded by even a temporary breakdown.

Testing and Earthing Panel.

Mr. Toppin, referring to his own experience in a three-wire D.C. system, gives particulars of a testing and earthing panel. On the right-hand section the middle wire busbar of the station switchboard is connected through the indicating and recording ammeters, and thence through an automatic circuit breaker to an earth-plate of ample dimensions. The cut-out is adjusted so that when the current flowing through it to earth exceeds 25 amps. the circuit is interrupted and the current is shunted through a 10-ohm resistance. When open, the circuit breaker arm closes a circuit through an indicating lamp and a relay on the recording ammeter, the latter actuating a needle to record the time during which the cut-out is open. The left-hand section of the panel has been designed for testing the insulation resistance of the outer conductors, the method being to earth each outer cable in turn through a known resistance, and noting the resultant current. Mr. Toppin also uses it to burn out minor earths which may occur on consumers' premises. If, for example, such a leakage is indicated on the negative outer, the procedure is to earth the positive busbar and by passing a current which can be varied by the regulating switch, the fault is burnt clear or localised by the melting of the consumers' fuses.

Localising Faults on Mains.

For faults localising, Mr. Toppin uses a two-wheeled rubber-tyred skeleton carrier, provided with steel brushes fore and aft, touching the ground. A voltmeter is placed on the pole of the carrier within easy reading distance, one of its terminals being connected with a steel rod, which is pushed into the ground about three yards away from the cable route. This done, the carrier is pushed over the route, the brushes to the ground, and the fall of potential between the earth connection and the ground in connection with the brushes is noted on the voltmeter. A small drum is provided for winding and unwinding the voltmeter lead as required. For more accurate purposes a centre zero low-reading voltmeter with multiplier is connected between the two steel brushes (insulated from one another). The

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fault is located by moving the carrier backwards and forwards until a zero reading is obtained. With very slight modification, this appliance is equally suitable for a two-wire system, and enables routine testing to be carried out quickly and at very little trouble or expense.

Electrification of Insulating Materials.

In another short paper, prepared for the same occasion, Mr. W. Jamieson, B.Sc., gives details of certain scientific experiments, and points out important deductions to be drawn therefrom. The experiments carried out were in connection with electrostatics, and in the course of these it was discovered that when a strip of insulating material was drawn between the fingers it was electrified, positively on one side, negatively on the other. The explanation of this phenomena seems to be that it is direct pressure that produces electrification, and the difference to the nature is due to the bending of the material, the molecules on one side being compressed, on the other subjected to tension. The lesson he draws from this is that great care should be taken to consolidate insulating materials when laid in layers in electrical machinery (certain types of transformers, for instance), to prevent its coming adrift, and so setting up the kind of electrification indicated. He thinks that cases of insulation breakdown in machines may be due to static charges being produced by simple vibration and rotation when the insulating material is not sufficiently consolidated.

Rand Mine Electrification and Labour.

The Report of the Transvaal Power Companies Commission is a whole-hearted plea for the encouragement of companies able to supply cheap power. It is held that cheap electrical power will benefit gold mining chiefly, but that bringing about general development would help every other industry. Electrification of coal mining is going on slowly, and although the substitution of electric for steam power is expected to bring about a slight check in coal mining, this effect will only prove transitory. The South African Engine Drivers' and Firemen's Association anticipate, as we reported at the time of taking evidence, that electrification will throw most of their men out of work. The Commission do not think so, as far as engine drivers are concerned, who could soon qualify as electrical artisans. Firemen are mostly blacks. Boiler makers would still find employment in power stations and at other plate work, while fitters would also find ample work. The engine men suggested compulsory certification of all men employed in connection with electrical machinery, and that only white men should be certificated. The Commission do not agree with this, but advocate certification of all men holding important posts. The Commissioners, who are all practical men, hold that electrification is bound to come soon, and on an enormous scale.

Electrical Engineers' Status in Collieries.

Professor W. M. Thornton, of Armstrong College, Newcastle-on-Tyne, has contributed a thoughtful article to the *Colliery Guardian*, in which he insists that the electrical engineer must be given a more prominent part in the hierarchy of colliery officials. The Professor sees the rapid advance made by electricity in colliery equipments, and that of the comparatively few fatalities and other electrical accidents, the vast number are due to preventable causes, resulting from careless or ignorant handling. Under these circumstances, a better status must be given to the electrician. Professor Thornton forecasts for the near future an order of responsibility and position such as the following: (1) the district inspector, (2) the electrical engineer, (3) the colliery manager, (4) the executive electrician.

Uninflammable Celluloid.

Professor Armand Gautier, on behalf of Dr. Clement Botrelle, told the French Academy of Sciences the other day of a new method of preparing celluloid, whereby, while all the natural properties are retained, it is rendered uninflammable. In this method the temporary solvent used to secure the agglutination of the nitro-cellulose and camphor is an ether silicate in place of the old alcohol and ether. This solvent produces perfect agglutination, but an evaporation leaves the fibres thinly coated with silica, rendering practically proof against fire. If this process proves easy of manipulation, and gives permanently the results claimed, it will prove welcome in electrical and automobile circles, to say nothing of other industries.

Western Canada Wants Electrical Machinery.

Mr. John E. B. May, a leading business man of Calgary, has been over here on a visit, and is enthusiastic about the rapid industrial development of North-Western Canada. He says that Calgary, the capital of Alberta, is a flourishing city, with its own electric street railways, power and lighting station, and so on. Other towns in the Province are also going in for electrification, and clearly the country offers a rich market for electric appliances of all sorts. But, as with Eastern Canada and British Columbia, local representation, and some adaptation to local needs, are required in order to command success.

WELSBACH FINANCE.

In view of the somewhat sensational incursion of the Welsbach Incandescent Gas Light Co., Ltd., into the metallic filament electric lamp market, the present position of the company is of interest to the electrical industry. The directors, in their report for the year ended March 31 last, state that the net profit of the whole undertaking, including the dividend for the year 1908-9 upon the company's holding in the Austrian company, amounts to £18,590. To this must be added £5,372, brought from last year, making in all £23,963. After deducting the interim dividend for the half-year upon the 6% Preference shares, which was paid on January 1, there remains to be dealt with £5,966. The board recommend that this sum of £5,966 be carried forward. They regret that the continued trade depression has again prejudicially affected the company's sales, and that the net profit for the year shows a decrease. The board regret that the result of the past year's trading does not allow of any further distribution to the shareholders. As regards the Ordinary shares, it is impossible, in view of existing conditions, to hold out any hope of dividends. After an exhaustive review of the position and prospects of the whole undertaking, and after conference with a number of the largest holders of Preference and of Ordinary shares, the directors are of opinion that the time has arrived when the final reorganisation of the capital of the company should be undertaken. The scheme which the board favour is set out in a circular letter to shareholders. This states that the company cannot continue to face a cumulative annual charge of 6% on the amount of the Preference capital; that the value of the goodwill should be reduced in correspondence with the earning power of the company; and that the continued existence of the ordinary shareholders as a separate class, who, according to the accounts, have no present hope either as to capital or dividend, is naturally detrimental to the position and future of the whole undertaking. When the last reduction of capital took place, in 1903, the court took the view that, assuming the correctness of the figures put forward (and after valuing at £70,000 patents, the chief of which have since expired), there appeared to be a further sum of £773,000 lost or unrepresented by available assets. This further figure it was not then practicable to deal with. The board therefore recommend that the capital should be written down by a sum of £843,000 (being the aggregate of the two figures of £70,000 and £773,000 above referred to), the new capital thus standing at a sum not exceeding £500,000. It is hoped that the course of trade may render it possible to earn regular dividends on the reduced capital of £500,000, and at the same time to make provision for consolidating and strengthening the company's future position. The directors propose to convert both classes of shares into common stock on the basis of 15s. for each of the 600,000 £1 Preference shares, and at the rate of 1s. 4d. each for the 743,975 £1 Ordinary shares. Stock will not be transferable in amounts of less than £1.

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TELEGRAPHY AND TELEPHONY: PROFESSOR FLEMING'S POSTGRADUATE LECTURES.

By G. B. Dyke, B.Sc.

At the conclusion of his recent Postgraduate Lectures given at University College, London, on "The Propagation of Electric Currents in Telegraph and Telephone Cables," Professor J. A. Fleming set an examination paper to be worked by the members of the class.

As the lectures were attended by over 70 telegraph, cable, and telephone engineers, and as Dr. Fleming's engagements did not permit of the individual examination of the papers, he has requested me to work out the solutions, and it may be of advantage to those who attended the class to be able to verify their results.

The examination paper was as follows:—

I. Plot, as lines radiating from any origin, the vectors: $\cosh(0{\cdot}5 + j\,0{\cdot}8)$, $\sinh(0{\cdot}5 + j\,0{\cdot}8)$, $\sqrt{\coth(0{\cdot}5 + j\,0{\cdot}8)}$

Writing out these functions as vectors, we have:—

$\cosh(0{\cdot}5 + j\,0{\cdot}8) = 0{\cdot}786 + j\,0{\cdot}374 = 0{\cdot}870 \angle 25°27'$

$\sinh(0{\cdot}5 + j\,0{\cdot}8) = 0{\cdot}363 + j\,0{\cdot}809 = 0{\cdot}887 \angle 65°50'$

$\coth(0{\cdot}5 + j\,0{\cdot}8) = 0{\cdot}981 \angle 40°23'$

$\therefore \sqrt{\coth(0{\cdot}5 + j\,0{\cdot}8} = 0{\cdot}990 \angle 20°11{\cdot}5'$

$= 0{\cdot}929 - j\,0{\cdot}342.$

These vectors may be plotted as follows:—

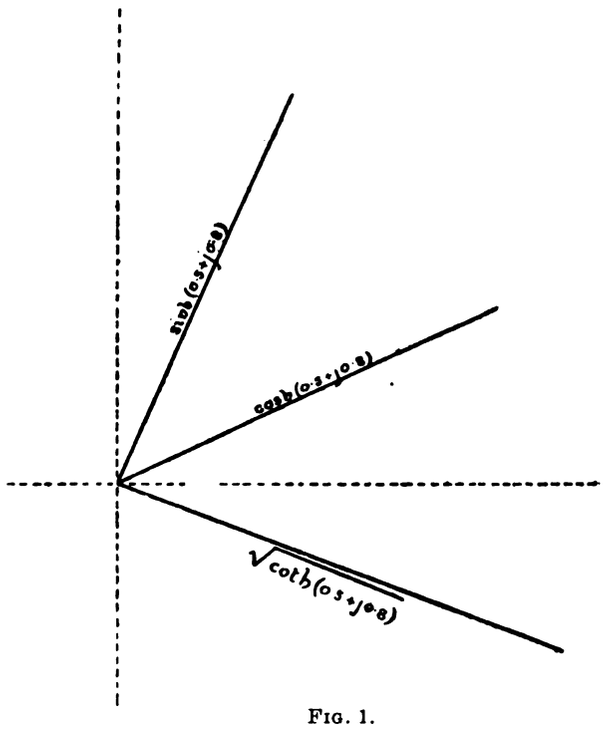

FIG. 1.

II. If a length of 40 miles of standard cable (88 ohms, 0·001 henry, and 0·054 mfd. per loop mile) has an alternating E.M.F. of 5 volts and frequency $5{,}000/2\pi$ applied to one end; calculate the potential difference at the receiving end when this end is insulated and the current if short-circuited.

We have—

Initial sending end impedance $= Z_0 = \dfrac{\sqrt{R + j\,p\,L}}{\sqrt{j\,p\,C}}$

$= 573 \angle 43°23'$ vector ohms.

attenuation length $= Pl = (\alpha + j\,\beta)\,l = (0{\cdot}106 + j\,0{\cdot}112)\,40$

$= 4{\cdot}24 + j\,4{\cdot}48$

For far end open

Receiving end P.D. $= V_2 = V_1 \operatorname{sech} Pl$

$= \dfrac{5}{34{\cdot}70 \angle 245°42'}$

$= 0{\cdot}144 \angle 114°18'$ vector volts.

and for far end short-circuited,

received current $= I_2 = \dfrac{V_1}{Z_0} \operatorname{cosech} Pl$

$= \dfrac{0{\cdot}144 \angle 114°18'}{573 \angle 43°23'}$

$= 0{\cdot}252 \angle 157°41'$ vector milliamperes.

III. Taking the above cable, let a telephone receiver be placed at the receiving end, having an impedance of $1{,}275 \angle 63°48'$ vector ohms. Calculate the current through the telephone for the same sending voltage and frequency as in Question II.

For a line so long as 40 miles, we may use the approximate formula:—

Received current $= I_2 = \dfrac{V_1 \operatorname{sech} Pl}{Z_0 + Z_r}$

Now $Z_0 = 573 \angle 43°23'$

$Z_r = 1{,}275 \angle 63°48'$

and $\therefore Z_0 + Z_r = 1{,}233 \angle 37°25'$

Hence $I_2 = \dfrac{0{\cdot}144 \angle 114°18'}{1{,}233 \angle 37°25'}$

$= 0{\cdot}117 \angle 76°53'$ vector milliamperes.

IV. Taking 40 miles of the above cable, let it be loaded at 2 mile intervals with Pupin coils, each of effective resistance 10 ohms and inductance 0·2 henry. Calculate the attenuation constants for the unloaded and loaded 40 mile lengths.

As the leakance is zero, we have:—

attenuation constant $= \alpha = \sqrt{\dfrac{C\,p}{2}\left\{\sqrt{R^2 + p^2L^2} - pL\right\}}$

wave length constant $= \beta = \sqrt{\dfrac{C\,p}{2}\left\{\sqrt{R^2 + p^2L^2} + pL\right\}}$

For the unloaded cable,

$R = 88$ ohms, $L = 0{\cdot}001$ henry, $C = \dfrac{0{\cdot}054}{10^6}$ farads per mile.

and $p = 5{,}000$

Hence $\alpha = 0{\cdot}106$

For the loaded cable,

$R = 88 + 5 = 93$ ohms, $L = 0{\cdot}001 + 0{\cdot}1 = 0{\cdot}101$ henry,

$C = \dfrac{0{\cdot}054}{10^6}$ farads per mile and $p = 5{,}000$.

Hence the "smooth" attenuation constant $\alpha'' = 0{\cdot}032$, and the wave length constant $\beta'' = 0{\cdot}370$,

and the wave length $= \dfrac{2\pi}{\beta''} = 17$ miles.

We have, therefore, 8½ coils per wave, and hence the "smooth" attenuation constant 0·032 gives a very close approximation to the true value.

V. Given a submarine cable 1,000 miles long, having resistance 3 ohms and capacity ⅓ mfd. per nautical mile, worked without terminal condensers.

Assume the letter *S* sent, uncurbed, with 20 volts impressed E.M.F., each dot and each space being 0·1 sec. long.

Predetermine the curve which would be drawn by the pen of the syphon recorder at the receiving end.

Let $\mu = \dfrac{\pi^2}{C\,R\,l^2} = \dfrac{9{\cdot}87}{\dfrac{1}{3\times10^6}\times 3\times10^6} = 9{\cdot}87$

and let $\epsilon^{-\mu t} = \theta$

and $f(\mu t) = \frac{1}{2} - \theta + \theta^4 - \theta^9 + \theta^{16} - \text{etc.}$

Then, if the letter *S* is sent, the received current I_t; after a time, t is given by:—

$I_t = \dfrac{2\,V}{R\,l} F(\mu t) = \frac{1}{75} F(\mu t)$ in this case.

$\therefore I_t = \frac{1}{75}\{f(\mu t) - f(\mu, t-0{\cdot}1) + f(\mu, t-0{\cdot}2) - f(\mu, t-0{\cdot}3) + f(\mu, t-0{\cdot}4) - f(\mu, t-0{\cdot}5)\}$

The received current can, therefore, be calculated for any assigned value of t.

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If this is done for several values and the results plotted, the form of the received signal may be drawn as below :—

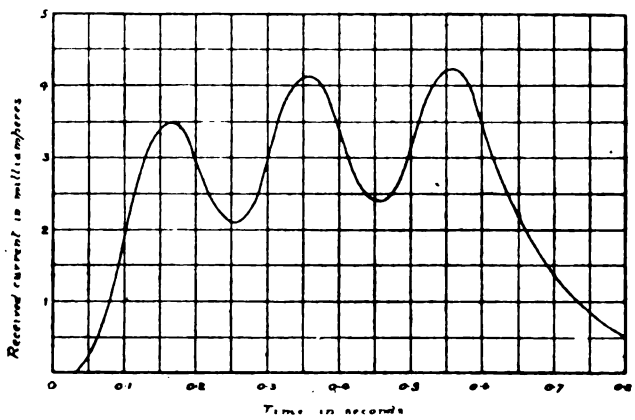

FIG. 2.

VI. If a power transmission line 50 miles long consists of a pair of No. 4 S.W.G. copper wires—each 5·9 mm. diameter, placed 1 metre apart—and if these lines are carried on poles 40 ft. above the ground, calculate the capacity, inductance, and impedance of this line for currents of a frequency of 25 ~, assuming the copper resistance to be 2 ohms per loop mile.

The capacity per mile in mfds. :—

$$= \frac{0{\cdot}0194}{\log_{10} \frac{2D}{d}}$$

where D = distance apart in cms.
d = diameter of each wire in cms.

$= 0{\cdot}00766$ mfds.

$\therefore$ total capacity of line = 0·383 mfds.

The inductance per mile in microhenrys

$$= 1483 \log_{10} \frac{2D}{d}$$

$= 0{\cdot}003752$ henrys.

$\therefore$ total inductance of line = 0·1876 henrys.

The initial sending end impedance $Z_0 = \frac{\sqrt{R + jpL}}{\sqrt{jpC}}$

$= 1318 \angle 36°48'$ vector ohms.

ARC WORKS ENGINEERING SOCIETY.

Annual General Meeting and Conversazione.

The annual general meeting and conversazione of the above society was held in the Arc Works Club House, Writtle-road.

The report of the committee for the past session showed that the society was in a thoroughly satisfactory condition. Eighteen meetings have been held during the session, at which papers covering a wide range of subjects have been given by members and friends of the society.

The society offers premiums for papers read at its meetings by pupils and apprentices at the works, and the first-class pupils' premium was won by Mr. C. G. S. Willet for his paper on "The Use of Electricity for Lighting and Cooking." Mr. F. Jackson and Mr. W. Peyton were bracketed for the first-class apprentices' premium, their papers being on "Metal Cutting Tools" and "Metal Founding" respectively.

The annual general meeting was followed immediately by a conversazione, which was presided over by Col. Crompton. After a short musical programme, in which the following gentlemen took part: Messrs. A. F. Bearsby, A. Burn Callender, E. S. Shoults, and W. G. Smith, an interesting exhibition of sleight-of-hand was given by Mr. J. B. Knight. During the interval there was an exhibition of models, among which were to be seen various types of aeroplanes. In addition to the scale models of various types, a full-size aeroplane, constructed by two members of the society, was on exhibition.

After the interval Col. Crompton presented the premiums to the successful competitors. The rest of the evening was devoted to aviation. The general principles underlying the construction of aeroplanes and flight in general were dealt with in a short paper by Mr. Crompton, which was illustrated by some interesting and most successful experiments. The paper was followed by a cinematograph exhibition, showing pictures of actual flights.

Lord Rayleigh, who was present during the greater part of the evening, was introduced to the meeting by Col. Crompton, and in reply he spoke in appreciation of the enterprising spirit that had become associated with the society. He further expressed the pleasure he had in being present and in listening to Mr. Crompton's interesting lecture. Discussing the question of the progress recently made in the solution of the problem of flight, he expressed some doubt as to the benefits which were likely to be derived by mankind from developments in this direction. Flying machines would probably be used for military progress which was not altogether a pleasant prospect. These opinions, he said, might possibly be nothing, but the natural conversation of old age, and a not unnatural reluctance to see such a complete change in the old order of things.

CANADIAN ELECTRICAL EXTENSIONS.

As an indication of the rapid development of electrical enterprise in Canada, we may quote the following extract from the *Electrical News* of Toronto. It says that owing to the material increase in the business of the Canadian General Electric Co., whose facilities, enlarged only three or four years ago, are again becoming overtaxed, it has been decided to expend, in the immediate future, about $250,000 in further additions to their Peterborough plant. These extensions will comprise the addition of three storeys to the engineering office building, an extension of about 300 ft. to the main machine shop, giving that shop a total length of about 1,000 ft., the erection of a new stores building about 300 ft. long, and a very considerable expenditure for machinery and equipment. Owing to an agreement recently entered into with the Corporation of Peterborough, the company will also build a power house at the waterworks dam, and equip it with water wheels and generators for a minimum capacity of 1,000 h.p.

The Canadian General Electric Co. is to be congratulated on the growth of business that makes such large extensions not only possible, but absolutely essential. The Peterborough site plainly possesses many advantages over a larger city, being at the same time fairly centrally located, to which will now be added the additional advantage of cheap and abundant power. All of these favourable conditions, making for lower cost of production, must, it would appear, benefit the purchaser of this company's goods.

On the other hand, the city of Peterborough has been well advised in placing no obstacle in the way of what appears to the onlooker as a very generous offer. By the agreement the city, at no expense whatever, reaps a yearly benefit of $2,000 for 20 years. At the end of that time the company makes a present of the plant to the city. Apparently this will be a present of no mean proportions, for we understand the city was preparing to submit a by-law for the expenditure of no less than $70,000 on the installation of a similar plant. Further than this, Peterborough will probably benefit by the addition of some two or three hundred workmen to its population, a factor of considerable importance to the trades people. It would not be correct, of course, to say that this company has made Peterborough; but it must be granted that the removal of their works would have meant a grave loss in prestige to the town, and that the contemplated extensions will mean even more than the actual dollars and cents named in the agreement.

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HYDRO-ELECTRIC POWER AS APPLIED TO IRRIGATION.*

By John Coffee Hays.

[In this paper Mr. Hays discusses topics which are of deep concern to engineers in our overseas dominions and in charge of development schemes in distant parts of the world. The information, based on practical experience, is, therefore, of peculiar value to British electrical engineers.]

Introduction.

Among the many uses to which hydro-electric power is being applied, that of electrically pumped water for irrigation, is being advocated at present in a great many instances; and while the mere pumping of the water is so simple as to be hardly worthy of discussion, it may be of interest to point out some of the operating conditions encountered in a project formed chiefly for this purpose.

A hydro-electric system to supply power for pumping water for irrigation will usually be required to build up its own market in the territory served, and it is manifestly necessary at the outset to carefully study the territory. Usually some pioneer work by progressive farmers will show what the land is capable of producing, but the greater part of the territory will consist of barren country planted to grain, or used for grazing purposes, with here and there a town. This land is in large holdings, and the first thing to be determined is the amount of sub-division which may be expected, and whether the proper men are in the field to bring this sub-division about. The character of the land is, of course, of primary importance, and the percentage of good land should be carefully determined. Irrigated land should have a slight slope for distributing the water, and must be reasonably smooth. Hard pan near the surface must be guarded against, as it generally denotes a rather poor quality of soil. The adaptability of the soil for different products and the climate should be considered, yet data on these two points are hard to get and are usually unreliable. Tests and analysis of the soil would seem to be the natural way of determining its adaptability to the different products, but the agriculturist pays very little attention to these analyses, and has apparently a good reason for this, as they are often unreliable.

In the San Joaquin and Sacramento valleys it has been demonstrated that almost any kind of products may be raised on the good lands. Only a small portion of this land has been planted to citrus fruits, but small groves may be found along the entire length of the valley, and it would, therefore, seem as though it were all adapted to this class of products if water is applied. The best conditions seem to exist, however, where the mountains rise abruptly from the valley, and the level flat land extends up to the foothills, for, where a long stretch or rolling country lies between the plains and the hills, hard pan and bedrocks are generally very much in evidence.

Due to the fact that the oranges in the San Joaquin valley ripen and are marketed a full month earlier than those in the southern part of the State, they bring exceedingly good prices, and the growth of this industry is very rapid. The present citrus districts, as, in fact, is most of the land in the citrus belt, are above the existing irrigation canals, which in most instances divert all of the water available from the rivers, and are, therefore, entirely dependent on ground waters for irrigation; and, as the profits from this crop warrant a large expenditure, it is naturally the best market for power for pumping purposes. Aside from citrus fruits, all kinds of high-class products, such as deciduous fruits, berries, vegetables, nuts, vines, and alfalfa are to some extent also irrigated by pumped ground water.

The amount of water required for the irrigation of different products varies to such an extent in the different communities, that it is impossible to get any figures which would be at all accurate. The character of the soil is accountable for the difference to a large extent, but the cost of water and the personal equation are accountable to a very much larger extent. There is usually a marked tendency to the over-use of water. The duty of irrigation water in California is believed to average about 2 ft. in depth, in addition to the average rainfall.

In the Imperial valley, in 1906, 120,000 acres were irrigated, and a total average depth of 2·04 ft. was used, the main crop being grain. In San Diego county, on land planted to citrus fruits, an average depth of 1·5 ft. was used from 1889 to 1899. Around Los Angeles it is estimated that an average depth of 2·4 ft. is used.

In the Modesto and Tyrlock districts as much as 8 ft. to 10 ft. in depth was used at the start, but in 1908 the depth varied from 1·2 ft. to 3·6 ft. In the Fresno district very little water is applied to the surface of the land at present, the land being sub-irrigated by seepage from the canals.

Comparison of Gravity and Ground Waters.

Where gravity waters are available, this method of irrigation is usually much cheaper than by ground waters, and will, consequently, be used in preference. However, the difference in price is not as great as is popularly supposed, and the cost of irrigation in the case of high-class products is really one of the small items in the total expense, and, therefore, the use of ground waters may show advantages which will easily offset the difference in actual cost. Ground water irrigation has the following advantages, all of which are of considerable importance:

First, the duty of water is higher, due to the fact that it is more economically used on account of the cost of pumping, and the water that is not evaporated and absorbed by the products again sinks into the ground to replenish the underground supply and be used over again.

The second advantage is the drainage function, as the over-use of surface water has, in many cases, ruined excellent land by causing the raising of alkali to the surface, and thousands of acres of the finest lands in the large irrigation districts have been waterlogged and ruined by the excessive use of gravity waters.

The third advantage of ground water irrigation is the freedom from weed seeds, which are often carried by ditches and canals, and which, if they do not actually ruin the property, greatly increase the cost of cultivation.

The fourth advantage which the pumped water has is its convenience, and the absolute independence of the farmer using it. The matter of taking turns at the water, and having to use it when you do not want to, and not being able to use it when you do want to, or trouble with the man further up the ditch taking all the water in the dry season and flooding you out in the wet season, is entirely done away with where ground waters are used.

The writer has found it impossible to obtain any reliable information regarding the cost of gravity water irrigation except from the large irrigation districts, and even this is incomplete. The large irrigation districts in Central California are not fully developed, and to take care of the lands which are not yet irrigated, but which are paying their portion of the irrigation tax, reservoirs must be built. The drainage of these lands may be counted upon to cost as much or more than the irrigation. In the case of the small ditches, practically no record of costs is ever kept. The cost of litigation is another large item which may be charged to practically every ditch and canal system. Taking all these things into consideration, it will be seen that, even where actual cost is concerned, the pumped water may compare very favourably with surface water in cost, and, in fact, there are instances where it is actually cheaper.

The only argument aside from the less expense that the writer has heard advanced in favour of the surface water irrigation is the fact that the surface water may be a better quality, it being nearly always soft and pure, while the ground waters are sometimes hard, and in some cases alkaline and injurious to the products. There are, of course, cases where these conditions exist when the use of ground water is out of the question.

Where intensive farming is practiced and the ground waters are entirely depended upon, some concern has been felt as to the sufficiency of the underground supply, and undoubtedly many localities could be found where more water would be withdrawn from underground basins than is restored by natural process. The Lindsay district is entirely planted to citrus fruits and other high-class products requiring a large amount of water. Every drop of

* Abstract of paper read before the American Institute of Electrical Engineers.

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water used for irrigation, domestic and stock purposes is pumped from the ground, and the water level averages a depth of 60 ft. to 70 ft. when pumping. It would seem that the Lindsay section should show a diminution of the ground water supply, if it is to be a serious problem, as it is probably the most disadvantageously situated district in the county in this respect, yet the water, after twelve years of heavy pumping, is standing as high in the wells as ever. It is also to be noted that the wells are not what might be considered deep, their average being about 150 ft. to 200 ft., and, as the cost of pumping is insignificant when compared either to the profits or to the expense of the grove, it is apparent that much deeper wells may be indulged in if the waters show signs of decreasing, and, within certain limits, the deeper the well the more water.

The San Joaquin and Sacramento Valleys are also favourable storage basins for ground waters, as the only outlet is the San Francisco bay through the narrow straits of Corquinez. The elevation of the Lindsay district, 250 miles away, is about 300 ft., and the ground waters must, therefore, of necessity travel very slowly and be in large quantities.

Development of System.

In determining the policies and the scope of a proposed hydro-electric system for the supply of power for pumped irrigation, it is necessary to determine at the outset the exact territory to be served and the general policies to be followed as regards charges, contracts, extensions, etc., or, in other words, a definite goal must be set, the power company must do everything possible to assist development, and any inhabitant in any section of the territory must be supplied with power whenever it is required. Therefore, the power system simply grows up with the country, and while this growth is taking place (it of necessity must take many years), it must be considered that the power system is in course of construction during the entire period. This is the main feature in which the power project, depending entirely upon an irrigation market, differs from the project supplying ordinary commercial business in an already well settled community, and this is a difference which is seldom fully understood and the time element not fully provided for.

The initial installation will usually cover various towns and communities, and, if the territory is partially developed, the development will probably be close to the towns. The business available may, therefore, be fairly well concentrated at the start, and consequently profitable as far as it goes, but naturally only a small amount of the ultimate power required will be marketed. The extensions to the system will be made from these towns, and the fact that development of the community always starts near the town and grows outward is a most favourable condition of affairs for a power company. The price of land is always greatest near the towns, and decreases in proportion to the distance from any centre, yet the land near the town is the first developed. These towns are built along the railroad, and being the shipping points, the reduced cost of hauling to the railroad to a certain extent offsets the additional cost of the land.

The Hydro-Electric System.

The character of construction of a system depends entirely on the class of market, and for irrigation a slight discontinuance of service is not serious, therefore a light construction is permissible. The generating stations at the outset should be of a fairly permanent character, but the distributing system may and actually should be of a light and in many cases even bordering on a temporary character, as it is necessary to economise in every way at the outset to warrant the low rate which it is necessary to charge in order that the market may be developed; for it is necessary at the outset to establish a rate which will continue in effect when the system is fully developed. Even the expense of the generating stations may be reduced to a considerable extent at first, and as the system increases and the market becomes concentrated, improvements of a more permanent nature may be added.

Notwithstanding this, the writer has heard engineers of standing make the broad statement that there was no excuse for the use of a wooden flume, and that a tunnel was the only proper thing; also that certain plants were altogether too flimsy and temporary in their design, and that the wooden pole line was entirely obsolete. When these statements are made, the writer cannot but think that the assertions are prompted by a lack of regard for the first principle of engineering, namely, economy. Every one who has had any experience with the wooden flume knows the many interruptions of service caused by it, yet if constant service is not absolutely necessary, what possible type of construction can compare with the flume. It is short lived, but several can be built for the cost of a tunnel, and during the early life of a transmission system every dollar counts. If the system warrants a tunnel, it may be constructed during the life of the flume to take its place. Of course, if the systems depends entirely upon one power plant, the replacement of the flume is both difficult and expensive, but few existing systems of any importance rely entirely on one plant, and there is usually sufficient capacity available during certain periods of the year to allow for the shutdown of one station. Also an auxiliary steam plant is often cheaper than a tunnel and much more useful.

Wooden pole lines are also perfectly reliable in our California climate, and are a very worthy substitute for the steel tower lines in respect to business development, and there is nothing to prevent the construction of the tower line when the wooden pole has outlived its usefulness; no interruption of service is necessary, as the right of way should be wide enough to accommodate both lines.

Among the different parts of the system where considerable expense may be saved is the switching gear, which may be extremely simple at the outset and still ample. A small galvanised iron building on a wood frame is a thoroughly satisfactory building for the pioneer sub-station, which can be replaced by a permanent and fireproof structure when the business warrants. By the construction of light, inexpensive tie lines one sub-station may be arranged to temporarily supply the territory of another, and by the construction of a ring system many miles of expensive transmission line may be replaced by a much lighter class of construction, which will answer all purposes for many years.

In the greater part of California the conditions are ideal for long pole spacing. High winds seldom occur and sleet is unheard of, but it not uncommon to see a line consisting of three wires ranging in size from No. 2 to No. 8 supported by poles spaced from 120 ft. to 150 ft. apart. However, on new lines, the fallacy of this mode of construction is apparently being realised, and much of the new work looks different. In one case the writer has seen a pole spacing of over 500 ft. in use on light lines, 40 ft. poles being used, which made a very nice appearing and businesslike line. Due to the less number of poles used, better poles, cross-arms and insulators may be indulged in. Other details may be treated in a similar manner.

Description of Typical System.

The writer has been connected for several years with probably the only hydro-electric power project that depends almost entirely on pumped irrigation for a market, approximately 70% of the power generated being used for this purpose, the balance of the power being used for the ordinary commercial purposes in towns and settlements within the territory served, and for the operation of one interurban railway. The entire territory, however, is supported by the agricultural and horticultural products and, therefore, the system is believed to be almost as nearly an exclusive power pumping system as can be imagined. The actual conditions obtaining on this system should apply closely to conditions which may be expected in other similar projects.

Territory.—The territory of the company referred to comprises approximately 1,050 square miles in Tulare and Kern counties, California, being a strip of country about 50 miles long north and south, and 22 miles wide. The only available gravity waters for irrigation are the waters of the Kaweah and Tule Rivers, all of which have been long ago appropriated. This gravity water irrigates about 90,000 acres of land and the balance of the territory, or approximately 560,000 acres, must depend entirely on the ground waters for irrigation before they can be made to produce other than grain or pasturage. The average annual rainfall for the territory is about 10 in., and the soil and climate are admirably adapted for the

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production of all kinds of high-class products. The territory may be for convenience divided into two sections, the citrus belt comprising approximately 200,000 acres of land, and what may be termed the valley portion. In estimating the power requirements it is considered that approximately half of the land in the citrus belt will be planted to products requiring approximately half as much water as the citrus fruits.

Forms of Contracts and Charges.

The bulk of the power is sold under three forms of contract, all being for a period of five years of longer. The contract under which the greatest amount of power is marketed, and which is used by the orange grower, is called the " continuous " rate and porvides for the supply of current at the flat rate of £10 per h.p. per year, as measured at the peak load at any time during the season.

The second contract, called the " spring and meter " rate, applies to other classes of products, such as deciduous fruits, alfalfa, etc., and provides for the supply of power at a flat rate of £5 per h.p. for the period from February 1 to July 31, when the meter is cut in and all current used during the remaining six months is charged for at the rate of 3 cents per kw.-hour. The minimum payment during the meter period is 4s. per h.p. installed, per month, thereby bringing the minimum charge to approximately £6 4s. per h.p. per year, the flat rate charge being based on the maximum demand. In nearly all cases where this contract is used the annual consumption is not in excess of the minimum, as the total amount of current the consumer is entitled to under the minimum may be used at any time during the meter period. The cost of pumping under this form of contract varies directly with the rainfall, but the minimum will be sufficient for the average season. This contract is used to a considerable extent on land which is irrigated by gravity waters, which are not sufficient in the dry seasons, and is in this way used as an auxiliary or an insurance. Most consumers, however, prefer the regular flat rate contract, and the " spring and meter " rate is seldom used in this district except in the case of a young grove, where less water is required. The exclusive use of this form of contract for irrigation would, however, be of advantage to a power company where steam power is used as an auxiliary during the dry season, as the operating ratio would be more uniform under these conditions.

The third long term contract applies to power for miscellaneous commercial purposes not pertaining to irrigation and consists of a meter rate with a graded base rate according to the season of the year. For motors having a capacity of less than 20 h.p. an addition is made to the base rate according to the size of the motor, to motors from 20 to 50 h.p. the base rate applies, and for motors from 50 to 100 h.p. a subtraction is made from the base rate. The minimum payment is 4s. per h.p. per month for the rated capacity of the motor. This method of charge, while somewhat complicated, works out very satisfactorily in practice, as will be observed from the fact that practically all other kinds of power have been displaced in the territory. The reason for adopting such a rate will be apparent by a study of the load curve and the curve of stream flow. Naturally most consumers cannot regulate their demands for power in such a way as to use the greatest amount during the time of the low rate and economise during the time of the high rate, but the general effect is good and a marked tendency toward the desired results is being obtained.

Aside from the above contracts, lighting rates and a monthly power rate are in force, but include no special features.

Under the pumping contracts, it is to be noted that the same rate is made on any size motor, which is most important, as the sub-division of the land into small tracts is necessary for the success of any community, and the small grower should receive all the encouragement possible.

The above contracts all include the following provisions, which are somewhat out of the ordinary:

1. All contracts are acknowledged before a notary public and recorded.

2. All contracts are an absolute lien on the property of the consumer, the property being accurately described in the contract.

3. The consumer grants the company a right of way over any part of the property described.

4. The use of the current is limited to the land described in the contract.

5. All delinquent accounts bear interest at the rate of 1% per month, compounded monthly.

6. The minimum charge under the flat rate contracts is for 75% of the rated capacity of the motor.

The advantages of the above provisions are as follows:

No. 1 is explained by those following.

No. 2 protects the company against all bad debts and takes the place of the often-used meter deposit. In connection with No. 5 it allows the company to carry the account of some hard pressed consumer longer than might be otherwise done, as the security, is amply sufficient. There are also many cases where the consumer prefers to pay the interest charge, if he can allow his account to run until the returns from his crops are received.

The third clause is one over which considerable trouble was experienced at first, but is nevertheless the most important one to the company, for, in a country where roads are few and far between, it is continually necessary to cross over private property, and the right of way over the property of one consumer allows for the construction of lines to serve his neighbour. The objections raised to this clause were that the company would have a right to run lines all over the consumer's property and might run right through his front yard or over his house, if it wished, but these objections gradually died out, for the company in all cases takes the path of least resistance, the consumer being consulted where it is necessary to run over his land, and the lines are constructed in accordance with his wishes, even though this is not always the shortest way across. It is also the aim to run all transmission lines on section lines, for it is considered that there should be a county road around each section and that eventually there will be. The company has a franchise over all county roads and naturally uses them wherever possible. The land owners have, therefore, been shown that the right of way privilege has not been abused, and that in all cases where their land has been crossed it has been for the benefit of their neighbours.

Nos. 4 and 5 are self explantory.

No. 6 is incorporated to encourage the use of the proper size motor for the service required. An electric motor operated at full load feels dangerously hot to the layman, and it is apparently the natural tendency of the farmer to purchase a larger size motor than is needed. The determination of the proper size motor is a simple matter, and a partially loaded induction motor has a power factor that does not do a transmission system any good, so the 75% of the rated capacity minimum payment is rigidly enforced.

By the installation of a double throw switch, the flat rate consumer is allowed the use of current for lighting purposes when not using the motor, ten 16 c.p. lamps being allowed for each horse-power contracted for; but, of course, this lighting is confined to the residence of the consumer. The grower generally provides a motor of one or two h.p. capacity for pumping water for domestic use, the pump operating in the daytime and the lights at night. Lighting is the only use of current allowed under these conditions, although small household appliances, such as a fan motor, flat iron, vacuum cleaner, etc., may be used. Electric heating and cooking, however, are not allowed, the regular meter rate being used for this purpose.

Generating Stations.

The generating stations consist at the present time of three hydro-electric power plants having an aggregate capacity of 4,850 kw. and one turbo-generator steam auxiliary plant having a capacity of 1,000 kw. Two of the water-power plants are on the Kaweah river and one on the Tule river, the steam auxiliary being in Visalia, the principal town on the system. The fourth water-power plant, which will have a capacity of 3,000 kw. will also be on the Kaweah river.

Power house No. 1 was the first constructed, and diverts the waters of the east fork of the Kaweah river through six miles of redwood flume. The plant was constructed in 1899, and the flume is to-day perfectly sound and will

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last at least 10 years longer before it will require replacement. The static head obtained is 1,310 ft. and the generators are driven by overhung wheels on the generator shaft. The equipment consists of three units of 450 kw. each, two belt-driven exciters, and four 500 kw. transformers, one being a spare transformer. The transformers are oil-insulated and were designed to be self-cooled, but additional cooling is obtained by pumping the oil through coils on which water is sprayed. The transformers are located in individual compartments entirely separate from the power house, as are also the lightning arresters and high-tension switches.

Regulation is manual, controlling stands being situated in front of the switchboard, two of which operate deflectors which regulate the amount of water applied to the wheels by deflecting the stream, and one of which regulates the water supply to the third machine by a needle nozzle. At the penstock a regulating reservoir in the form of a large flume has been constructed, having a capacity of 25,000 cu. ft. The main function of this reservoir is to smooth out the daily variation of stream flow, as, due to the method of regulation at the power house, no great economy of water can be practised, although the needle nozzle allows the regulation of water to some extent. Since the other plants have been constructed, however, no regulation is done at No. 1, which simply takes a certain load and holds it.

Plant No. 2 was constructed during 1904 and put into operation in January, 1905. The water for this plant is diverted from the main Kaweah river, and is conducted to the penstock through 15 flumes aggregating 0·87 mile, and 3·1 miles of ditch. The flumes are all redwood and the ditch is concrete lined, the ditch construction being used where the slopes will permit, the flumes being constructed on the rough broken ground and to cross ravines. A concrete lined penstock reservoir is excavated in the side of the hill having a capacity of 75,000 cu. ft. The static head is 360 ft. and the power house equipment consists of three units of 500 kw. capacity, each direct connected to high-head turbines regulated by Lombard governors. Two turbine-driven exciters are installed, which are hand regulated. Seven 350 kw. step-up transformers are installed in compartments outside of the power house, one being in reserve. The transformers are cooled in the same manner as those at No. 1 by circulating the oil.

The No. 3 Kaweah plant, on which construction is just started, will divert water from the main Kaweah river, which after passing through a conduit 10 miles long, will discharge just above the intake of No. 2, thereby using the water twice. The static head of this plant will be 1,960 ft.

The transformers at Nos. 1 and 2 are arranged on trucks so that they may be easily run into the power house under the crane for repairs, etc., if necessary. In No. 1, individual tracks are run from each transformer, and in No. 2 a transfer truck is run on the track in front of the transformer compartments, so a transformer may be pushed out on to the transfer truck and taken to a short piece of track entering the power house. The switching gear in both stations is arranged so that the spare transformer may be immediately cut in in place of any other transformer.

The buildings at both Nos. 1 and 2 are constructed of corrugated iron on wood frame; foundations, floors and transformer compartments being constructed of concrete. The corrugated iron structure is, for all practical purposes, ample, as the climatic conditions are most favourable, and a protection from rain is about the only requirement necessary. These buildings are, however, cold in winter and hot in summer, and would not be considered strictly permanent or fireproof.

The third, or Tule river plant, was constructed in 1908 and 1909, and started operation in September, 1909. The water is diverted just above the junction of two forks of the river, there being two diverting dams and headworks from which short flumes lead to a point at approximately the junction of the river, and join. The water is conducted to the penstock through 4·5 miles of pine flume, 2·06 miles of concrete lined ditch and 880 ft. of inverted siphon pipe, the siphon working under a 5-ft. head and having its lowest point 120 ft. below the conduit grade. This siphon was used to cross a long gulch.

The ditch is lined with concrete and excavated well into the mountain, very little reliance being placed on the filled bank, the water level being only 6 in. above the natural level of the downhill slope. The ditch is 4½ ft. wide and 3 ft. deep, the sides sloping 1 to 1. It is lined with concrete 2½ in. thick, over which ½ in. of cement plaster is applied. A small amount of alum was mixed with both the concrete and the plaster, which renders the lining practically water tight. Due to the steep slope of the mountain side and the size and depth of the ditch, the sloping of the upper bank to a slope of 1 to 1 required considerable excavation. However, the finished product is a most permanent piece of construction. The flume is of the standard bent and stringer construction, the bents being placed 16 ft. apart, and a strip of burlap saturated with an asphaltum compound is placed under the battens for waterproofing.

At the penstock a regulating reservoir is excavated in the side of the mountain. A small portion of the upper end is 5 ft. deeper than the balance of the reservoir, and is used as a sand-trap. The reservoir is 12 ft. deep, 350 ft. long, and of an irregular shape, varying from 12 to 125 ft. in width, following the contour of the hill. The side slope is ½ to 1, and it is lined with 8 in. of concrete and ½ in. of plaster. A concrete wall at the end separates it from the penstock.

The reservoir has a capacity of 175,000 cub. ft., which will operate the plant 1¾ hours at normal load. Therefore, in the case of a break in the flume, sufficient time will be available to start the steam auxiliary plant without interruption of service. The reservoir also has sufficient capacity to regulate the daily fluctuation of stream flow during the low water period, so that the highest use may be made of the water. The static head is 1,135 ft., and the whole plant is designed with a view of ultimately doubling the present capacity.

The power house equipment consists of two 1,000 kw. units with overhung wheels, Lombard governors, directly actuating needle nozzles, an auxiliary nozzle being provided which automatically opens in the event of the main needle nozzle closing too quickly and ramming the pressure pipe. These auxiliary nozzles, when opened, close at a predetermined speed regulated by the dashpot principle. This arrangement allows the most economical use of the water. Two exciters, each of sufficient capacity for both generators, are installed, one being driven by a water-wheel and one by an induction motor. Seven 400 kw. water-cooled transformers are placed in the transformer room on one side of the power house, one transformer being held in reserve. Lightning arresters and high-tension switches are in a separate building.

The power house building and arrangement differ from the other plants in several respects. The power house is constructed of ferroinclave on a steel frame, the ferroinclave being plastered on each side with 1½ in. of cement plaster, therefore making a reinforced concrete roof and sides 3 in. thick. A partition of the same thickness divides the generating room from the transformer room, and a similar partition divides the transformer room into two compartments, fireproof doors completing the separation. The switch house is constructed of the same material, and both buildings have metal window casings and wired glass windows, no wood being used in the construction. The above may seem inconsistent after the statement that the other power house structures were practically sufficient, and this would be the case, were it not for the fact that the transformers which present a certain fire hazard are placed in the power house building. Also the company has passed the pioneer period, and can, consequently, afford a little more permanent construction.

The switching gear and wiring has been greatly simplified by connecting the transformers in two banks, the spare one not being connected. The transformer "railway system" is also dispensed with, simple rollers being provided instead. In the event of an accident to one transformer, its bank may be disconnected, the leads removed from the affected transformer, water pipes disconnected, and the transformer skidded to one side. The spare transformer can then be skidded into place and connected up and the entire job performed in about one hour, certainly a short enough time for a system of this character.

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In connection with all of the power stations, the question of the operator's comfort has been given proper attention. From a practical business point of view, this is a paying investment, as a much better class of men can be procured. Comfortable cottages are provided, the surrounding grounds are cultivated, and a small ice plant is a part of the standard equipment. A few fruit trees and a garden will not only greatly improve the looks of the property, but will also greatly reduce the boarding house expense.

Transmission System.

The transmission system is in the form of a figure 8 or a double ring. In this way current is available at both sides of any sub-station, thereby giving all of the advantages of duplicate lines. The main transmission line from power houses Nos. 1 and 2 feed in at the north-east corner of the system, and the line from the Tule river plant feeds in at the centre of the system. The steam auxiliary is in the northern ring, and can, consequently, feed both ways. The old transmission lines have wires spaced 36 in., the sawed redwood poles being spaced 120 ft. apart. The new transmission lines in the valley consist of a double circuit, the 34,000-volt lines being placed on one side of the pole, and a 6,600-volt distributing line on the other side. The circuits form equilateral triangles, the apex of which point downward; the wires are spaced 36 in. apart on each circuit. The main line from the Tule river plant consists of one circuit, the poles being of cedar 35 and 40 ft. in height and spaced 300 ft. apart. On all new lines a pole spacing of from 300 to 420 ft. is used, with 35 and 40-ft. poles, depending on the character of the country.

The current is distributed from 12 sub-stations situated in the various towns and settlements, and the transmission and distribution systems are laid out to provide for additional sub-stations as the load increases. The sub-station construction varies, all but one having started in the same way, namely, as a cheap wood or galvanized iron building, with the most simple switching apparatus, and, as the sub-station grows in importance, substantial brick buildings are constructed, with more or less elaborate switching gear, storerooms and offices.

The power is distributed at 6,600 volts and 2,200 volts, two-phase, the first distributing being at 2,200 volts; 6,600 volts eventually proved more satisfactory on the power circuits. The city lighting systems distribute at 2,200 volts, two-phase, with the exception of two new systems, where three-phase has been adopted. There are 246 miles of 6,600-volt line, 53 miles of 2,200-volt line, and 28 miles of lighting circuits of 2,200 volts, and about the same length of low-voltage line, with a connected load of 1,190 kw. of lighting transformers. The consumer supplies the secondary transformers for power supply, and the power is measured on the primary side of these transformers.

Effect of Power Pumping on Land Values.

While some exception may be taken to the statement that the development in this section is due almost entirely to the application of electric power for pumping purposes, it is, at the same time, believed to be the case, and this seems to be proved by the land values where pumped irrigation has been established.

Unimproved lands lying south of Porterville sold in 1890 for from £1 to £1 10s. per acre, in 1900 for £2 to £3 per acre, and in 1909 for £12 per acre and higher. Lands north and east of Lindsay, which sold in 1895 to 1900 at from £7 to £8 per acre, now sell at £30 per acre. The assessed values of two sections, one three miles north-east and the other one mile west of the town of Lindsay, show that in the first instance the assessed value was £2 16s. per acre in 1890, £7 4s. in 1899, and £18 4s. in 1909; and in the second instance, £3 16s. in 1890, £7 4s. in 1899, and £23 8s. in 1909. The above figures represent about the average conditions, there being many cases of increase where the figures have been greatly exceeded.

Investment Value of a Power Irrigation Project.

The application of a hydro-electric system exclusively for the furnishing of power for pumped irrigation from an investment point of view is not of the get-rich-quick variety. The investor who wishes to receive immediate results on his money should not enter into any such scheme, unless the power company owns the lands to be put under irrigation, when the project develops into a real estate transaction, the power part being insignificant. Where the project is confined wholly to a power proposition, it should be gone into only by the most conservative investors or developers and pioneers who are content to bide their time and be satisfied for many years without dividends, but with the increased value of their investment. The power company must indirectly meet the opposition of other irrigation districts, and the large government projects, as well as the opposition of gasoline engines and other power, and the charges for service must be as low as possible.

The territory served is sparsely populated at the start, and usually no irrigation is indulged in except by some few scattering pioneers, who may be using gas or steam engines and windmills, and the marketing of power, therefore, depends entirely on the rate at which the territory served is put under high-class cultivation; and this is a slow process. To support a project of any magnitude requires an immense territory, and in the early years of development it is not unusual to construct a line 5 or 10 miles long to supply a motor of as many horse-power; for any part of the territory must be supplied regardless of its location with reference to existing lines, and everything must be done to encourage the development of the entire territory taken as a unit, and, for the first few years, even though the territory is settled rapidly, it can not be hoped to make the power project pay.

The power company, after a few years, should show a profit above interest charges and operating expenses, but for every dollar earned several more must be expended on extensions, and, while it is true that, after the system commences to show earnings a great many extensions may be taken care of by bonds, these always require a certain amount of money to be provided by the company. If the development is rapid, the stockholders are often required to subscribe additional money aside from the earnings, and must in many cases content themselves solely with the increased value of the property. The increased value of the property may be large, and the investment, as far as security is concerned, be of the finest, as it usually is; but in this day of progress and quick returns on investments it is rather difficult to find many investors who are content to wait a generation before receiving any actual cash returns on their money, no matter what the company's books may show as to earnings or as to increased value of property.

When the system is fully developed and loaded, the dividends may be large, and the reliability and permanence of the market will often place the stock almost on a bond basis, and in this way a carefully planned and developed hydro-electric system for the supply of power for pumped irrigation may be considered a splendid investment, but never in the light of a speculation. It must be clearly outlined at the inception of the enterprise just what is to be accomplished, for it is a long job, and one which requires a great deal of looking into the future.

The final results must be arranged for years before they are obtained, and everything shaped to this end. A desire to hasten the marketing of the power may set some precedent which would be most difficult to overcome, and the failure to provide for emergencies may undo the work of years and completely demoralise a system. An overloaded system is to be particularly guarded against, as too much valuable produce depends entirely on the service, and any damage to the producer may completely stop development and stifle the entire community. The power company, therefore, has a very large moral responsibility to face, which is not to be lightly considered.

CORNISH MINE ELECTRIFICATION.

Dolcoath Mine is to be electrified, and the power will be supplied to the central shaft from the Camborne and Redruth Electric Supply Co., who will forthwith erect a large works at Hayle, similar to that at East Hill, Tuckingmill. The power will be transmitted by cable from Hayle to Camborne, and a considerable saving will be effected by transforming coal into power at the port instead of paying carriage to the Tuckingmill works.

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A TELEPHONE RELAY.

Discussion on Mr. S. G. Brown's Paper.

There was a large attendance of members at the Institution of Electrical Engineers, at the Royal Society of Arts, London, on Thursday, May 5, when Mr. S. G. Brown, M.I.E.E., read his paper on "A Telephone Relay," an abstract of which appeared in our last issue.

At the close of the paper, Mr. S. Evershed, who presided, expressed regret that the author was unable to give them a demonstration of his relay. He was delighted to find that Mr. Brown had gone away from carbon and got to a transmitter full of promise. To use something besides carbon was to break new ground, and it was new ground which they wanted to break in telephony. Mr. Brown dealt with the transmitting end, but he (the Chairman) urged him also to deal with the receiving end. The receiver was precisely what it was when Graham Bell finished it. Mr. Evershed thought it was almost useless to devise a loud-speaking transmitter capable of dealing with large currents, and imagine that the present receiver would deal with it successfully. He believed that the moment they tried to make the receiver increased in amplitude they decreased the articulation. What was wanted was a receiver which would give greater amplitude and the same articulation obtainable from the Bell receiver.

Mr. J. E. Taylor, in opening the discussion, detailed the results of experiments with Mr. Brown's telephone relay. Provided one could get suitable points and a good instrument to start with, it would maintain its adjustment and keep its magnifying properties without a great deal of variation. It was capable of picking up wireless telegraph signals which were entirely inaudible on the ordinary telephone receiver. Signals which were just audible were very considerably magnified, probably about 20 times. He inquired whether it was necessary that extreme care should be paid to keeping the points of the upper contact as perfect as possible in order that the magnifying power of the instrument might be properly maintained and its reliability and constancy assured. Concerning Mr. Brown's new form of microphone, he was very much struck with the volume of sound which it was possible to obtain at the end of an artificial cable representing 60 miles of standard cable. Forty-three to 45 miles of standard cable was the maximum length of that type of cable which could be spoken through, using ordinary telephone apparatus, but through the 60 miles of cable which Mr. Brown used, he (the speaker) heard a speech quite plainly. The instrument was capable, at any rate, of giving considerably better effects under laboratory conditions. It was a little early yet to predict how much real utility there might be for the new instruments, but he considered that these were exceedingly interesting and suggestive of future progress.

Mr. B. Davies sketched the work done by Sir Oliver Lodge in connection with the solution of the problem of a relay, some 10 or 11 years ago. Sir Oliver worked in carbon, which at that time was the only material one could think of. The idea of Sir Oliver Lodge was to produce a monophone relay, and, of course, that was a much more difficult problem. The difficulty with the carbon was that, although the speech was good, there was a loss in articulation which was rather serious. He produced one of Sir Oliver Lodge's instruments for inspection.

Dr. Voysey observed that he could appreciate and understand the application of the author's valuable invention to the purposes of an electrical stethoscope. He had had an opportunity of testing such a stethoscope in the ordinary way in a room in the out-patients department of a hospital, and over the telephone, and had been much impressed by it. The fact that it had been possible to transmit the sounds of a heart with distinctness over long and short distances by telephone was sufficient testimony of its magnifying power.

Mr. J. E. Kingsbury thought that the author did not do complete justice to other workers on the problem prior to his own invention. Expressing his appreciation of Mr. Brown's relay, he pointed out that there were still difficulties to be overcome. A relay that talked only one way was not a practical system.

Mr. B. S. Cohen said that, without detracting from Mr. Brown's valuable work in any manner, it was advisable to emphasize that the new apparatus could at present only be considered as a laboratory apparatus from the practical telephone standpoint.

Mr. A. C. Booth mentioned that Mr. Brown's relay was first tried for intensifying the received signals at radio-telegraph stations, and gave very promising results: magnifying the received signals from 4 to 12 times. It had also been tried for working as a repeater for telephone purposes, *i.e.*, it was placed in the middle of an artificial telephone line of 68 miles of standard cable. The speech at the end of this line was very little inferior to that over 34 miles of standard cable without the relay. When the line was put direct through 68 miles, speech was practically *nil*. As a further test, the relay was placed half-way along 108 miles of standard cable, and, although conversation was out of the question, one could clearly distinguish that speech was being made, whereas without the instrument the 108 miles of cable was absolutely silent. Regarding actual trunk line working, they had not yet more than just about commenced that stage of the experiments. Dealing with the weaknesses of the instrument, he said, in the first place, although the adjustment was simple, he found that it took time to settle down to its work. Sometimes more than an hour was spent continually regulating before good results could be obtained, but that, of course, might be due to insufficient experience on his part. Secondly, in regard to radio-telegraphy, the detectors were as a rule absolutely dead silent, except when signals are being received, whereas the relay gave a very slight, but appreciable, noise, due to its microphonic qualities. Respecting trunk telephone circuits, it was obvious that such a very sensitive instrument would magnify any defects or disturbances that might exist upon a line, and, as a rule, the longer the line the greater the number of minor defects, and it was on the long lines that such an instrument would be used. Then as regards the to-and-fro conversation, the switching necessary for this was certainly a disadvantage, and if the public were paying 10s. for three minutes, he was afraid the switching operations would appear to occupy more time than the conversation. The instrument had not been in use sufficiently long to give any idea as to its stability under continuous working conditions, and he fancied that some slight re-regulation would occasionally be necessary. This, of course, was another weakness, as the telephone public expected perfect speech with no lost time, quite irrespective of the length of line employed. In conclusion he considered that Mr. Brown's invention marked a very long stride in the direction of that most desirable object—a perfect telephone repeater.

Dr. W. H. Eccles spoke on the application of the telephone relay to wireless telegraphy. He showed a relay in a crude state in a cardboard box, which, he said, was based on almost the same principle as Mr. Brown's invention, except that it was selective and had a free wire instead of a damped reed. The difficulty he found with this selective form of relay was that it did not select so well as could be desired. He was greatly surprised to hear that the author, unlike himself, had succeeded in maintaining the gap perfect. The speaker added that it took him something like half a day to adjust the instrument.

Mr. E. H. Rayner referred to experiments with Mr Brown's relay. He thought that the invention, when worked into practical shape, would really increase the distance over which telephonic speech would be possible.

Mr. W. M. Mordey hailed the invention as a real and substantial advance in telephony.

Professor John Perry said the theory of the instrument was exceedingly simple, and it was marvellous how two things so remarkably close together could do all their work by variation and yet with absolute certainty.

The Chairman (Mr. S. Evershed), in closing the discussion, said that, not only was Mr. Brown's so-called relay not a relay, but no telephone relay had ever been invented, nor had any approach to it been made. The fact that the repeater could be used to such advantage in wireless telegraphy, opened up extraordinary possibilities.

The author, who promised to communicate his reply in writing, was heartily thanked for his interesting paper.

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ELECTRIC POWER.

For the third time, Mr. D. Selby Bigge, of Newcastle-on-Tyne, has reviewed before the Iron and Steel Institute's Conference the development in the production of electric power. The three papers form a valuable and most encouraging record of progress. In 1902, at Dusseldorf, he pointed out the advance made since 1894, when two papers had been read dealing with the electric drive for tools and machines in iron and steel works; fresh fields for conquest were indicated. Then in 1907, in London, Mr. Bigge was able to discuss a very notable step forward, for his subject was electric rolling-mills, with special reference to the high power reversing type then being introduced on the Continent. Now, after a lapse of three years, he was able, again before the Conference in London, to point to some progress. But he contended that manufacturers here have lost many opportunities, and are far behind their Continental and American rivals. There is, no doubt, a great deal of truth in the contention of the author that the two years of general slackness in the iron and steel trade ought to have given the opportunity for re-organising works and introducing electricity. Of course, this has been done to some considerable extent, as our readers know from accounts we have published from time to time, especially within the last twelve-months. But Mr. Bigge is right in saying that our manufacturers have not shown the same enterprise as their foreign *confrères*. A considerable portion of the paper under review was devoted to a discussion of prime movers suitable for general adoption in this country, and the author was able to point out the splendid improvements introduced in the design and construction of steam engines, gas

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engines and turbines, the last-named (but first considered) naturally coming in for special attention as a source of immense saving in an up-to-date equipped works. An actual case of electrification, that of the Fife Coal Co., was cited. This company has five mixed-pressure turbines of 1,000 b.h.p. each, and one of 800 b.h.p., and the current is generated at a tension of 3,000 volts and 50 periodicity. The complete electrification has not yet been effected, but at one colliery where a 750 kw. plant has been at work for a year, and after allowing 12% for interest and depreciation on plant, the current was produced at 0·2109d. per unit, and already, with partial electrical equipment, a saving of upwards of £3,000 a year has been achieved by the company. In iron and steel works something has been done, and Mr. Bigge deservedly gave praise to such firms as Dorman, Long & Co., Bell Bros., and Alfred Hickman. Nevertheless, though we have pioneers in industrial reform, we want a bolder army of followers. Mr. Bigge quoted the fact that one firm of electrical machinery manufacturers who had, within the past three years, laid down 300,000 b.h.p. of electrically driven mills on the Continent, and only 20,000 b.h.p. in Great Britain. Another firm had equipped electrically 234 mills abroad, with an output of 305,000 b.h.p., making for two firms alone, 605,000 b.h.p. in three years. We, unfortunately, have nothing to show like this, even making due allowance for the difference of the industrial field covered. Coming to the questions of voltage and transmission, Mr. Bigge gave expression to strong opinions, but opinions that have been gaining support in influential circles. He thinks that the overhead system, with bare conductors, is to be preferred, because costly protective insulating covers soon perished, and then became worse than useless. A bare line is also easier to deal with in the event of accidents. He would reserve insulation for towns, shops, etc. It is pleasing to find so close a student of events declaring in favour of aluminium stranded cables, which he considers far cheaper, capacity for capacity, than copper. As regards voltage, Mr. Bigge is all in favour of high tension. Seven years ago he introduced a uniform tension of 2,200 volts in South Wales collieries, and as this answered well, he increased the standard to 3,000 volts, and for driving auxiliary machines in mines he used a voltage of 1,000, three-phase current. With all these installations he experienced no tension troubles and no fatal accidents. Yet, with low tension installations of 220 to 500 volts, a number of fatal accidents had occurred. The facts being, of course, first, that greater precautions were taken in the equipment; and, secondly, in the general running of the concern. While not advocating high tension for cranes, machine tools and small motors, Mr. Bigge is in favour of its employment for all heavy work, and in this he will carry with him the majority of electrical engineers.

L.C.C. ELECTRICITY REGULATIONS.

The London County Council propose to issue new rules regulating the laying down of (1) high tension mains, (2) low tension mains, (3) high and low tension mains, (4) mains in subways, (5) construction of transformer boxes in the public streets and places under their jurisdiction.

CORRESPONDENCE.

All communications intended for the Editor should be addressed "The Editor, 149, Fleet Street, London, E.C." Anonymous communications will not be noticed. Letters should reach the Editor not later than Tuesday afternoon to be included in that week's issue of the Journal.

The Editor is not responsible for, nor does he necessarily endorse opinions advanced by correspondents.

COMMITTEE FOR PROTECTION OF ELECTRICAL INTERESTS.

Sir,—Referring to previous communications on the subject of an organisation for the protection of the legislative and commercial interests of the electrical industry, I have now the pleasure to inform you that at a meeting held at the Savoy Hotel, London, on Friday, May 6 last—the Hon. Arthur Stanley, M.P., presiding—the undermentioned gentlemen were constituted a Committee for the Protection of Electrical Interests, and the following is an abstract from the Rules which were adopted:—

1. The primary object of the Committee is to endeavour to secure united action with a view to the protection and advancement of the commercial and legislative interests of the British electrical industries, and for that purpose to take such steps as may from time to time appear advisable, and to co-operate, as far as possible, with all institutions, societies and associations, having similar or kindred objects.
2. The name of the Committee shall be the "Committee for the Protection of Electrical Interests," and may be shortly referred to as the "Electrical Committee."
3. The number of the Committee shall be limited to eighty members (besides the President, Hon. Treasurer, and Hon. Secretary). Any casual vacancy may be filled by the Committee at an ordinary meeting.
4. Any gentleman connected with the electrical industry and receiving the support of not less than five members, shall be eligible for election by the Committee. Election shall be by ballot: two black balls shall exclude, there being not less than six members present.
5. Every member of the Committee shall pay an annual subscription of one guinea, to provide for the expenses of the Committee; and any member whose subscription remains unpaid more than three months after it becomes due, shall be liable to have his name removed by the Committee from the list of members.

The Committee in its collective capacity starts with neutrality on all contentious matters.

Proposals for the election of a President, Hon. Treasurer, and Hon. Secretary will be submitted at a meeting of the Committee to be held at an early date.

The Electrical League and the Electrical Industrial Association of Great Britain, referred to in former correspondence, will not now be proceeded with, and all subscriptions which I have received are being returned in full.

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I am, Sir, your obedient servant,

R. BORLASE MATTHEWS, Wh.Ex., A.M.I.C.E.,

Hon. Secretary.

Bank-buildings, Kingsway, London, W.C.
May 10, 1910.

BURTON-UPON-TRENT TRAMWAYS.

Mr. P. J. Pringle, Tramways Manager and Borough Electrical Engineer, in presenting his seventh report on the working of the tramways for the past 12 months ended March 31, notes an increase in traffic on the previous year. This increase was due to the fact that there are two Easters falling in this financial year against one last year. Still, deducting the effect this year's Easter has had on the receipts, we have practically held our own compared with last year. Last year the traffic receipts were £701 14s. 4d. lower than the previous year ending March, 1908, and this latter year showed a reduction of £636 10s. 10d. on the year ending March, 1907. It is difficult to say what has led to the improvement in the last quarter as there is still severe trade depression to contend with and a scarcity of special events in the town.

The car mileage this year is 428,219, compared with 425,843 last year, or an increase of 0·56%. This increase is due to the speeding up of the service on the Horninglow route up to mid-day, and on the Stapenhill and Winshill routes from about 7.30 p.m. to finish, these alterations being put into force on July 1, 1909.

The total income this year, including £931 11s. 3d. received from the Burton & Ashby Light Railway on account of their cars running over our lines, and a further £157 6s. 8d. balance of rent on the lines leased to them, amounts to £15,132 19s. 6d., compared with £15,109 6s. 8d., or an increase of £23 12s. 10d.

The current consumption per car mile, including the Burton & Ashby Light Railway cars, amounts to 1·29 units compared with 1·28 last year, and of this the estimated consumption of our own cars is 1·27, compared with 1·26 last year.

As four more cars were covered in in March, 1909, about 30% more of the total mileage has this year been run with covered cars. As a covered car is generally estimated to consume about 10% more energy than an uncovered one, our current consumption would on last year's figure have been increased from 1·26 to 1·3 units per car mile. As it has only increased to 1·27, there is actually a reduction.

The current consumption is still a reasonable figure, and out of 75 Municipal Tramway Undertakings, there are only 22 having a slightly lower consumption per car mile.

The revenue per car mile from our own traffic has dropped from 7·73d. to 7·70d., although we have given an improved service.

The weather generally has not been so good as last year. There have been 225 fine, 33 wet, 95 partially wet, 4 foggy and 8 snowy days, compared with 244 fine, 19 wet, 88 partially wet, 9 foggy and 5 snowy days last year.

A statement shows that 3,082,804 passengers have been carried, against 3,096,805 last year. The passengers per car mile have reduced from 7·25 last year to 7·18 this year.

This is an increase in the ordinary 1d., 1½d., and 2d. tickets, and a decrease of 4·5% in the workmen's 1d. tickets, the issue of which constitutes a universal 1d. fare. Certain 2d. stages, it will be remembered, were reduced to 1½d. at the beginning of 1907, and the issue of 2d. and 1½d. tickets for the past 3 years compare as follows:—

Year.	1½d. tickets.	2d. tickets.	Total.
1907–8	21,775 ..	176,619 ..	198,394
1908–9	261,608 ..	17,083 ..	278,691
1909–10	279,211 ..	17,372 ..	296,583

From the above it will be seen that 98,189 passengers more have travelled over a two-stage ride during this year, compared with the year 1907–8. This year's reduction in the total passengers carried, coupled with the increase in receipts, is due to a similar cause, *i.e.*, more people have travelled over a two-stage journey this year, compared with last year.

The maximum number of passengers carried on any one day was 19,343, on Saturday, June 26 (Life Boat Demonstration), the receipts, which were also the maximum, being £86 12s. The corresponding figures for 1908–9 were 18,367, on Thursday, December 24, the receipts being £81 7s. 11d.

The average earnings on Sundays have again dropped, being 7·01d. per car mile, compared with 7·22d. last year; 7·41d. for the year 1907–8; and 8·37d. for the year 1906–7. In the second year of working, 1904–5, our Sunday traffic averaged as high as 10·5d. per car mile. There was a drop on each of the first three quarters of this year, compared with the previous year, but the last quarter has shown a strong upward tendency amounting to an increase of £282, and more than balances the previous decreases.

The operating expenses have been reduced from 6·37d. to 6·26d. per car mile. The principal reduction is in traffic expenses. Repairs and maintenance show a small increase of £136 11s. 3d., notwithstanding the fact that they have carried out a great deal of extra repair work this year. The traffic revenue and operating costs for the first and last years are given below:—

	Traffic Revenue.	Operating Cost
1903–4 (8 months) ..	9·84d...	*7·57d.
1909–10	7·70d...	6·26d.

* Several initial expenses and cost of stock included.

In considering the above serious reductions in traffic revenue per car mile, it might be noted that an extra 1d. per car mile on the present year's return would represent nearly £1,800. The operating expenses of 6·26d. per car mile for an undertaking having almost completed its seventh year of working, will compare favourably with other undertakings in the country.

Taking the mean of some 63 municipal undertakings (these being all the statistics available) who purchase power in the same way as Burton does, their mean operating costs are 6·578d. per car mile, and only 23 have lower costs than Burton's.

The parcel traffic, which includes carriage of passengers' luggage, continues to show an increase. This year the number amounts to 55,005 against 48,831 last year, or an increase of 12·7%.

The parcel delivery system, which is included in the above, and by which parcels up to 28 lbs. are delivered within half a mile of the tramway route, at a charge of 1½d. per parcel, again shows an increase, the total number delivered being 7,511 against 5,951 last year, or an increase of 26·3%. The total revenue from passengers' luggage and

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parcels traffic amounts to £244 16s. 8d., compared with £215 17s. 2d. last year, while the expenditure only amounts to about £25.

The undertaking has been carefully and thoroughly maintained. There has been a good deal of re-painting of cars and repairs to woodwork to carry out. Certain improvements in the sanders have been completed, and, in addition, 9 cars have been fitted with trolley earthing devices to give increased safety to the public, at a cost of £24. Overhead maintenance is up £33, but as a special expenditure of £101 on painting work has been incurred, this item otherwise is down. There have been no fractured trolley wires to report.

After nearly seven years' running, the permanent way is necessarily incurring a great deal of consideration. This item is up £106, but sub-dividing this, repairs of paving is down £182, while repairs to permanent way alone is up £288.

Hammering and pumping joints have had to be seriously tackled, and some 165 have been thoroughly overhauled, including anchoring, and put in satisfactory condition. In addition, the rails have been anchored in 160 other places. The checks of part of four curves have been renewed, and some seven points and crossings repaired with manganese steel to further prolong their life. The work of maintaining the level crossings has been heavier this year, nine having been overhauled. Two of these have been fitted with special boxes, so that every bolt and nut is now accessible without disturbance of the pavement. Much thought has been given to carrying out this work in the best and most economical manner, and I anticipate that the attention we are now giving to the joints will greatly reduce the cost of paving repairs, besides valuably prolonging the life of the track.

The fitting of the skid emergency brake on certain of the cars has been instrumental in saving three very small children from serious or possibly fatal injury, and three collisions. Seven drivers have been awarded a 5s. bonus for special promptness in averting accidents, and two of these have, in addition, been specially rewarded by the public.

This year the number of articles left on the cars is 231, of which 206 articles have been claimed. Last year there were 223 articles left in the cars, and 194 were claimed.

The gross revenue account for the twelve months shows a surplus of income over expenditure of £3,243 5s. 7d., compared with £3,188 3s. 5d. last year, and represents 3·06% on the capital expenditure.

The repayment of debt and interest charges have increased this year by £63 10s. 11d., and amount to £4,998 19s. 8d. The Council have again decided to adopt the same wise policy as hitherto, and set aside £1,000 as a reserve or renewals fund. This brings the fund up to £6,789 10s. 5d., or 7·15% on the capital expenditure. Apart from this contribution to the reserve or renewals fund, the trading account for the year shows a deficit of £1,755 14s. 1d., compared with £1,747 5s. 4d. last year. As £1,000 of this year's contribution to reserve fund has to be found in addition, the total deficit amounts to £2,755 14s. 1d.

Burton and Ashby Light Railway.

These cars have run 49,870 miles on the running powers section, compared with 49,690 last year, the receipts from same having increased from £926 8s. 4d. to £931 11s. 3d. They have consumed 49,833 units of electricity for the working of the leased lines, and their estimated amount on the running power lines is 72,311 units.

Although it does not appear in Mr. Pringle's report, it is only fair to say that this year the Council have provided, in addition to the £1,000 for depreciation, a further £495 12s. 6d., mainly on account of rebate in income tax granted to us for the three previous years. This should be borne in mind when the trading deficit of £1,755 14s. 1d. is compared with £1,747 5s. 4d. of last year. This brings the reserve fund up to £6,789 10s. 5d., or 7·15% on the capital expenditure.

COOKING BY ELECTRICITY.

The annual staff dinner of the Bournemouth and Poole Electricity Supply Co., Ltd., took place at the Gervis Hall Restaurant, Bournemouth, when Mr. A. H. Sanderson, J.P. (chairman of the company), presided, being supported by Dr. J. Atkinson Hosker, J.P. (vice-chairman), Mr. H. Page Croft, M.P., Mr. H. B. Renwick (electrical engineer), Mr. W. D. Brightman (local secretary), and a numerous company.

An interesting feature of the function was the fact that the whole of the dinner was cooked exclusively by electricity, and the oven and other apparatus used were in the dining room, the cooking operations being carried out before the dinner and were open for inspection. The dinner proved to be an excellent one, and demonstrated in a splendid manner the usefulness of electricity as a means of cooking, whilst the various dishes of the *menu* were cooked and served admirably When it is remembered that the *chef* (Mr. Dawson) had only tried the apparatus on the previous Saturday, and had no other experience, the result of his efforts were most satisfactory and pleasing. He had said there was no doubt whatever about the cooking by this method generally, although with reference to the omelettes he had some doubt, but those proved to be one of the best dishes of the eveinng. The room had also been artisitcally decorated with numbers of electric lights, which greatly enhanced the appearance of the scene.

ELECTRICITY IN GERMAN EAST AFRICA.

News comes to hand from Frankfort-on-Main that the Governor of German East Africa has granted a concession to Mr. Cieseniss, of Frankfort, for an electric power installation at the Pangani Falls. A syndicate is being formed with a capital of 6 million marks to work the scheme, and a 30,000 h.p. plant, to be afterwards enlarged to 80,000 h.p., is to be erected. The intention is to use the power for the manufacture of artificial nitrates from the air. Amongst the chemical companies whose reports have just been issued are the (Hungarian) Clotilde Chemical Works, which are again paying 8%. The aniline colour company, Kallé & Co., Biebrich, show a net profit of 852,382 marks, against 222,730 marks, and are paying 10%, against 4% last year. Further particulars are not yet available. The Schuster & Wilhelbrug Chemical Co., Forlitz, are again paying 4%, and a more profitable year is anticipated. The Billwärder Chemical Works, formerly Hell & Sthamer, Hamburg, report a net profit of 380,859 marks, against 319,927 marks last year, and are again paying 10%. The capital is 2½ million marks. The Griesheim Electron Chemical Works, Frankfort, manufacturers of aniline colours, are erecting a large new plant at Bitterfeld for the manufacture of organic acids used in their business.

A NEW ELECTRIC ASSOCIATION.

We cordially welcome the formation of the Association of Electrical Engineering Students, L.C.C. School of Engineering, Poplar, E., of which Mr. H. A. Garratt, M.I.N.A., Assoc.M.Inst.C.E., is President; and Mr. J. Paley Yorke, F.Ph.S.L., and Mr. W. W. S. Ibbetson, B.Sc., A.M.I.E.E., Vice-Presidents; with Mr. M. F. Allsop, Student I.E.E., as Hon. Secretary and Treasurer; and Mr. W. T. Brading as Assistant Hon. Secretary and Treasurer. The objects of the new society are: To hold meetings, at which papers will be read and discussed. The first paper was read on Saturday, April 30, by the President, H. A. Garratt, Esq., the title being, "James Watt." The next paper will be read on Wednesday, May 25, by one of the Vice-Presidents, Mr. W. W. S. Ibbetson, the title being "Hydro-Electric Power Stations."

INCORPORATED MUNICIPAL ELECTRICAL ASSOCIATION.

In connection with the annual Convention of the above Association, to open at Glasgow on June 14, our contemporary, *Electrical Industries*, has arranged to run special saloon carriages on the 2 p.m. train from Euston, on June 13, reserved for members attending the Convention. The train, which will arrive at the Central Station, Glasgow, at 10.20, will stop at Willesden, Rugby, Crewe, Preston and Carlisle, where members may board the saloons. The return fare from Euston is at the very reasonable rate of £2 1s. 3d.

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PUBLICITY.

In this Section of "The Electrical Engineer" we give Publicity to New Inventions and Specialities.

OIL ECONOMY.

Oil being one of the heavy items in station expenditure, anything tending to economy in its use must prove welcome. Now, the Valor Co., Ltd., have made a special study of this question, and have three thoroughly practical appliances, which have already met with approval as the result of actual experience, but which deserve to be even more widely known. The first of these is the "Valor" automatic waste oil filter, of which we give two illustrations. It will filter dirty oil from gas engines, dynamos, and all kinds of machinery, making it quite fit for using over again. It is quite simple to use. The dirty oil is poured into the container B (in the larger patterns there is a strainer chamber to hold back the grosser impurities), and when the oil rises above the upper filtering chamber C, filtration commences. The oil penetrating upwards through the perforated plate D, cotton waste E, and plate G, overflowing into and down outlet tube H, on to and through upper perforated plate in the lower filtering chamber C1, cotton waste E1, and finally dripping into filtered oil container, can be drawn off thoroughly purified, ready for use at tap P. Even with excessively dirty oils, these filters enjoy long lives with efficient work, and the recharging of the filtering mediums is not an expensive affair. Our third illustration represents the Company's "Rapid" improved oil filter. It will be seen that the construction is rather different, but it is as easy to use, and, if anything, even more efficient than the "Valor." In this case, the lid and waste oil receptacle are first removed, then clean warm water is poured into tank until it runs out of gauge tap B. This being done, empty in pure oil until it rises to filtered oil tap C, fix the steam connection to the steam coil at bottom of the filter, and turn on sufficient exhaust steam to keep the water warm, then replace waste oil receptacle A. All being ready, empty the waste oil into receiver A, until it rises above the perforated lid, and cover D. The oil will then run through perforated lid and waste E, into compartment F, down pipe G, and on to underside and up through perforated disc H. The oil then rises, and can be drawn off thoroughly filtered and ready for use at tap C. The filtering material lasts well, and when exhausted can be replaced in a few seconds. Our fourth illustration represents a somewhat more humble, but nevertheless necessary article, a store for oil. This patent oil cabinet, which is painted a bright red, is always clean, safe, and a preventer of waste. It has no taps, and the lid can be padlocked. The oil is removed by means of a polished brass pump of simple construction. It should be pointed out that if a vessel be pumped too full, the overflow runs back into the cabinet. Filling from a barrel is equally easy, so that there is no excuse for waste or dirt. These cabinets, with one or other form of filter, are necessary in every station and sub-station.

FIG. 1.

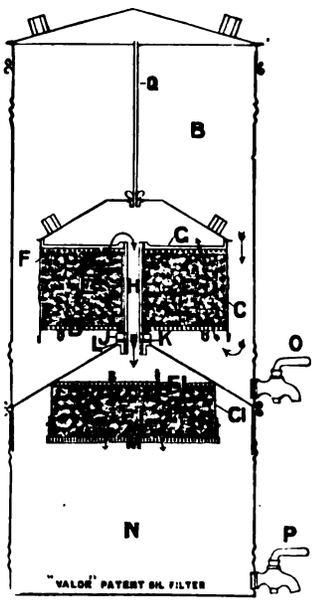

FIG. 2.

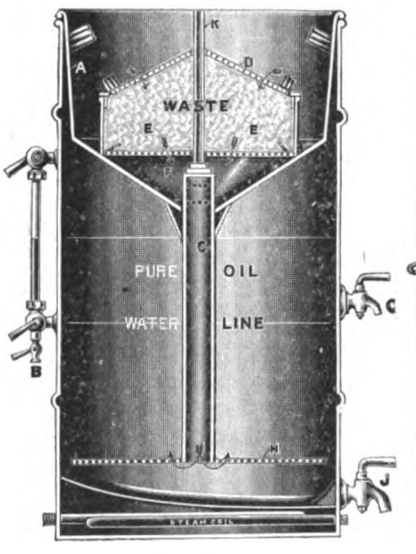

FIG. 3.

FIG. 4.

INTERNATIONAL ELECTRO-TECHNICAL COMMISSION.

Canadian Branch.

A Canadian branch of the International Electro-Technical Commission has been formed, Professor L. A. Herdt, head of the Electrical Engineering Department, McGill University, Montreal, being elected chairman. The other members are: Dr. H. T. Barnes, McGill University; Professor T. T. Roserugh, Toronto University; Professor L. W. Gill, Queen's University; Mr. O. Higman, chief electrical engineer, Electrical Standards Laboratory, Ottawa; John Murphy, electrical engineer, Railway Commission, Ottawa; W. A. Duff and A. B. Lambe, Winnipeg.

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CIRCUIT BREAKERS.

Certain New Types.

The transmission system of the Idaho-Oregon Light and Power Co., in the region surrounding Boise, Idaho, possesses more than local interest, chiefly owing to the experience with different types of circuit breakers. It should be mentioned that there are two hydro-electric generating stations: one of 1,500 kw. capacity and the other of 900 kw. capacity, together with about 112 miles of high tension transmission line, approximately one-half of which operates at the transmission potential of 66,000 volts and one-half at 23,000 volts.

Some particulars of the equipment are given by *The Electrical Review and Western Electrician*, Chicago, from which we take the following:—

The two generating stations supply the principal load of the system, the lighting and traction service of the city of Boise, through 23,000 volt lines. To supply the region north and west of the town, where, besides the local service, power is used for mining, a transformer substation has been installed 42 miles from the city and 16 miles beyond the larger power station, stepping up from 23,000 to 66,000 volts through three 1,000 kw. delta-connected Westinghouse transformers. From this station the 66,000 volt lines continue through the Plymouth and Ontario substations to the Weiser substation.

The principal substation, both in the present plant operation and in the transmission scheme, including the new Oxbow stations, is that at Emmett. This station equipment includes three delta-connected 1,000 kw. transformers, stepping from 23,000 to 66,000 volts, for transforming the principal through load; and three 100 kw., 66,000 to 2,300 volts, transformers, star-connected, for supplying the local distribution lines in the territory adjacent to the station.

The in-coming 66,000 volt lines from Ontario and Weiser, of stranded aluminum cable of a carrying capacity equivalent to No. 1 copper, are brought into the Emmett substation past aluminium cell, electrolytic lightning arresters, and carried through disconnecting switches to impedance coils, and thence to the 66,000 volt station busbars. Feeding from these, the main power load of the system is led through three Westinghouse type "GA" oil circuit breakers to the group of 1,000 kw. transformers, stepping down to 23,000 volts. The low tension terminals of these units are connected through Westinghouse type "E" oil circuit breakers to the line, after passing lightning protective apparatus, in general, similar to that on the incoming 66,000 volt lines. The second circuit taken from the 66,000 volt station busbars is led, through a similar set of type "GA" oil circuit breakers, to the 100 kw. transformers of suitable ratio, lowering to the 2,300 volt distribution voltage. From these 2,300 volt busbars, the feeder circuits are controlled by Westinghouse type "B" circuit breakers. The equipment of the other substations is quite similar in the arrangement of the distributing and feeder circuits and the apparatus involved, although the Emmett station is the only one where the main power load must be controlled at the full transmission voltage.

One of the interesting developments of the Idaho-Oregon installation has been the performance, as recorded in service, of the Westinghouse type "GA" oil circuit breakers. On this transmission system there are now four of these three-pole units operating. Two of these are in the Emmett substation, and one in each of the Weiser and Ontario substations.

The Westinghouse type "GA" circuit breaker is made up of single pole units immersed in oil in separate boiler steel tanks, without other connections than the operating or pull rods working the contacts. The operating system consists of a simple arrangement of levers, bell cranks and links, actuated by a toggle from the switchboard handle. The trip coils are actuated from the low tension winding of series transformers connected in the line wires. In the newer and present standard type of these circuit breakers above 100 amperes capacity, these series transformers are mounted directly over the high tension bushings of the breaker forming a part of the breaker. The controlling force in the opening of these circuit breakers is that of gravity, the moving parts being so positioned and proportioned that the contacts automatically drop open to produce a wide and ample break in the clean oil of the centre of the tank when the mechanism is released by the handle or tripping coils. The spring socketed seats of the butt contacts also assist in producing a rapid positive break, besides assuring a self-aligning and firm closure of all of the contacts.

The leads or bushings of these circuit breakers are of the well-known condenser terminal type brought out by the Westinghouse Co. A simple tell-tale device indicating the position of the contacts is provided by a small double pole, double throw switch operated by the controlling system which is arranged to light a red lamp on the switchboard while the circuit is closed, and a green lamp when the breaker is open.

The 66,000-volt "GA" circuit breaker for the Idaho-Oregon system have a total break of about 17½ in. per contact, or 35 in. per pole. Each breaker has a rated capacity of 300 amperes, being especially designed to open the circuit under severe conditions. The small space and head room required by this apparatus especially recommends it for installations where space is limited, and the thorough insulation afforded by its oil immersed contacts in lined tanks, the internal insulating barriers and condenser terminals insure the reliability and safety of its operation in handling the heaviest overloads and short circuits. The ease with which these circuit breakers are installed and adjusted, and the accessibility of all operating parts for examination, are also important items in gaining the favour of operating men where "GA" breakers have already been put into service.

The "GA" circuit breakers on the lines of the Idaho-Oregon Light & Power Co. have already been operated more than six months, and during this time have handled some extreme overloads and surges in a manner gratifying to the company's engineers. Several surges have occurred in which the voltage rose beyond the scale of the meters, 90,000 volts. These phenomena have been observed during heavy wind storms and when the Boise sub-station trips out. The Boise load is inductive, and tends to neutralise the heavy capacity of the lightly loaded transmission line. No static appears on these terminals, although at times the wiring and porcelain insulators have displayed considerable corona. The performance of these circuit breakers has been a source of much satisfaction to the operating officials, as their operation has been uneventful and dependable under all conditions so far met during the most severe season of the year.

BRITISH SCIENCE GUILD.

The first annual dinner of the British Science Guild was held on Friday last at the Princes Hotel, Piccadilly. Lord Strathcona presided, in the absence of Mr. Haldane, M.P. (the President), and among those present were Lord Blyth, Sir Thomas Barlow, Sir David Gill, Sir William Ramsay, Sir Alfred Keogh, Sir William White, Sir Boverton Redwood, Colonel Sir John Young, Sir Aston Webb, Mr. Roger W. Wallace, K.C., Dr. Halliburton, F.R.S., Mr. F. Verney, M.P., Sir Norman Lockyer, Professor Perry, F.R.S., Dr. W. N. Shaw, F.R.S., Mr. Thomas Carmichael, Dr. Waller, F.R.S., Sir Henry Trueman Wood, Mr. C. Freeman Murray, and Dr. F. M. Perkin (hon. secretary). Sir William Ramsay, after referring to the value of science to the manufacturer, said that at a military dinner recently he was asked the best way to destroy dirigible balloons. He made certain suggestions, and then they said to him, "Why should not men like you come and tell us what you know?" He was willing to give what advice he could, and there were thousands of men able and willing, if asked, without pay, to do the same. The practical solution of the problem seemed to have been hit off by Mr. Haldane in his suggestion that there should be consultative committees formed representing, not only all departments of science, but all branches of knowledge. He did not see why the State should not occupy the same relation to its consultants as manufacturers did to theirs and pay them. Sir William Keogh said that Mr. Haldane had been the great exponent of science to methods of government.

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Electrical Contractors' Section.

A Survey of New Things and Business Prospects.

NOTICE.

Contract and Miscellaneous Advertisements should reach this Office by Mid-day on Wednesday. For rates apply to the Manager, 149, Fleet Street, London, E.C.

CONTRACTS.

BECKENHAM URBAN DISTRICT COUNCIL.

ELECTRICITY UNDERTAKING.

TO ELECTRIC WIRING CONTRACTORS.

THE BECKENHAM URBAN DISTRICT COUNCIL invite TENDERS for the ELECTRIC WIRING OF HOUSES in their District.

Specifications, General Conditions, and Forms of Tender can be obtained from the Resident Engineer, Mr. J. E. Tapper, Electricity Works, Churchfields-road, Beckenham, on production of the receipt of the Council's Collector for the sum of Two Guineas. The Collector attends at the Council Offices, Bromley-road, Beckenham, from 9 to 10 a.m. daily. The deposit, which may be made by post, will be returned upon the receipt of a *bona fide* Tender.

Contractors are asked to quote alternative prices, one price to include canvassing the other on the assumption that the Council will do the canvassing and hand over the orders.

For any further information with regard to the proposed Contract, application should be made to the Resident Engineer, Mr. J. E. Tapper, Electricity Works, Churchfields-road, Beckenham.

Sealed Tenders, endorsed "Wiring," to reach the undersigned not later than 4 p.m. on Monday, the 23rd May, 1910.

The Council do not bind themselves to accept the lowest or any Tender.

By Order,
F. STEVENS,
Clerk of the Council.

ST. PANCRAS BOROUGH COUNCIL.

TO COLLIERY OWNERS AND CONTRACTORS.

THE ST. PANCRAS BOROUGH COUNCIL invite TENDERS for the SUPPLY OF WELSH and other STEAM COAL for use at the Regent's Park and King's-road Electricity Stations, for twelve months. Delivery to be made as required.

Copies of the specifications, conditions of contract, and Form of Tender to be obtained upon application at the Electricity Department Offices, No. 57, Pratt-street, Camden Town, N.W., on payment of a deposit of £1, which will be refunded only on the specification being returned, accompanied by a *bona fide* Tender.

Tender to be sent to the undersigned, endorsed "Tender for Coal," by twelve o'clock noon, MONDAY, MAY 23, 1910.

The Council do not bind themselves to accept the lowest or any Tender.

C. H. F. BARRETT,
Town Clerk.

Town Hall, Pancras-road, N. W.,
May 3, 1910.

PATENTS.

S. SOKAL, Chartered Patent Agent,
AND
Certified Austrian Patent Attorney (Patentanwalt),
Specialist for German Patents and Patent Litigation.
55, CHANCERY LANE, LONDON, W.C.

THE PROPRIETORS of the PATENTS, Nos. 9413 of 1906, 9418 of 1906, 9423 of 1906, 9424 of 1906, for "Improvements in Pneumatic Tube Systems" and "Improvements in Governing Mechanism for Pneumatic Tube Systems," are desirous of entering into arrangements by way of license and otherwise on reasonable terms for the purpose of exploiting the same and ensuring their full development and practical working in this country. All communications should be addressed in the first instance to HASELTINE, LAKE, and Co., Chartered Patent Agents and Consulting Engineers, **7 and 8**, Southampton-buildings, Chancery-lane, London, W.C.

CONTRACTS OPEN.

HOME.

BECKENHAM.—Council invite tenders for the electric wiring of houses in the district. Particulars from Mr. J. E. Tapper, Electricity Works, Beckenham. May 23.

BELFAST.—Borough Tramways and Electricity Committee.—Contract No. J. 7, motor boosters and switchgear. Contract No. J. 8, extension of lighting switchboard. (Specification, £1 1s. each, City Electrical Engineer, East Bridge-street, Belfast). May 23.

BLACKPOOL.—Borough invite tenders for alterations and extensions to the offices at the Electricity Works. Particulars from Surveyor. May 18.

CROYDON.—Borough Council.—Lighting two isolation pavilions and administrative block (additions). (Specification, £1 1s., Borough Electrical Engineer, Town Hall). May 20.

DARLINGTON.—Borough invite tenders for one cooling tower, one electrically-driven centrifugal pump, one electrically-driven air pump, one boiler feed pump. Particulars from the Borough Electrical Engineer. May 25.

DUBLIN.—Corporation.—Flame arc lamps and arc lamp pillars. (Specification, £1 1s., City Electrical Engineer, Fleet-street, Dublin). May 20.

EGREMONT.—Wallasey Urban District Council.—Two years' supply of alternating current transformers. (Particulars, Electrical Engineer, Seaview-road, Liscard). May 30.

LEICESTER.—Corporation Tramways Committee.—Contract (a) one mixed pressure steam turbine, direct coupled to a 750 kw. direct current generator, together with condensing plant, switchboard, etc. Contract (b) two Lancashire boilers, fuel economiser, steam feed, blow off, and drain pipes, etc. (Specification, £2, Tramways Engineer, Belgrave-road Station). May 28.

LONDON, ST. PANCRAS.—Borough Council, 21 flame arc lamps, 20 iron cradles. Particulars from Electrical Engineer. May 23.

LONDON: ST. PANCRAS.—Borough Council invite tenders for twelve months' supply of Welsh steam coal to Regent's-park and King's-road Electricity Works. Specifications from Electrical Engineer. May 23.

SOUTHAMPTON.—Borough Council.—One 1,000 kw. generator, boiler, alternator, and motor alternator. (Particulars, Borough Electrical Engineer, Western Shore Works). May 24.

CONTRACTS OPEN.

OVERSEAS.

ROME.—Italian State Railways Department invite tenders for electric motor spare parts. May 22.

TENDERS ACCEPTED—Home.

EDINBURGH.—The tender of the Western Electric Co. for the supply of insulated cable at over £6,400 was accepted. The lowest tender, £5,866, was put in by the Lahmeyer Electric Co.

LONDON.—London County Council: The following tenders for installation of electric lighting at the Board's schools have been accepted: Lauriston-road, Hackney, Central Motor Engineering Co., 77, Parkhurst-road, Holloway, £111 16s.; the Reay, Brixton, E. Newbold & Co., Court-road, Sutton, £113 3s. 6d.; the Barnsbury Park, Islington, Waring & Withers, 10A, Soho-square, £184 9s. 9d.; Manor-lane, Lewisham, Johnson & Phillips, Ltd., £371 10s.; Shelbourne-road, Islington, Johnson & Phillips, Ltd., £209; Torriano-avenue, St. Pancras, Johnson & Phillips, Ltd., £233 10s.

LONDON.—The London County Council have accepted the following tenders: (i.) the Patent Shaft and Axletree Co., Ltd., for the supply of 4,800 steel driving wheel tyres for electric cars at the price of 21s. 6d. each; (ii.) John Batt & Co. (London), Ltd., for the supply of 1,600 steel pony wheel tyres at the price of 15s. 9d. each; and (iii.) Alley & MacLellan, Ltd., of Glasgow, for supply of air compressor and receiver for second section of the central car repair depôt, at £187 10s., with right to sub-let the air receiver part of the contract to Muir & Findlay, or T. Balmforth, Ltd., and the valves to Dewrance & Co., Ltd.

WALTHAMSTOW.—The tender of Messrs. Siemens Bros. Dynamo Works, Ltd., Tyssen-street, Dalston, London, N.E., has been accepted by the Walthamstow Urban District Council for the supply of "Tantalum" lamps.

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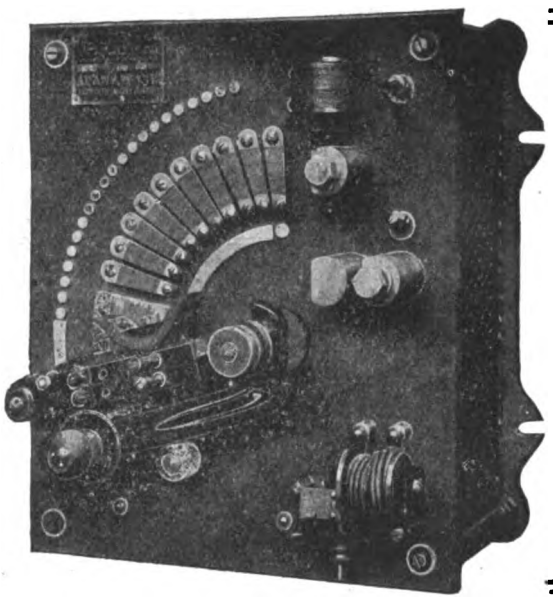


Only One Handle

is required for starting and regulating the speed of Machine Tools when

ADAMS'

'IGRANIC'

Machine Tool Controllers

ARE USED.

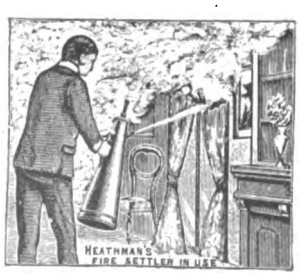
NOTES.

Mercury Vapour Lamp for Blue Prints.

Blue printing outfits are largely in demand, not only for engineering and architectural offices, but also in connection with law stationers' and even typewriters' offices. It is, therefore, of interest to dealers to hear that the Westinghouse Cooper Hewitt Co., Ltd., have brought out a new patent outfit. It consists of one or two Cooper Hewitt lamps mounted on a special reflector arranged so that it can be lowered past the face of an ordinary printing frame at a speed under the control of the operator. The reflector is mounted on a vertical tube supported by a copper cable passing down the centre of the tube, attached to which is a piston. The supporting tube having been filled with water and all necessary electrical connections made, the apparatus is ready for service. When not in use, the reflector is retained at the top of the supporting tube by a special catch, which having been released and the valve opened, the reflector with the lighted tubes will fall by gravity under the restraint of the piston acting hydraulically through the valve. The light is uniform throughout the whole length of the tube, and, being displaced at a constant speed, the sensitized paper is evenly exposed on all parts of its surface. The light is of an unvarying quality, which enables exposures to be determined definitely. Low current consumption; two lamps, providing an illumination of 2,000 c.p., consuming 3½ amps. on 200 to 250 volts, or 7 amps. on 100 to 120 volts.

Heathman's Fire Settler.

Like the proverbial stitch in time, the jet in time saves nine, as a small fire is quickly snuffed out which being suffered, rivers could not quench; so that herein lays the value of the Heathman Fire Settler, which is a two-gallon pyramidical cylinder charged with chemicals which produce carbonic gas to a pressure of about 60 lbs. per sq. in.



immediately a plunge rod is pushed down, and a powerful jet of water super-saturated with carbonic acid gas is ejected to a considerable distance. Messrs. Heathman & Co., of Parsons Green, S.W., are manufacturing these settlers in large numbers, as we see such things upon every motor omnibus, as well as in the electric trams and on motor rail trains.

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The Latest and Most Novel Patterns.

The Best and Cheapest In the End.

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"IGRANIC" Controllers are made in the largest electric control factory in this country.

They have 20 years' experience behind them—experience gained by experts who have devoted their brains and energies to the one subject of Electric Control.

Descriptive pamphlet post free on request.

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ADAMS

Elektromotorenwerke Heidenau G.m.b.H.

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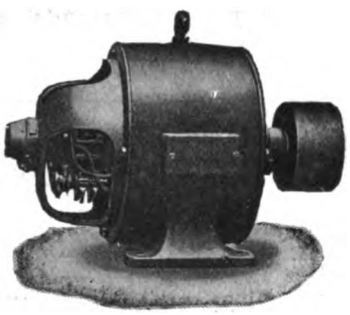

Electrical Motors, Dynames and Accesseries.

Price List Free upon application.

Large discount allowed to retail dealers.

Expert representatives required.

Progress Papers.

Messrs. T. W. Broadbent, Ltd., are bringing out a series of electric illustrated leaflets describing their machinery. These leaflets are called "Progress Papers," which are worth having to place before customers. By the way, Messrs. Broadbent report that trade continues very satisfactory, the following being some of the orders which they have booked this year:—

MACHINES: One 90 b.h.p. continuous current motor to run at 525 r.p.m. on a 200-volt circuit (repeat order); one 48 b.h.p. continuous current motor to run at 600 r.p.m. on a 200-volt circuit (repeat order); one 32 kw. dynamo, compound wound for an output of 139 amps., at 230 volts at 750 r.p.m.; one 30 b.h.p. three-phase motor to run at 1,400 r.p.m. on a 400-volt 50-cycle circuit; one protected continuous current motor to give 15 b.h.p. at 800 r.p.m. on a 200-volt circuit; one 9 kw. dynamo, compound wound to give an output of 39 amps. at 230 volts at 1,075 r.p.m.; one single-phase motor to give 8½ b.h.p. at 2,720 r.p.m. on a 100-volt 100-cycle circuit; one 3 b.h.p. single-phase motor to run at 2,680 r.p.m. on a 200-volt 100-cycle circuit; one 2 b.h.p. single-phase motor to run at 2,660 r.p.m. on a 220-volt 50-cycle circuit.

STARTERS AND SWITCHBOARDS: one continuous current lighting switchboard, capacity 40 kw.; one H350 continuous current motor starter (90 b.h.p. at 220 volts); one H175 continuous current motor starter (40 b.h.p. at 220 volts); one H50 continuous current motor starter (12 b.h.p. at 220 volts); one P10 single-phase motor starter (2 b.h.p. at 220 volts 50 cycles); one P10 single-phase motor starter (3 b.h.p. at 220 volts 100 cycles); one P50 single-phase motor starter (7 b.h.p. at 100 volts 100 cycles); one TP50 three-phase motor starter (30 b.h.p. at 400 volts 50 cycles).

Osram Lamps Survive a Heavy Smash.

Extraordinary evidence as to the remarkable strength of the present-day Osram filament is to be found in an accidental occurrence which happened in Glasgow during the recent gusty weather. A heavy sun blind fitted to the shop front of a small drapery establishment in Calder-road,

Glasgow, became dislodged, and fell upon two brackets supporting Osram lamps. The force of the fall—something over 4 ft.—was so great that it shattered the front board of the sun blind and permanently deflected the bracket

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Continental Expert in the manufacturing process of Wolfram-Metal and Wolfram Filaments for Glow-lamps

is ready to teach and train responsible gentleman in the best methods of establishing plants in the U.K. and render such services as may be necessary for the successful conducting of this marvellous, highly profitable business. Charges reasonable. Negotiations through—**Alfred Scheilhase, 290, Old-st, E.C.**

PLANT FOR SALE.

Advertisements under this heading: Twenty-four words, 1s. per insertion; three insertions for 2s. 6d.; or each additional line of eight words, 4d.

COMPLETE ELECTRIC LIGHT PLANT, consisting of "Crossley" High Speed Gas Engine, Type S.E., No. 39635, with self-starter, 25 b.h.p., 1 dynamo by "Vaughan & Brown" V. 105, A.225, carbon brushes, switchboard, meters, etc., also dynamo by "Pickup & Co.," V.100, A.40, carbon brushes, switchboard and meters.—H. N. BROCK & Co., LTD., 16-18, Bath-street, City-road, E.C.

FOR SALE, TWO GENERATING SETS, 36 kw., 150 amps. 230-300 volts. Engines by Browett Lindley: cheap for prompt sale.—WALKER, HILL & Co., Nottingham.

FOR SALE, 2 ELECTRICAL OVERHEAD CRANES, 15 and 20 tons, 37½ feet span, by Sunderland Forge Co.; 1 Pintel and Scarfing Machine; 1 48in. Iron Saw; 1 20-ton Steam Forge Crane; 2 50-horse motors; 1 4½ Carter Disintegrator; 1 Special Steam Hammer for Sternframes.—Apply, ALEXANDER, Iron Merchant, Sunderland.

ELECTRIC MOTORS (10, 5, 2½-h.p.), in stock.—GEO. DIXON, Electrical Engineer, Popham-street, Canal-street, Nottingham.

EIGHTY MOTORS AND DYNAMOS for sale or hire.—MARTIN, 320, Witton-road, Birmingham.

FOR SALE, 20 h.p. Suction Gas Plant and 14 b.h.p. Engine; also 10 h.p. Vertical Boiler and 6 h.p. Vertical Steam Engine.—Box C.E., c/o THE ELECTRICAL ENGINEER, 149, Fleet-street, London, E.C.

ELECTRIC MOTORS.—Two 15 h.p., 500 volts; one 20 h.p., 100 volts; one 10 h.p., 460 volts; tramway controllers.—Box W.G., c/o THE ELECTRICAL ENGINEER, 149, Fleet-street, London, E.C.

PLANT WANTED.

PLATINUM UTENSILS, SCRAP, LAMP TOPS.—Best prices given by DERBY AND Co., LTD., 44, Clerkenwell-road, London, E.C. N.B.—Platinum Sold.

SITUATIONS VACANT.

SWITCHGEAR DRAUGHTSMEN WANTED, Manchester district. Accustomed to the lay-out and detailing of H.T. and L.T. Switchboards. None but first-class men need apply. State age, experience and salary required, to Box No. 41, c/o THE ELECTRICAL ENGINEER, 149, Fleet-street, E.C.

WANTED, FIRST CLASS MAN, with previous experience in small armature winding; good recommendations essential; to take charge of winding shop. Address—Box 42, c/o THE ELECTRICAL ENGINEER, 149, Fleet-street, London, E.C.

SITUATIONS WANTED.

ELECTRICAL and GENERAL ENGINEER requires situation, station or private plant.—W. WINTERBURN, 192, High-street, Harlesden, N.W.

ELECTRICAL ENGINEER desires berth in Central Station, or charge of private installation.—Box C., c/o THE ELECTRICAL ENGINEER, 149, Fleet-street, London, E.C.

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New Series No. 1.
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"LIGHTNING CONDUCTORS,"
By ALFRED HANDS, F.R.Met.S.
Author of "Scientific Protection," "A Guide to the proper Application of Lightning Conductors," "Lightning and the Churches," etc.
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Which retain their high efficiency under the most severe working conditions.

JOINTING COMPOUNDS & BOX COMPOUNDS.

MAJOR & CO., LTD.,
Sculcoates,
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at least 7 in. In spite of this, however, the filaments of the Osram lamps fitted inside were not in any way damaged, and are still burning with the very best results. The above illustration has been reproduced from an untouched photograph taken immediately after the accident.

Municipal Exhibition.

Two exhibits of great interest to electrical engineers are on view at the Municipal and Health Exhibition, Royal Agricultural Hall, Islington, which closes to-morrow. Messrs. Wallach Bros., Ltd., bring forward an excellent type of electric drilling machine, compact, handy to manage, and while simple in construction, very effective. They are entirely of British make. These machines are attracting a good deal of attention. The Metal Jointing Co., Ltd of Adelphi House, 71 and 72, Strand, W.C., give a comprehensive demonstration of their method of jointing all kinds of metal without lead burning or plumbers' metal, but with their metallic flux "Amalgaline." This certainly gives a very clean, secure joint, the electrical fittings looking especially well. This firm, by the way, have special forms of coned invisible joints, and also a useful patent pipe-cutting machine.

CONTRACTS WORTH WATCHING:—

Brighton.—The Royal Pavilion is to be lit by electricity at a cost of £500.

Cardiff.—Glamorgan County Council propose raising a loan of £76,500 for new county offices in Cathays Park.

Carlisle.—A faculty has been obtained to light Christ Church (Vicar, the Rev. J. Fell) by electricity.

Dublin.—Improvements Committee, City Hall. Third section of the Bride's-alley area dwelling scheme.

Durham.—Mr. A. J. Dawson, Clerk to the Education Committee. Alterations and improvements to various schools.

Guildford.—Mr. E. L. Lunn, architect, 36, High-street, Guildford. Additions to workhouse and master's quarters.

Hereford.—There is a proposal to establish an Athenæum here; a sum of £3,000 is to be raised to acquire premises and adapt them.

Torquay.—The Corporation are applying for a loan of £45,000 to be spent on the erection of a new block of Municipal Buildings, and a Pavilion in Princes'-gardens.

Wallasey.—Mr. J. Briery Preston, surveyor, 41, North John-street, Liverpool. Public Library, Earlston Park, Liscard.

Wednesbury.—Mr. C. W. D. Joynson, architect, Springhend, Wednesbury. Holyhead-road Council School.

Whalley (Lancs.).—Architect, County Offices, Preston. Asylum at a cost of £300,000.

Whitby.—Mr. H. S. Walker, architect, Golden Lion Bank, Whitby. Villa residences.

PERSONAL.

As a result of his acceptance of the chairmanship of the Road Board, Sir George S. Gibb will shortly retire from the Board of the North-Eastern Railway Company, and of all the other companies of which he is a director. It is expected that his retirement from the chairmanship of the Metropolitan District, Baker-street and Waterloo, Great Northern, Piccadilly and Brompton, and Charing Cross, Euston and Hampstead Railway Companies will take place immediately after his address to the shareholders of these companies at the half-yearly meetings in August next. Besides being chairman of these companies, Sir George Gibb holds the position of managing director of the Underground Electric Railways Company of London (Ltd.).

Mr. Morgan Williams is retiring from the practice, but the business of Morgan Williams & Couzens, consulting engineers, at 39, Victoria-street, Westminster, S.W., will be continued under the same style by Mr. Couzens.

We regret to report that Mr. G. J. Porter, superintendent of the Brush Electrical Engineering Co.'s works, was killed by electric shock on the 7th. He was engaged in the testing department, when from some unexplained cause he received a shock of about 2,000 volts. He leaves a widow and three children.

Mr. C. W. Salt, deputy electrical engineer, of Bradford, and formerly of Croydon, has been appointed electrical engineer of Torquay.

Mr. Shepherd, general manager of the Edinburgh and District Tramway Co., Ltd., has been elected chairman of the Scottish Tramway Managers' Association for the year.

Mr. J. M. Smyth has been obliged, through reasons of ill-health, to resign his post as electrical engineer to the Keighley Corporation.

ELECTRICAL JUTE PRESSES.

According to *Indian Engineering*, the Central Jute Pressing Co., Calcutta, with Messrs. Andrew Yule & Co. as their agents, are erecting a new jute press in the vicinity of Chitpore, which is expected to be ready for the coming jute pressing season. The complete plant will be electrically driven, and the contract for the electrical equipment has been placed with the Lahmeyer Electrical Co. The erection of the electrical plant will be carried out under the supervision of Mr. H. R. Speyer, A.M.I.E.E,, chief engineer to the company in India.

Seth Hursook Dass Dooly Chand is erecting a new jute press, the Ocean Jute Press, adjoining the existing Sun Jute Press at Chitpore, and has decided to drive the plant by electricity. The contract for the complete electrical equipment has been placed with the Lahmeyer Electrical Co. Messrs. Shaw, Wallace & Co. are the sole agents for the company in India.

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Electrical Progress at Home & Abroad.

A Review by our Special Correspondents.

TYNESIDE.

NEWCASTLE-ON-TYNE.

Until the advent of the metallic filament lamp, the gas undertakings were reasonably sure that they would at any rate be able to hold their own in the department of street lighting, except where the electric arc was employed in the illumination of main thoroughfares. Another turn of events has, however, been effected by the metal lamp, and one of the latest effects is seen in the action of the Electricity and Lighting Committee of the Sunderland Corporation, who have resolved to recommend the Council to remove 266 gas lamps from the streets and to replace them by the same number of Osram metal filament lamps. The capital cost involved in the alteration is estimated at about £465, but it is anticipated that the benefits secured by the change will more than compensate for this initial outlay.

Further Powers for the Newcastle Corporation Tramways.

Owing to the extension of the population of Newcastle towards the more outlying suburbs of the city, it has been strongly urged for some time past that further developments of the tramway system of the Corporation were necessary. This movement has been brought to a head during the past week by the meeting of a sub-committee of the Tramways Committee in order to consider the necessary points preliminary to the promotion of a Parliamentary Bill by the Corporation to secure extension either upon the present system, or by means of a trackless overhead trolley system. The latter is, I believe, not to be regarded as being at present a serious competitor with the present system, although there is a suggestion that the trackless trolley system may possibly be used to effect a connection between the Elswick-road and the Scotswood-road routes. The probabilities are that the main purpose of this development is to secure such powers in advance as may render the Corporation competent to take advantage of the new system at a future date should such a course be regarded as advantageous. The chief features which, it is probable, will be sought for in the new Bill will be the extension of the present system to Coxlodge and Benton on the Gosforth route, and to Newburn and Blaydon on the west of the city.

Electrical Equipment of an Iron Mine.

An installation of unusual interest in this area is the equipment of the Skelton Park iron mine with a complete electrical system for such operations as pumping, haulage, and ventilating. In order to keep the mine free of water, two Sulzer high lift pumps are being installed, each driven at 2,320 r.p.m. by a 60 b.h.p. motor. Among a considerable number of motors for various purposes, supplied by the British Westinghouse Co., Ltd., may be mentioned a 60 b.h.p. motor driving an endless rope haulage gear, a motor driving a jack winch in one of the pits for the purpose of examining the ropes, etc. The switchgear for the installation is of the Keyrolle type, while the cables were supplied by the British Insulated and Helsby Cable Co., Ltd. In the underground workings are a four and five panel switchboard.

Storm-Proof Telegraph Service.

Considerable satisfaction has been felt on Tyneside at the news contained in a letter from the General Post Office, and read at a meeting of the Newcastle Chamber of Commerce, to the effect that in this year's estimates to be placed before Parliament provision would be made for the completion of the underground telegraph service between Leeds and Stockton. The effect of this improvement, if sanctioned, will be that the delays to the telegraph service between Newcastle and the South, which have been so evident, for example, last winter, owing to severe gales and snow, will be stopped.

THE MIDLANDS.

BIRMINGHAM.

At the meeting of the Birmingham and District Electrical Club, held on Saturday last, the subject of producer gas, especially in its relation to electricity as a competitive method of power distribution, was discussed. A paper on "The South Staffordshire Mond Gas Distribution Plant" was given by Mr. William Dudley, with lantern illustrations. This was the first installation erected to supply producer gas over a large area to customers requiring power and heat. Its area of supply covered 123 square miles. The plant was started in February, 1905, and had since run continuously day and night without a single stoppage. To-day the gas was being sold to over 100 customers at prices varying from 1½d. to 2¾d. per 1,000 cubic feet, according to the quantity taken. The lecturer said that Mond gas was being extensively adopted for furnace work, having the advantage over coal fired furnaces in cleanliness, longer life, even temperature, and, generally, pleasanter and more economical working. One firm had effected a saving of £500 per annum in railway rates through being able to effect on the premises treatment for which castings used to be sent to Scotland.

Producer Gas as Prime Mover.

As a prime mover in the generation of electricity, producer gas, Mr. Dudley said, had proved itself to be more economical than other source of power. An example of this was to be found in the Wednesbury Corporation Electricity Power Station, which was successfully driven by gas in competition with some of the most up-to-date steam plant in the Midlands. In a comparison with 82 private plants, this plant gave the lowest cost of all. Mond gas was being used in the district in gas engines varying from 5 to 750 b.h.p. The amount of gas used per b.h.p. was 70 cubic feet. The gas being such a clean one, engines had been run night and day for 12 months without having their pistons drawn for cleaning. At the shipyard of Messrs. Cammell, Laird & Co., Tranmere Works, Birkenhead, there were three 2,000 h.p. Mond gas producers feeding three 250 h.p. Premier gas engines direct coupled to 140 kw., D.C. Generator (Bruce Peebles), 440 volt, compound wound; and two 400 h.p. gas engines (Premier), each direct coupled to 240 kw. D.C. generator (Bruce Peebles). The fuel used was Lancashire special gas slack, costing about 10s. 6d. per ton. For the week ending November 10, the working costs, including power station wages, repairs, oil stores, coal and wages for a total of 40,401 B.T.U. averaged ·344d. per unit. In the following week, with a total of 41,278 B.T.U., the average was ·328d. For the third week with a total of 44,347 B.T.U., the average was ·317d.; and for the fourth week, with a total of 49,905 B.T.U., it was ·291d. The average cost per unit for four weeks, with a total production of 175,931 B.T.U., was ·320d.

Problems.

In the course of the discussion, Mr. Smith asked whether there was any means of baffling the flame and so preventing injury to the boiler tubes. He also suggested that there was a disadvantage arising from the accumulation of liquid in the pipes, and thought that the estimate of cost per unit given in the paper was insufficient. At all events, he facetiously suggested it was difficult to see how a high rate of payment for officials was possible on that basis. Nothing appeared to be allowed for depreciation, and costs generally seemed to him to be somewhat too lightly dealt with. They were all acquainted, he said, with the estimate

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of 10 h.p. for one-tenth of a penny. Still, he thought there was a future for Mond gas, although he did not think it was going to oust electric lighting. It would be a bad thing for them if it did, because then there would be no cables wanted. Mr. Phillips enquired whether a considerable amount of trouble was not experienced in the electrical section with the generator? He had witnessed tests with one of the most up-to-date engines, where the consumption worked out at about 85 cubic feet. per b.h.p., and with 10% overload at 87 cubic feet. He also thought trouble would probably be found in getting the moisture out of the pipe. Mr. Foster asked whether there was any leakage from the mains due to subsidences in the district. He rather thought that the prime business was the production of sulphate of ammonia, and he had been told that gas had been turned into the boilers solely for the purpose of keeping up the output of ammonia. With regard to the engines used with this gas for generating electricity, he believed they were principally of the Nuremburg type. He thought they were all rather sceptical about the gas consumption with the gas engine. Mr. Green asked whether there was any extra cost to consumers at the end of the 10-mile run, while Mr. Waygood suggested trouble through valves getting stuck up with the residue from the gas.

As a Competitor.

The President (Mr. A. O. Donovar) said that he could speak feelingly because he happened to be a shareholder in a plant in Chester. The gas was sold to an electric light company at about 1¼d. per 1,000, and the plant had been running for over 12 years. The engines ran very satisfactorily, and the cost was said to be on the whole fairly satisfactory. The plant was rather well situated, because it could be used in pumping the brine. He understood that the very serious danger in regard to leakage was that there was no smell from Mond gas. This gas certainly seemed to him likely to be a serious competitor with electrical power, and with their profession, since if there were no wires, no switches would be wanted.

The Reply.

With regard to the flame when Mond gas was used for boilers, Mr. Dudley explained that they used a special kind of firebrick. It received the first shock of the flame before it struck the tubes of the boilers, and so the tubes were not injured. The only trouble was that sometimes the pipes were to a small extent through the water being driven rapidly from them. They had special syphon arrangements for dealing with water accumulations, and the pressure was constant. Considerable difficulty had been experienced with the generators with the gas engines, but they managed to keep them clean, and they got no sparking, though the fumes still blackened the copper. They sometimes found customers very exacting, and occasionally the gas plant was thrown out after trial, apparently because the customers had formed exaggerated ideas, and wanted to work at about half the cost of any other. A staff was kept to locate leakages and deal with them. The form of engine generally recommended was the Nuremburg, as working at a lower cost than any other. But they also found the Premier engine give very good results.

The Electric Club.

Saturday's meeting of the Electric Club was the last of the Session, but the members will take part on Monday, June 20, in a visit to the works of the Rugby Lamp Co. The honorary secretary (Mr. W. G. L. Riddle) has had some correspondence with the Public Library Committee with regard to the non-appearance lately of THE ELECTRICAL ENGINEER on the table at the Reference Library. He was informed that the paper was included in a number discontinued with a number of others on a recent revision of the list, but subsequently the Chief Librarian had written to say that in compliance with the representation made by Mr. Riddle on behalf of those interested, the Committee had re-instated THE ELECTRICAL ENGINEER in the list of papers subscribed for.

LANCASHIRE.

MANCHESTER.

At the present moment a dark cloud hangs over industrial Lancashire—the crisis which has arisen in the cotton trade through the manufacturers' proposal to reduce the rates of their operatives by 5%. The trade unions say they are prepared to fight the whole matter out, while the owners are equally determined. In the interests of all branches of trade, including the electrical industry, it is to be hoped that an amicable settlement will be arrived at without any strikes or lock-outs to still further reduce the small amount of business that is at present being done. If a strike should occur, the resulting disorganised condition of the cotton trade would undoubtedly postpone for some considerable time that wholesale conversion of mills and textile works to electric drive, for which electrical engineers have been eagerly waiting for a very long time. The effect of a cotton trade strike would be severely felt in almost every branch of engineering work here.

Owing to continued ill health, Mr. V. A. H. McCowen, Chief Electrical Engineer at Salford, has resigned. The Council on Wednesday regretfully accepted his resignation, and placed on record their high appreciation of his services during the time he has been at Salford. To show how keenly they realise that only by appointing another first-class man can the fine success their past chiefs have made of the Department he maintained, they have decided to reduce the commencing salary attached to the post from £700 to £500 per annum. Evidently they mean to benefit by the slump in "talent" which is heard of from time to time.

Recent Developments at Salford.

The cooling towers, which have recently been put up at the Frederick-road station (to Mr. V. A. H. McCowen's designs), are now undergoing their official tests. The results up to date are most satisfactory and well within the estimated figures. The towers are capable of dealing with 750,000 gals. of water per day, which gives a 25% margin over peak load. The pumps at present installed have about double the capacity required for the peak load. It is found that there is a loss of about 85,000 gals. per day from the cooling towers. To make up this loss, a bore hole is being sunk, the water from which will be used. The hole is 18 in. diameter, and it is estimated that at least 300 ft. is the depth which will be reached before water is reached. The maximum quantity to be lifted is estimated at about 15,000 gals. per hour, but this quantity is not guaranteed by the contractors. The pump for this bore hole will be motor driven through helical gearing, and will be placed over the bore hole, which will be covered over by an extension of the present pump-house. A new battery is to be installed. The maximum rate of discharge is 3,200 amperes for one hour, and it is arranged to run automatically on a traction load, through a Tirrell regulator. It is thus probably the largest battery yet installed in this country, working automatically in this manner. It will be run with one or two 750 kw. steam sets in conjunction with a Lancashire Dynamo & Motor Co.'s reversible booster. It is also being arranged for hand regulation on a lighting and power load, and is expected to prove most useful in taking the overlapping peak loads of lighting and power and traction in winter. Its capacity will be equal to two reciprocating sets. The battery consists of 225 cells of the Tudor Co.'s make. It is interesting to note that the Salford station has practically become too small to deal with any large increases in load. Owing to the peculiar position (between a railway line, road and canal) it is impossible to extend the works. The proposal to erect a second station has been considered at various periods during the past three years, but nothing definite has been decided upon.

The "Chronicle" Home Exhibition.

The City Exhibition Hall, Manchester, is filled with a six weeks' show organised by the *Manchester Evening Chronicle* in aid of their Cinderella Fund. There is not much to interest electrical engineers as such, although from the ordinary point of view this exhibition is by far the best show so far held in this hall. John Dugdill & Co.

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show their patent fittings and have a very fine display. The Northern Electric Syndicate are about the only other electrical firm showing. A few specimens of electric heating apparatus are to be seen on this stand, and also some electrical advertising novelties, but so far as taking advantage of this popular exhibition specially relating to the home and using it to push electricity supply and develop domestic day loads, or to sell the apparatus that will do this, no serious attempt has been made by the electrical trade. As I have previously pointed out in these columns, these are the shows which, intelligently used, would bring the supply authorities and the electrical manufacturers the best and most lasting return. They prefer, however, to go on showing their goods to one another instead of to the people most likely to buy.

UNITED STATES.

NEW YORK.

The training of electrical engineers, and especially the education for leadership in electrical engineering, formed the subject of a paper and an informing discussion at the last meeting in this city of the American Institute of Electrical Engineers. The paper in which the subject was introduced was by Dr. Samuel Sheldon, who will be remembered as a very able and distinguished past president of the Institute, and present Professor of Physics and Electrical Engineering at the Brooklyn Polytechnic. Dr. Sheldon devoted the opening portion of his paper to a recital of some striking statistics showing that the percentage of electrical engineers in the United States was very much less in proportion than the percentage of the total wealth of the country invested in electrical enterprises, and that although electrical engineering leaders are about as numerous in proportion to the total number of electrical engineers as in other engineering professions, engineers who are leaders are in general not as numerous as the importance of engineering enterprises would seem to warrant.

Analysis of Training.

Analyzing the educational preparation of 98 notable members of the American Institute of Electrical Engineers he finds 80·6% having college degrees and 90% who had college instruction. A further analysis of the acquired traits of 12 of these notable electrical engineers as made by five disinterested and competent judges is then given. The five fundamental acquired traits considered are: mental training, distributed and comprehensive knowledge, facility of expression, discipline of the will and æsthetic taste. The last analysis showed mental training to be very highly developed among these 12 picked leaders. Dr. Sheldon concludes that if any changes are advisable in educational methods in order to produce still higher character in engineering leaders, they should be directed to those educational processes that result in marked development of the last four of the acquired traits named above. Greater attention should be directed to the study of languages, literature, fine arts, history and the political and social sciences, with the idea of gaining a mastery of the methods of thought and of action of man and of men. In other words, a knowledge of human nature is essential to leadership, for the very word implies a man to lead and men to follow. Dr. Sheldon therefore recommends that any college seeking to produce leaders in engineering should adopt: (1) a more discriminative system of selecting entering students; (2) new subjects and methods of teaching them, particularly literature, and (3) that more time should be found for these subjects.

The Making of a Leader.

Dr. Charles Howe, the well-known President of the Case School of Applied Science at Cleveland, who opened the discussion on Dr. Sheldon's paper, urged that far more important than the giving of facts by teaching a few definite things was the ability of the student to find the things he wants at any time in his career: "Where to look for it," is one great secret, and another is that of teaching the student to think for himself. "Most men are not leaders," said Dr. Howe; "they merely follow the men before them. If we can only develop methods by which students will understand the laws of learning to think, to think along engineering lines, we shall greatly increase the number of leaders, and the leaders themselves will be still greater leaders. Many of our institutions are coming to believe that the technical course should be increased to five years, so that more time may be given to courses of broader instruction, not now given, and that will also be additional time to give to engineering subjects. The reason why all this has not been done in the past has been that the technical schools have utterly been unable to graduate men enough to fill the places open for them. The subject of English composition and rhetoric especially has been greatly neglected in most of our technical schools, until within a very few years. Now we are beginning to devote more time to this subject, because we are finding out that the technical graduates we have been sending out without any ability to write, without any facility of expression, do not succeed as well as the men who can express their thoughts well upon paper and present engineering subjects to boards of directors or to organisations like the Institute. Another thing which is necessary for leadership is the ability to get along with and to handle men. That is something that it is exceedingly difficult to teach in the technical school. It is the man who can work with other men, and handle them, who generally achieves the greatest success."

Need for Broader Culture.

Dr. A. Flexner, of the Carnegie Foundation, for the Advancement of Teaching, also urged the need of a broader basis of education, and declared that a four years' course was not sufficient to produce a highly specialised engineer with culture superadded. Mr. J. W. Lieb, who, like Dr. Sheldon, is a past president of the Institute, agreed with other speakers in declaring that under present conditions the technical school graduate is not sufficiently well grounded in the power of expressing and presenting his conclusions. "As one grows older," he said, "one feels the lack of the broader culture which it has not been possible for the technical schools to give"; and he strongly advocated the extension of the course from four to five years.

Electricity and Fire Damage.

A good deal of discussion has been aroused by a paper read at the Chicago Electric Club by Mr. W. H. Merrill, manager of the Underwriters' Laboratories in that city. His subject was the relation of electricity to the national fire waste. This fire waste runs to nearly £60,000,000 sterling per annum in this country, and Mr. Merrill declares that the development of electrical fire preventing and danger-announcing devices had not kept pace with other phases of electrical invention, and deplores the fact that American inventors have not exercised more ingenuity toward the perfecting of fire-alarm systems. He indicated the control that the electrical engineer possessed in making his part of the installation as nearly fire-proof as possible, and showed how the greatest care was necessary so that there would not be an element of danger existing in many forms of wiring and in other uses of electrical apparatus. It is urged in reply to Mr. Merrill that electrical fire protection devices are numerous and thoroughly effective, but the difficulty is that there is no power to compel factory owners and others to instal these appliances.

Reducing the Smoke Nuisance.

The fact that recently in these Notes Chicago was referred to as the "Smoky City"—the subject dealt with was that of railway terminal electrification—seems to have been somewhat taken to heart in that busy industrial centre. The *Electrical Review and Western Electrician* devotes an editorial to the smoke nuisance generally, and compares the United States with Europe, greatly to the disadvantage of the latter. The writer observes that although the smoke nuisance is not so pronounced in American cities as in European cities where the use of open fireplaces is still almost universal, it is nevertheless of sufficient import to warrant practical suggestions being put forth for its reduction. "Early morning in an English town, for instance, is always heralded by the clouds of black smoke which come pouring forth from the chimney stacks of the houses when

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the kitchen fires are lighted to warm the house and to cook the morning meal, and the smoke is continuously in evidence until the fires are allowed to die out at night time. Hot water and steam heating, and gas ranges for cooking, are more used in America than open fireplaces, but heating boilers make smoke, and both smoke and gas fumes are objectionable and insanitary. The Englishman likes his open fireplace, largely because of its cheeriness, and by the same token cordially detests the steam or hot water radiator because of its lack of this quality and also because it not only tends unduly to dry the air in the house, but also does not assist in ventilation as does the open fire with its continual draft up the chimney."

The Luminous Radiator.

Seeking for a remedy, the writer finds in the luminous electrical radiator a device which combines the convenience of steam or hot water with the obvious advantages of the visible open fire. With this modern device, he observes, there is no boiler to belch forth its smoke to hang as a pall over the landscape, no attendance is required, no dust or dirt is made, and drying of the air is largely avoided. "Its portability is an added point in its favour, and with an electric fan or ventilator as auxiliary, renewal of the vitiated air in the room is easily effected. The luminous radiator is quite as cheerful as the open fireplace and is certainly much more of an ornament from an artistic standpoint. Add to this electric cooking appliances, and the boiler fire, and the coal or gas range can be for ever abolished from our homes." But there is a small fly even in this ointment, and that is their cost of operation, but even with prices as they are at present there are many offsets to the apparent cost. "Any electric appliance can be used just when it is needed, and when it has fulfilled its purpose for the time being the current can be turned off and that is all there is to it. A boiler or stove fire is not so flexible. Moreover, the absence of dust and dirt lengthens the life of the furnishings, etc. But the time is near at hand when the price of electric current for heating and cooking will be materially reduced, and the use of electricity for these purposes will be greatly increased, much to the benefit of the load factor of the central station. This has already been done in Portsmouth, England, where the charge for electricity for heating and cooking is now one cent per kw. hour. and the load and load-factor of the Portsmouth generating station are going up by leaps and bounds, with very little increase in operating costs. Thus the ultimate solution of the smove problem would seem to be the centralisation of electrical distribution and the utilisation of electricity for heating and cooking in the household. When this is done, and it is not by any means visionary, and when the electric-motor drive displaces entirely the obsolescent mechanical drive in our shops and factories, then and only then will the smoke question become a forgotten evil."

Another Tungsten Development.

Several striking developments of the tungsten lamp have been recorded in these Notes during the past few months, and another is now on the way. It is announced that Mr. Robert C. Finch, consulting engineer of the Colonial Illuminating Company, New York, in collaboration with Dr. Isador Kitsee, has succeeded in developing a new tungsten lamp after experiments extending over the past four years. Mr. Finch says that they will be able to have a demonstration of the lamp ready for testing purposes about July 1. He believes that they have succeeded in constructing a lamp that will rate at 1 watt per c.p., and he thinks it possible that it may be even better than this. He also believes that the new filament will be as strong as a carbon filament, and that the life of the lamp will be greater than that of any tungsten lamp yet developed.

Electric Drive in Machine Shops.

In a paper read at a joint meeting in this city of the American Institute of Electrical Engineers and the American Society of Mechanical Engineers, Mr. A. L. De Leeuw dealt with the economics of the motor drive for machine tools. He classed the savings effected by driving a shop electrically under the heads of increased output and less expense. Increased output results from the flexibility in speed control of the electric motor; but, there are other reasons why a change from belt to electric drive may increase the output of a machine. The electric drive may enable one to place the machine in a more convenient position, or bring it under a crane; or it may be the means of giving the machine more power than it could have with a belt drive; or again, it may be the means of doing away with some harmful conditions which have diminished the machine's efficiency. Among such circumstances may be mentioned the slackness of belts due to weather conditions, or to the varying loads placed on an upper floor, making the belts from pulleys attached to the under side of this floor either too loose, having been adjusted at a time when the load on the upper floor was light; or too tight, owing to adjustment at a time when the load on the upper floor was heavy. Then there is the convenience of altering speed if a machine has a motor or a convenient gear drive, when the operator might forget that there is such a thing as a change of speed for varying conditions of work, if he had to shift a belt. An almost unlimited number of considerations affect the result to be obtained from the application of a motor to a machine tool; so that it is almost impossible to forecast the economy which will result from such a change, though it may be perfectly possible to say that the change will be beneficial to some extent.

The Equipment.

This paper was followed by one by Mr. Charles Fair relating to the application of electricity to machine tools and also to the question of controlling devices, and Mr. Charles Robbins also dealt at length with the equipment for machine tool driving. A fourth paper, read by Mr. J. Riddell, had particular reference to the machine tools in the Schenectady plant of the General Electric Company. In this plant there are 8,500 machine tools, of which 8,150 are individually motor driven. Group driving has been adopted for some sensitive drills, speed lathes, and other small miscellaneous machines. Of the above tools there are 48 portable machines, consisting of slotters, milling and drilling machines, radial drills, etc. These machines are operated on 32,675 sq. ft. of iron floor plate, in addition to which there are 7,000 sq. ft. of iron rails, cemented into the floor, for erecting purposes. If use were made of lineshafts, countershafts, and belting there would be about 34,570 ft. of lineshaft, or about 6½ miles, and about 4¾ miles of countershaft which would require about 21,225 hangers and bearings. Allowing two belts to each machine, with an average length of 25 ft. per belt, there would be for the 8,500 machines a total of 425,000 ft. of belting, equal to about 80½ miles.

Another Storage Battery Car.

The success of the Edison-Beach Storage Battery Car has stimulated the Third Avenue Railroad Company to a series of experiments with a new car equipped by the Gould Storage Battery Company. The vehicle with which the trials are being conducted is a reconstructed horse-car weighing 7,200 lbs. when empty, and six tons when carrying its full load of 26 passengers, an average of 461 lbs. per passenger. To run at 7 to 8 miles per hour, allowing 8 stops per mile, only two 5 h.p. General Electric motors are required, and, in fact, the car is so light that one man can easily push it along a level track. The batteries are of the pasted type, composed of 29 plates per cell and 44 cells per set. At 84 volts, the battery has a rating of 420 ampere hours. The batteries are placed under the longitudinal seats on each side. There are four crates of five cells each, and eight crates of three cells each. The battery covers are screwed down tightly, and the gases are carried off by the natural ventilation which is afforded when the movement of the car sends air through a pipe on each side of the car. As this air passes over the batteries it drives off the odours and exhausts them under the step at the back of the car, so that there is no odour in the car from the batteries. So far the trials have proved highly satisfactory, and if the upkeep of the storage battery comes out as is anticipated, 25 of these cars will be placed on the service.

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GERMANY.

BERLIN.

Dr. Tobler supplies some interesting particulars about the latest development of submarine telegraphy. A new cable has been laid from Emden, on the coast of Hanover, to Teneriffe, and is 2.107 knots in length. Its resistance is only 2·26 ohms per knot, corresponding to a conductivity of 98·5%. The capacity is 0·405 microfarad per knot.

Metals in Arc Carbons.

It is well known that a copper-carbon direct current arc acts best when the carbon is the cathode, and the same is observed with other metallic combinations. News reaches us that a tension series has recently been established by Jäger, of Vienna. He made one electrode of different pairs of metals, one enclosed in the other, and applied the other electrode which was always of pure carbon to the meeting place of the two metals before the current was switched on. When the arc was formed by separating the electrodes, the current goes to one of the metals only, that one depending on which electrode is the cathode. He has established the following series: Gold, carbon, silver, copper, iron, zinc.

Air Moistening.

The Allgemeine Elektrizitats Gesellschaft has installed at Cassel electric contrivances for moistening the air of rooms by mist. The mist carries down the dust of the atmosphere so that by using the apparatus for a short time the air of a room is rendered absolutely dust free. Moreover, rooms which are heated by hot air pipes, or hot water pipes, may be kept sufficiently moist during the operation of the contrivance.

Wood Preservation.

Few things are more important in electrotechnics than the preservation of wood from decay by rot and weather. Wood has always played an important part in current transmission, and will probably continue long to do so. Seidenschner, of Berlin, has recently published in the *Chemische Zentralblatt* some very important results obtained from investigations undertaken by him. He finds that coal tar oil freed from its acid constituents is an excellent impregnating medium for preserving wood. It appears that the general opinion that the preservative action of coal tar was due solely to the presence of carbolic acid and its homologues is quite erroneous, and that everything depends on the neutral constituents with high boiling points. As regards the preservative action of petroleum residues on wood, the results are equally important and interesting. Seidenschner finds that they are practically valueless, but that if sulphurised they become perfectly efficient. The sulphurisation is done by stirring in about 2 lb. of sulphur for every 100 lb. of heavy residue at 150° C. The heat is then raised to 280° C., during which process most of the sulphur escapes in the form of sulphuretted hydrogen. The distillate passing over between 210 and 280° C. (*i.e.*, after all the sulphuretted hydrogen has escaped) is collected, and mixed with what remains in the still. The result is a clear liquid soluble in chloroform, benzole, or ether, and is an ideal preservative of wood against damp and mould.

Electric Heating.

The latest development of this important branch of electrotechnical applications to general industry is an electric coffee roaster. These machines have been made to roast 10 lb. of coffee at a time, with a very small cost for current. Confectioners' ovens have also been constructed which are electrically heated, and have given excellent results. Switzerland has the credit of introducing these applications of the heating effects obtainable by means of the electric current.

Economy of Water Power.

A Loacker, of Bregenz, has been calling attention to the defects at present attached to the utilisation of water power for the production of electricity. He points out that it is impossible to get the full advantage of natural heads of water under the present system, when the available force varies according to the season of the year, and even unexpectedly with sudden changes of weather. He considers that ordinary lodges or basins are but an alleviation of the difficulty, and is of opinion that water power cannot be made independent of subsidiary assistance unless reservoirs are made by damming valleys as has already been done for the purposes of supplying water for other than power purposes to large cities. His remarks have raised much interest among German and Swiss hydraulic engineers, who are but too well acquainted with the difficulties which variation in the flow of water, to say nothing of ice and dead leaves, and other *debris* getting to the turbines cause, thereby largely discounting the otherwise undeniable advantages of water power. It is quite easy to keep a large reservoir free from floating *debris* by placing strainers at the mouths of the supply streams, and as to ice, there is always plenty of water available from below any ice that may cover the surface of the reservoir.

Machine Design.

Leonhardt Adler has been calling attention to the trouble caused by currents in the bearings of electrical machines due to want of symmetry in construction. His remedy for them is to interrupt the axle current entirely. This may be done by the following means: (1) Insulating the surface of contact between brasses and cover; (2) insulating the plummer block; (3) insulating the surface on which the plummer block rests and all the bolts used for fixing.

Company Notices.

The Bergmann Elektrizitatswerk A.G., of Berlin, is paying a dividend of 18% on 14 million marks of capital, and 9% on the remaining 7 millions. The gross profit was 5,228,483 marks, as against 4,483,989 for 1908–9, but the turnover was 60% greater. It has been proposed to increase the capital to 29 million marks, and there is little doubt that the general meeting which was held on May 11, unanimously approved the suggestion of the directors. Even in the current year the orders received so far exceed in value by 30% those received in the corresponding part of the previous financial year.

The Heddernheimer Kupferwerk und Suddeutsche Kabelwerke A.G., of Frankfort, has made a net profit of 869,000 marks for last year and will pay a dividend of 7%.

The Gesellschaft fur Elektrische Hoch und Untergrundbahnen, of Berlin, is paying a 5% dividend for last year. The company is extremely prosperous and is building several new lines to be completed at various times up to 1915. The shareholders present at the ordinary general meeting represented nearly 30 million marks of capital.

The Gesellschaft fur Elektrische Unternehmungen pays 8% and hopes to pay more for the current year. The general meeting represented 20 million marks of capital.

The Elektrizitats Lieferungsgesellschaft, of Berlin, pays a 10% dividend on the capital of 15 million marks.

INSTITUTION OF ELECTRICAL ENGINEERS.

Glasgow Local Section.

The office-bearers and committee for the session 1910–1911 will be as follows:—Past Chairman—Francis G. Bailey, W. W. Lackie, and E. George Tidd; Chairman—Sam. Mavor; Vice-Chairman—J. A. Robertson; Chairman of Students' Section—Henry A. Mavor; Hon. Secretary and Treasurer—James E. Sayers; Ordinary Members of Committee—Robert Robertson, Magnus Maclean, William M'Whirter, J. Campbell Macmillan, W. C. Martin, J. T. Bottomley, T. B. Murray, T. C. Parsons and John Ferguson.

Glasgow Students' Section.

The following is a list of office-bearers for next session:—Chairman—H. A. Mavor, M.Inst.C.E.; Vice-Chairmen—John S. Nicholson, B.Sc., and R. B. Mitchell; Hon. Secretary—E. V. Buchanan, A.G.T.C.; Committee—F. H. Downie, B.Sc. (1911), F. A. M'Gowan, A.G.T.C. (1912), A. Rushton, B.Sc. (1913), F. Gerstenberg, A.G.T.C. (1913), M. Pitt, A.G.T.C. (1913) and D. W. Low (1913).

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PRICE OF ELECTRICITY.

By R. S. Hale.

[The problems connected with charging for current, which exercise the minds of our own engineers, also trouble American electricians, who have perforce studied the various phases very closely. Some results of those studied are given below in a closely thought out paper by the General Superintendent, Sales Department, Boston Edison Co., presented at the convention of the New England section of the National Electric Light Association, Boston, Mass., March 16 and 17, 1910.]

The question of prices depends very largely, in fact, entirely on costs. These differ in different companies and from time to time, but I shall devote my attention almost exclusively to the costs and prices of the Boston Edison Co. in recent years, because, so far as the principles are concerned, these differ but slightly from those of other companies. However, as our costs vary from year to year, and as we are discussing the principles rather than the exact figures, I wish it understood that I am not attempting to give them with absolute accuracy, but am using them chiefly for illustration. In fact, the 1904 figures are higher than our present costs, though the principles are the same.

The total cost for supplying service is, of course, the same as the gross income. When I say that the total cost corresponds to the gross income, I am assuming that a fair dividend on the stock is really a part of the cost. Of course, if there is a deficit after paying a fair dividend, or if there is a larger surplus than is necessary for a proper reserve, then the gross income is less or more than the total cost, but in most well run companies, the gross income and the total costs are substantially the same.

The question of the total cost is simple. It is merely a question of adding together the costs of the different departments and of the various taxes, fixed charges, reasonable dividends, etc.

The question of the total of the prices is, likewise, simple, because the total of the prices must be the total of the costs.

The really difficult question is the proportioning the part of the total costs to be borne by each different customer, or class of customers.

Using Boston Edison figures, the total cost of our current and service was $2,700,000 in 1904, and $4,100,000 in 1909, and these total amounts were a fair price for our total current and service; but not only is it necessary that the total price should be a fair one, it is also necessary that the division of the price among our different customers should be a fair one. In fact, this is a most necessary feature, since it does not affect a business man very seriously to pay an extra charge of 10%, provided his competitor likewise pays the same extra charge, while if a business man pays only a fair charge, but his competitor gets 10% rebate, then the first customer is worse off, in spite of the fact that in this case the seller is getting a low price, while in the other case the seller was getting an unfairly high price.

Now, how is the $2,700,000 which it cost the Boston Edison Co. in 1904, or the $4,100,000 which it cost it in 1909, to be divided up among its customers.

If we divide the total income by the total number of customers, we find that the average income was about $200 per customer in 1904, or $160 in 1909.

If we divide the gross income by the total number of lamps or their equivalent, we find the cost was about $3 per lamp in 1904, or $2·25 in 1909.

If we divide the gross income by the total number of kilowatt hours, we find that the average cost was about 10 cents per kilowatt-hour in 1904, or about 6½ cents per kilowatt-hour in 1909.

While these are the average costs or average prices per customer, per lamp, or per kilowatt-hour, it is perfectly clear that we cannot depend solely on averages in any particular case any more than we, ourselves, would be satisfied to have the total pay-rolls of our various companies divided by the total number of employés, so that each employé should be paid exactly the same salary. The average cost per customer of the Boston Edison Co. is between $150 and $200 each, but some customers cost very much more and some very much less. The average cost per lamp is between $2 and $3, but some lamps cost much more and some much less. The average cost per kilowatt-hour is from 6 cents to 10 cents, but some kilowatt-hours cost us 15 cents, 20 cents, 50 cents, and 50 cents each, and some cost hardly more than one-half cent each. It is obvious that we cannot make the same charge either per customer, or per lamp, or per kilowatt-hour.

When work is done by private companies the prices should depend on the costs, since there is no special reason for giving electricity without charge or at less than cost, as the use of roads and bridges is given without charge, and there should be some electric unit or basis of charge proportional to cost. There is no essential reason why either the kilowatt-hour or its multiples or submultiples, the lamp-hour or horse-power-hour, should have been used. The telephone companies and some water companies charge so much per customer, but by a graded differential system they take account of the fact that some customers cost them more than others. In the old days the electric companies charged so much per lamp (usually $12 per annum), and some electric companies and some water companies still use the same principle, the water companies' charge being so much per fixture. In all these cases, however, the companies (or municipalities, when the supply is municipal) have by various systems of differential charges, recognised the fact that some telephones, or customers, or lamps, or fixtures cost them more than others.

I will not go into the history and science of electric supply to explain why it is that most electric companies have finally settled on the kilowatt-hour as the basis of charge; but I do wish to state most emphatically that there is just as much reason for differentiating between the kilowatt-hours that cost the company 20 cents, 30 cents, and 50 cents each, and even more, and the kilowatt-hours that cost the company less than one-half cent each, as there is between customers and lamps. It would be just as unfair to charge the same rate per kilowatt-hour for all kilowatt-hours as it would be to charge each customer $160 per year, whether it cost us $1 a month to supply him or $10,000 a month. We intend that each customer shall give us a fair margin of profit, if we can get it, and shall in no case be supplied at a loss. We supply some lamps at a cost of $1 per annum each, and even less, and get as high as $10 or $15 per annum from others, and again intend that they shall all give us, so far as possible, a fair margin of profit, and that none shall be supplied at a loss. We supply some kilowatt-hours at 20 cents and some at three-fourths cent, and while we try to get a fair margin of profit on them all, yet we actually lose money on a great many of the kilowatt-hours we supply at the highest prices.

Now, how do we distinguish between the kilowatt hours that cost 20 cents or 30 cents, and those that cost only one-half cent? In the case of a customer we have a definite address or location and know exactly what happens when he comes on to the system and uses current. In the case of different lamps we know very clearly that to supply one lamp for a year will probably take only 60 pounds of coal and to supply another over half a ton, so that the first lamp may be supplied at the cost of half a ton of coal cheaper than the second, if the other expenses are the same. The kilowatt-hour, however, while more exact and definite than the customer or the lamp, is more a definition than a concrete quantity.

Take the case of a particular customer who has the equivalent of 10,000 to 15,000 lamps connected, of which he would probably use about 8,000 at any one time; and suppose this customer used his lights about ten hours a day, say 1,200,000 kw.-hours in all. Adding the cost of the coal and lamp renewals to the cost for keeping ready and dividing by the number of kilowatt-hours, we find the rate to be about 3·2 cents per kilowatt-hour; and, of course, if the customer should use his lights twenty-four hours per day the cost per kilowatt-hour would be lower still. The above analysis has been for a customer with sufficient lamps to require one-tenth of one of our turbines. It is, however, perfectly obvious if we consider a customer who only requires one-ten-thousandth of one of the turbines, say a customer with ten or twelve lamps, that most of the cost will be in the same proportion and the same per kilowatt-hour as in the case of a large customer.

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Now, how shall we take care of this tremendous difference in cost between the customer who uses our investment steadily and the customer who uses our investment only a very short time? The obvious way is to charge him by the method known as the Hopkinson System, and instead of making a charge of so much per kilowatt-hour, we make the charge in two items. One item on the bill is the fixed charge, which is made in proportion to the amount of our investment that the customer uses, independently of how long he uses it. This in our case is a charge of $60 per year for each kilowatt of investment that the customer uses. In addition to the payment of this fixed charge, which corresponds to our fixed expenses, the customer pays a rate of only 5 cents for each kilowatt-hour that he actually does use. The result is that the customer pays in proportion to our costs. These figures are not by any means the exact costs, since when we compare our figures of costs with the prices of $60 per kilowatt and 5 cents per kilowatt-hour, we find that the $60 a year is too small, especially for our small customers, while the 5 cents per kilowatt-hour gives us a tremendous profit as compared with our operating costs after excluding our fixed charges. Still the figures that we have actually adopted, work out in practice much better than the theoretical figures. One reason is that we cannot insist on all our customers paying according to this yearly rate, and in fact the majority pay, and prefer to pay, on the very simplest possible plan, and pay so much per kilowatt-hour, and we give this option largely for policy's sake.

Of course, charging so much per kilowatt-hour means that some customers are very much more profitable to us than others, but the case is not so bad as it might be, because while the customers who use our investment only a very short time means that we have a very good chance of selling the use of that investment two or three times over. Say our investment costs on a small customer are $90 a kw. per year. If such a customer pays us 11 cents a kilowatt-hour, then, practically speaking, 10 cents an hour is available for our fixed charges, and if the customer uses the investment 300 hours a year this gives us $30 a year towards fixed charges of $90. Then if we sell the use of that investment to three customers, we get the $90 for our fixed charges only once.

If we sell it only twice we lose. If we sell it four times it balances some of the losses that occur when we only sell it once or twice.

The result of the two optional rates, one a per kilowatt-hour rate, and the other the Hopkinson rate, are pretty nearly what we want, since though we lose very heavily on some of our 11-cent customers, yet on some others we make a good profit. When, however, an 11-cent customer uses our investment for so long a time that he would become abnormally profitable, then he has the option of taking current on our yearly rate on the Hopkinson system, and getting a much lower rate per kilowatt-hour than 11 cents.

At the same time such a customer uses our investment long enough so that the profit on the five cents charge makes up for the loss in charging him only $60 per kilowatt fixed charge, and the two features, or, rather, the two rates balance up pretty well.

When we get beyond a certain point the costs are not the same for different size customers. A pole line for 100,000 lamps costs almost nothing per lamp. A pole line for 1,000 lamps begins to be expensive, while a pole line for 10 lamps or one lamp is almost prohibitive in cost. In other words, the cost of manufacturing electricity and delivering it in wholesale quantities at a single point is one thing, while taking this electricity and distributing it retail makes a very great additional expense.

Now take one of our practical cases. When the town of Wellesley comes to us and wants us to deliver our current wholesale at the town line, letting the town distribute it to its citizens in the town, the Edison Co. is relieved of a very large amount of expensive distribution work, and, naturally, is willing to make a much lower price to the town of Wellesley for its wholesale supply than it would if the Edison Co. had to distribute the electricity retail in the town of Wellesley, or than the Edison Co. does make in the adjoining town of Natick, where the Edison Co. has to pay the distribution expense.

This is the whole principal of wholesale and retail, the only difference between the Edison Co.'s business and other businesses being a question of degree.

Now, our wholesale rate is very much less than our average rate, and even than our average costs, but it should be kept clearly in mind that the small customers lose nothing in any way from the fact that the wholesale rate to large customers is less than the retail rate to the small customers. The use of our service by large customers at less than the average price does not add anything to the expense of supplying small customers, but in fact enables us to supply our small customers at a less rate than would otherwise be necessary.

For the amount of current that would be used by a large customer who gets our wholesale discounts, the cost of making so large an amount of current for himself in an isolated plant would be only 10 or 15% greater than our price to him. At first sight, therefore, it might seem that this 10 or 15% represents the advantage that the wholesale customer gets, as compared with his small competitor, over what he would get if we refused to make a wholesale rate. However, the wholesale customer gets his current, we will say 15% cheaper than if there were no central station supply, but if the retail customer had to make his small amount of current for himself, it would cost him, not 15%, but 100% more than our price, so that the retail customer gets 100% and the wholesale customer only 15% advantage from the fact that the Edison Co. exists.

There is one case that frequently comes up, and that is that in an office building, the owners buy wholesale at the same price that, for instance, a town would buy, but the expenses of distribution from the basement of an office building to the offices are much less than they would be between a central point in a town and the final consumer along the roads.

It follows, therefore, that the when Edison Co. goes into a big office building at the request of the owner, it could sell to the tenants retail at a very much lower price than it could in the towns of Natick or Wellesley, though, of course, not quite as low as the wholesale price at which it would sell to the town or to owners of the office building.

If, therefore, we followed out completely the theory of determining the cost in each particular case we would have a different cost in each town and in each block of buildings, since, when we have a very great many customers side by side our costs of supplying them are much less than when we have the same number of customers spread out over a large area.

If, however, we should attempt to make a different price in each section and each block according to the number of customers we had, or according to any other local reason, the differences would be very unsatisfactory, and, fortunately, there is another feature in our expenses and costs that enables us to take care of this difficulty.

The reason is that in addition to all the expenses I have outlined that are actually increased every time a customer comes on our line, there are a great many other expenses. For instance, when we lay a main in a street we have at first only one or two customers on the street, and these perhaps use only 1% of the whole capacity of the main. It would be bad engineering to put in a main so small that whenever a customer came on it had to be dug up and replaced by a larger one, and yet the excess cost of the large main put in looking towards the future growth can hardly be charged to the particular customer who uses it first, but must be spread over the whole business, or rather charged to those customers, who, on the whole, get the benefit.

Another expense of this nature is the fact that many of our engines are of older type than the modern turbine, and involve considerably higher coal and labour cost. In our work we aim at keeping the total expense at a minimum. If we should throw away these old engines and put in turbines we could reduce our coal expense, but would increase our depreciation charge by an even greater amount, hence, we run the old engines until we can afford to scrap them. But it would not be fair to charge the extra coal due to running these old engines, only to the old customers

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for whom these engines were put in, and to give the whole advantage of the turbine to the new customers, hence this extra cost forms an item which must be distributed over the whole business and cannot be ascribed to any particular customer. When the City of Boston abandons a street and makes us abandon our conduits without compensation, that again is an expense that cannot be ascribed to any particular customer. Besides these three sample cases, there are many similar expenses.

The next question is that of power and why should power prices be different from those for light.

We use the same turbines, transmission lines, mains, meters, etc., and two customers may be using the same amount of current side by side, and the one that used it for power gets a much lower rate than the one who uses it for lights. Why should this be so?

There are two reasons, or classes of reasons, for this.

One is that power service requires much less care and attention than lighting service. For one thing we do not have any expense for renewal of incandescent lamps. We do not have to regulate the pressure as closely for power as we do for light, and that means that even when the current is supplied over the same wires, that the expense of the extra good regulation required for light should be collected as far as possible from our lighting customers.

These items, however, while important, are not the most important. The really important difference between light and power is that power is called for at any time during the work day, and, therefore, the result of all our power business, even if individual customers only use their portion of our investment a short time, is that our station and transmission line investment and much of our distribution investment is used steadily ten to twelve hours a day.

On the other hand, the same number of lighting customers instead of coming on at any time from 7 a.m. to 5 p.m., will practically, all of them, come on some time between 4 p.m. and 6 p.m. in the winter, and will result in requiring a very much larger investment in proportion to the kilowatt-hours used. We can, therefore, afford to supply intermittent power at a lower rate than we can supply intermittent light.

When a power customer becomes even moderately large-sized, or a moderately long-hour user, he begins to be able to get his power in other ways. In other words, he ceases to get as much benefit from our service as a small user, and cannot afford to pay as high a price per kilowatt-hour.

We, therefore, reduce his rate so that he can still afford to use our service, although he is not as profitable as a smaller customer in proportion to the kilowatt-hours used. On the other hand, he is a very profitable customer indeed in proportion to the investment required.

The foregoing discussion has brought out the four most important principles that are used in making prices, and these are:

First—That the customer who uses the investment a long time is much cheaper to supply, and is entitled to a better rate than the customer who uses the investment only a short time.

Second—That a large customer who does not require any large expenditure for distribution in proportion to the amount of service rendered, can be supplied at a very much lower rate than small customers who require a very large distribution expense.

Third—The third is in one sense an extension of the first principle, in that a customer who uses the service for power, even if the individual customer uses the investment a short time, produces the same result on the station, and, to a certain extent, on the distribution system, as though he used the investment a long time, and can, therefore, be supplied more cheaply than if the current is used for light.

Fourth—That there are a large number of expenses which cannot be classified and ascribed to any particular customer, or class of business, but must be paid somehow. By proper distribution of these unclassified expenses, we are enabled to smooth out our prices and rates and make them far more simple than we would otherwise have to do, and also make them more uniform as between individual customers.

One question that has been frequently asked of us in the last few years is, why we have made all the reductions in prices to the short-hour consumer, and have made hardly any to the long-hour consumer.

A few years ago our ordinary lighting rate was 18 cents per kilowatt-hour, and we have, by gradual steps, reduced this, first to 15 cents, then to 12 cents, and now to 11 cents, and during this time the Hopkinson rate to our small long-hour consumers has remained at $60 a year fixed charge and five cents running charge.

If the 18-cent rate and the Hopkinson rate balanced each other four years ago, it would look as though we might be losing money on all of the 11-cent business now, or, rather, on most of it.

The case is very similar to the old woman who sold apples and said that she lost a little money on each apple that she sold, but she sold so many that it more than made up the difference, and gave her a little profit at the end of the day. Though we may apparently lose money on the 11-cent business, yet we do not actually lose money, except on a small proportion of our customers. What happens is that the customers who pay 11 cents pay only a small proportion of the unclassified expenses, and these unclassified expenses are almost entirely borne by the customers who take the yearly and wholesale and power rates.

From some points of view it does not seem quite fair that a drug store should pay so much larger proportion of the unclassified costs than the residence, but, on the other hand, it is evident that the public prefers a simple, uniform rate, and the only way that we can have a simple, uniform rate is to let the drug store and similar business pay a large proportion of the unclassified expenses.

There is another question often brought up, and that is why, as long as we have machinery lying idle in summer and in the early morning, we do not make a special price in order to have that machinery used.

Electric-vehicle people, for instance, are all the time coming to us and asking for a special price, in consideration of their agreeing not to use current at the time of our peak.

The reasons why we do not make any concession in this regard are as follows: The first being an Irish reason, in that we already do do it.

If a customer takes service from us at our ordinary lighting rate, he pays 11 cents, but if he takes service at our so-called yearly rate he pays a fixed charge and then gets all the electricity he uses at five cents, or less than half price. We have thousands of such customers, and if there were really any general demand for a low rate for current "off the peak," all that is necessary is for the people who want it to go to these customers of ours and get them to re-sell the electricity at six cents, making 20% profit. In fact, by reason of our power rate and wholesale rates, there are thousands of places that can sell current at three cents or less in Boston "off the peak."

While this feature of our price does take care of a great deal of vehicle charging in Boston, it does not satisfy the people who want us to put in a separate line and new service for them, and sell to them at a low price, because they will use it "off the peak." If we have to put in a special service, it is clear that so far as that service goes, and probably as far as the transformer and part of the distributing system goes, such supply is not "off the peak" in the sense that no investment is needed. Even in the case of the customer whose service is already in, but who pays 11 cents for all he uses, we must remember that the only reason we can afford to let him use current at the peak at 11 cents is that we know from experience that we shall also sell enough current "off the peak" at 11 cents to bring us out whole, and a lower "off the peak" price, therefore, means an immediate cut in income, unless we could devise some means so that our present "off the peak business" shall still pay full prices.

I do not mean that it is not wise to encourage "off the peak" business, since whenever we can fill up the valleys in our load curve, it means more income with no more investment.

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On the other hand, we must sell, and are to-day selling a good deal of current "off the peak" at much more than bare operating expense in order to be able to sell "on the peak current" at 11 cents. If we make any lower price for "off the peak" than we are to-day making, we must remember that it will cut off some of our present income, and whenever we consider any "off the peak" price, we want to be shown that its final result will be favourable to the whole of our business.

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Business Notes and News.

LIGHTING AND GENERAL—Home.

BRIGHTON.—The electricity installation at the Pavilion is to be entirely renewed.

BURY.—The Electrical Engineer has reported that on the publication of the Borough Treasurer's annual statement, he anticipated there would be a profit of about £3,800 on the year's working after payment of all charges, compared with a profit of £2,914 for the previous year. He reminded the committee that during the past year two small generating sets had been disposed of for the sum of £600. These plants were provided under the original contract in 1896 at a cost (including foundations, pipes, and switchgear) of about £3,500, the term of years for the repayment of capital being twenty-five. At the end of March last fourteen twenty-fifths of this amount, say £1,960, had therefore been repaid through the sinking fund, so that with the amount received from the sale, the sum of £2,560 had been provided to liquidate the debt, leaving a balance to be made up of £940. At the last Local Government Board inquiry the inspector stated that it was the practice of the Board to reduce future borrowing powers by an amount equal to the outstanding debt on any plant disposed of, and for such balances to be made up from the annual revenue account or from the reserve fund, if such a fund existed. In order to give effect to the Board's requirements the engineer recommended that the sum of £940 be taken from the reserve fund and applied towards the part purchase of the 500 kw. motor generators, which had superseded the generating sets, so that when details of expenditure on the new scheme are submitted to the Board the particulars given will show that the Board's recommendations have been complied with.

CARLINGFORD LOUGH.—The Irish Lights Board have notified that the Board of Trade have decided not to sanction the expenditure on the lighting of the Lough during 1910-11. The Lough Commission have made a protest.

COLCHESTER.—Mr. H. R. Hooper held a Local Government Board inquiry into an application for power to borrow £8,000 for purposes of the electrical undertaking. The proposed loan covered two sums of £638 2s. 6d. and £295 11s. 2d., excess expenditure on previous loans sanctioned on March 19, 1902. The second and greater part of the loan was in respect of new works. The sum of £2,700 was required for five miles of mains mentioned in a statement furnished to the Local Government Board for districts where a supply of current will in the immediate future be requisite, and in respect of which applications from residents have already been received. The application was now made to the Local Government Board in order to obtain the sanction, and so be in a position to carry out the works as need arises. The proposed mains were for the following districts: Ipswich-road to Laundry, Port-lane, Lucas-road, Cromwell-road, Alexandra-road, Kendall-road, Winsley-road, Mill-street, Mile End, Three Crowns-road, Braiswick, King Stephen and Morton-roads, Harwich-road, Fairfax-road, Portland-road, William's-walk, Gladstone-road, Canterbury-road (two places), Straight-road (Cherry-road to Parson's-hill), Essex Hall-road, Albert-street, Albert-road, and Mill-road to Hospital. For house services in connection with the above mains an estimated amount of £1,125 is included. The Council had at the Electricity Works two small generating sets of 6 kw. each, which are now too small for the requirements, and the Committee desire to substitute for these, if a purchaser of them at a fair price can be obtained, one complete generating set for £1,300, as now included in the application. The substitution of such a complete set would increase the efficiency of output, and enable greater economy in working. The Hythe and Lexden sub-stations, for which £960 6s. 4d. was required, had already been put down, and are working satisfactorily. On the suggestion of the inspector the sum of £295 11s. 3d. was reduced to £193, the balance to be met out of revenue. The sum for the mains, which included the previous amount overspent, was increased to £4,500, and the house services to £1,800. The question of the generating set was left in abeyance. Therefore the amended application was for sanction to borrow £7,453.

CREWE.—The total income during the past year from the Electricity Department was £8,034, showing an increase of £525 10s. 4d., and leaving a surplus on the year's working of £1,219 11s. 7d., which, with the surplus at April 1, 1909 (after deducting £500 transferred in aid of general district rate account) brought forward of £1,222 0s. 11d., made a total surplus of £2,441 12s. 6d. on revenue account, and suggesting that such surplus should be appropriated as follows: Transfer in aid of general district rate account, £500; transfer to reserve fund, £305; transfer to capital account to meet expenditure in excess of loans sanctioned, £658 3s. 10d.; carry forward as a working balance, £978 8s. 8d. It was moved by the Mayor, seconded by Councillor Chapman, and resolved, that £600 be transferred to the credit of general district rate account instead of £500.

DARLINGTON.—An application is to be made to the Local Government Board for permission to raise a loan of £1,500 for additional machinery at the electricity works.

DOVER.—The Corporation electricity works are doing well; there is an increased revenue from the Duke of York's School, and the supply light and power for both of the Admiralty will soon commence. A proposal is on foot to expend £1,000 on additions to the works.

EDINBURGH.—An attempt has been made to rescind the Town Council's decision to instal cooling towers at the Electricity Works (which are estimated to result in a saving of £10,600 a year), chiefly on the ground of their ugliness. The minute was, however, confirmed.

GREENOCK.—The Harbour Trust have authorised the laying of a cable to supply electricity to the workshops at the fitting out berths on the east side of Victoria Harbour.

HARROGATE.—The Town Council unanimously passed the Borough Electrical Engineer's scheme for an additional 500 lamps to be converted from gas to electricity. Competitive schemes have been submitted by both the gas and electricity undertakings, and the saving by substituting electricity was found to be a very substantial one. The cost per post to be charged to the Lighting Committee for a 50 c.p. lamp—including renewals and all accessories—is 17s. per annum, the lamp being extinguished at midnight.

HECKMONDWIKE.—The Town Council desire to spend an additional £4,200 on their electrical undertaking. As they have spent £19,959 over their borrowing powers, the Local Government Board is to be asked to sanction the raising of a loan of £24,159.

LONDON.—The County Council have conditionally approved of cables being laid by the following bodies in the streets named: County of London Electric Supply Co., in Schubert-road; St. James' & Pall Mall Electric Supply Co., in St. James'-street and Sackville-street (also alterations and construction of distributing boxes in various streets); South Metropolitan Electric Light & Power Co., in Blackheath Rise; and the St. Pancras Metropolitan Borough Council in Prince of Wales-crescent and Tottenham-mews.

LIMERICK.—Owing to the loss of £8,142 (£1,255 on last year's working) of the Corporation Electricity Department, an expert is to be called to investigate and report to the Council.

MORLEY.—The Municipal Electricity Department had a revenue during the past year of £2,954, against an expenditure of £1,711. Interest, sinking fund contributions, etc., however, amounted to £2,035, thus leaving a net deficit of £792.

NELSON.—A loss has been made on the year's trading, although there was a decreased expenditure of £101. This state of affairs is attributed to the failure to complete arrangements for the supply of the Burnley Corporation Tramways with power.

NEWCASTLE-ON-TYNE.—The result of the year's trading of the Electricity Department, showed a balance of £6,888, £414 more than the previous year in spite of the increased cost of coal and expenses of arbitration. A net balance of £1,128 (as against £584) has been placed to the reserve account. A suggestion is under consideration that consumers should be allowed meters free as soon as their rents had covered cost and interest.

PENMAENMAWR.—The Board of Trade have granted a year's extension in connection with the Provisional Order under the Electric Lighting Act. The time for providing a supply had elapsed. Negotiations are being carried on with the North Wales Power Co. for purchase of current in bulk, and enquiries are also being made as to the cost of a producer gas plant.

PENRITH.—The Carlisle Consistory Court has granted a faculty for the substitution of electricity for gas at Christ Church.

ROTHERHAM.—The Electricity Department made a profit of £6,917 last year; of this, £2,000 has been allocated in relief of rates, £3,807 carried to the tramways accumulated renewals fund, and £922 carried to the electricity accumulated renewals fund.

WESTHOUGHTON.—Pending the securing of a Provisional Order, the Atherton Urban Council are to be allowed to supply consumers on their borders with electricity.

WIGAN.—The Local Government Board have written stating that, with reference to the application of the Corporation for sanction to borrow £36,000 for purposes of their electricity undertaking, the Board will not raise any objection to the Council commencing the work at once.

LIGHTING AND GENERAL—Overseas.

ASANSOL, INDIA.—Estimates have been sanctioned for an extension of the power house at Asansol, and for the supply

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therefrom of electricity to the East Indian Railway office and staff quarters.

COPENHAGEN.—The Commune, which has raised a loan of two millions sterling, will spend part of this sum on the erection of an electric power station. It is probable that only Danish tenders will be considered, except where foreign appliances are absolutely necessary.

FORT SASKATCHEWAN.—The Town Council are taking steps to develop electric power for lighting and power purposes from the Sturgeon River. A by-law for $30,000 will be submitted at an early date to cover the cost.

OVERIJSSEL, HOLLAND.—Plans and specifications have been drawn up for the construction and joint working of an electric generating station by the towns of Deventer and Zwolle, in the province of Overijssel. It is expected that the plans will be adopted.

VILLA DEL CARMELO.—The Uruguagan Minister of the Interior has issued a decree granting to Don Antonio Rossi a concession for the establishment of a telephone service at Villa del Carmelo (Department of Colonia). The concessionaire undertakes to arrange that his telephone line shall not interfere with the State lines.

WINNIPEG.—The Board of Control are about to consider tenders for the supply and erection of conduits, the erection and fitting of sub-station transformers and switchgear.

TRACTION—Home.

BOURNEMOUTH.—The General Manager of the tramways presented his annual report, which showed that the traffic receipts amounted to £85,392 13s. 11d., and the sundry receipts to £147 2s. 1d., making a total of £85,539 16s. The expenses amounted to £55,677 4s. 4d., leaving a gross balance of £29,862 11s. 8d., being an increase of £3,325 13s. 6d. on the previous year. The receipts per car mile amounted to 11·5d. as against 11·27d., an increase of ·23d. The expenses per car mile amounted to 7·46d., as against 7·62d. the previous year. There is a proposal to substitute the overhead for the present conduit system. Mr. C. W. Hill, the manager, estimates that this could be done for a capital outlay of £1,910, while the annual saving would be at least £3,000.

BRAUNTON.—The proposal to form a small company to supply electricity, provided the Parish Council undertake to pay £54 a year, and purchase lamps and shades, but not lamp posts, for public lighting, seems likely to be carried out.

CARLISLE.—A proposal has been made to purchase the City of Carlisle Electric Tramways Co., Ltd., for £7,000, subject to the debenture charge of £40,000. This means an offer of 2s. 2d. per share. The directors are recommending the scheme to the shareholders, and if time agree, a special general meeting will be called shortly.

COLINTON.—The Colinton Tramway Co. propose to make an extension to Juniper Green.

DUNFERMLINE.—The Dunfermline and District Tramways Co. have been authorised to raise £90,000 additional capital, and to borrow on mortgage a sum of £30,000 to be expended on tramway extensions down Grange-road, from Lochgelly to Lochore, and from Auchterderan to Kinglassie.

FARNWORTH.—The loss on the town electricity undertaking for last year amounts to about £1,000. Some £6,000 has been spent on new machinery, which is expected to result in economies, but apart from a drop in revenue as a result of the use of improved lamps, there has been a serious loss of customers.

SOUTH SHIELDS.—The Corporation have decided to oppose the North and South Shields Electric Railway Bill.

WEMYSS.—The Wemyss & District Tramways Co., Ltd., have obtained a concession on their Colinton Order, the tenure being extended from 28 to 35 years, this is as a result of the recognition that the development of the district is due to the company's enterprise.

TRACTION—Overseas.

BUENOS AIRES.—According to a local correspondent, the final work in connection with the construction of the new Anglo-Argentine Tramway stations of Hipodromo and Centenario is being pushed forward with all speed. The latter station will have capacity for 200 cars. For the expected increase of traffic during the Centenary Celebrations the company is also increasing the number of its cars. At present, for any particular occasion, 1,300 trams with an additional 400 trailers are put in service, by which from 70,000 to 80,000 passengers are carried per day. An additional 50 cars have recently been received from England and Belgium, and this month a further lot of 80 is expected to arrive, while 50 are being constructed in Buenos Aires.

RIO DE JANIERO.—The Brazilian High Court of Justice has issued an injunction against the Companhia Brazileira de Energia Electrica, restraining that company from exercising a concession to use the streets of the city for the purpose of supplying electric light and power for a period of 90 years, in competition with the Rio de Janiero Tramway Light & Power Co., declaring that the latter company has the exclusive concession for the purposes mentioned. It is also announced that the Town Council have granted to the "Compagnie Brésilienne d'Electricité" the concession for supplying electric power to the town and municipality of Rio de Janiero for a period of 90 years. The work will be started without delay by the company. The contract was signed on April 28th ult., at 30% beyond the previous price.

SAVONA.—The Italian State Railways have decided to extend the electrification of the Savona San Giuseppe Railway line as far as the station of Ceva. The total length of the electric line will be about 28 miles. The Consiglio Provinciale of Genoa has granted to a preliminary committee composed of several capitalists of Savona a 30 years' concession for the construction and working of an electric tramway from Savona to Vado. A company is about to be formed, with an initial capital of 800,000 lire (about £32,000), and it is hoped that by the end of 1911 the line will be completed and ready for use.

COMPANIES' MEETINGS AND REPORTS.

BRISBANE ELECTRIC TRAMWAYS INVESTMENT CO., LTD.

Cable advice announces that the traffic receipts of the Brisbane Tramways for the month of April amounted to £17,690; corresponding month last year, £15,530; increase, £2,160.

WEST AFRICAN TELEGRAPH.

The report shows a net profit for 1909 of £36,841, while £1,731 was brought forward. The sum of £27,000 has been transferred to reserve, and a final dividend of 2%, making 4% for the year, is declared, leaving £930 to be carried forward.

DUDLEY, STOURBRIDGE AND DISTRICT ELECTRIC TRACTION.

The directors recommend a dividend of 2% (2s. per share) on the Ordinary shares for the year; placing £2,000 to renewals account, £998 to depreciation account, and carrying £12 forward.

GREAT NORTHERN TELEGRAPH.

The net profit for 1909, including the balance brought forward, amounted to £417,758, out of which the board propose to place £55,555 to reserve and renewal fund, £8,333 to staff pension fund, and to pava final dividend of 7½% and a bonus of 5½%, making 18% for the year, leaving £81,369 to be carried forward.

WEST COAST OF AMERICA TELEGRAPH.

The report states that after providing for the interest on debentures and income bonds and for income-tax, there remains a balance of £3,797, to which is added the sum brought forward, making a total of £4,427. Of this amount, £1,000 has been placed to the general reserve fund, and the directors recommend a dividend of 2½%, free of tax, leaving £614 to be carried forward.

WEST INDIA AND PANAMA TELEGRAPH.

The amount to credit of revenue is £34,678, against £34,871 for the corresponding half-year of 1908, and the expenses have been £23,557, against £22,160. The result is, therefore, a balance of £11,120, to which is added £1,529 interest on investments, and £659 brought forward from last account, making an available total of £13,310. The directors propose to pay on the First Preference shares a dividend of 6s. per share for the six months to December 31 last, and on the Second Preference shares payment of 9s. per share on account of dividends accrued to December 31 last, leaving a balance to the current half-year's account of £840.

BRITISH WESTINGHOUSE ELECTRIC AND MANUFACTURING.

The accounts for the past year show a profit of £84,156, from which is deducted Debenture interest, etc., leaving a balance of £7,647. This balance has been absorbed by the appropriation of £5,300 required for the prior lien redemption fund, expenditure on contracts of previous years

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amounting to £2,485, and by the writing off of £660 from expenses of issue of Prior Lien Debentures, leaving a debit balance of £798. This debit balance, together with the debit balance of £6,521 brought forward from last year, making a total of £7,319, is now to be carried forward. In addition to a substantial sum appropriated out of revenue during the year for the maintenance of buildings, machinery and plant, a further amount of £16,742 has been applied to the depreciation of the same items, which sum the directors consider sufficient under the circumstances.

DELHI ELECTRIC TRAMWAYS.

The fourth ordinary general meeting of the Delhi Electric Tramways and Lighting Co., Ltd., was held at Winchester House, E.C., Colonel Sir Buchanan Scott presiding. The Chairman, in moving the adoption of the reports, said that the loss for the year of £3,225, after charging debenture interest, was disappointing, but was principally due to the low receipts from the tramway section during the winter months of 1908. As regarded working expenses, the board had been able to effect considerable reductions in expenditure on establishment and also in fuel, owing to the price of coal having fallen to the normal again. The Diesel oil engine and other plant had arrived in Delhi, and its erection was nearly completed. The total cost of this extra installation was approximately £5,000. With a view to popularising the tramways and to bring their charges more within the means of a large number of their passengers, a further small reduction in fares had recently been given effect to. The tramway receipts from March 1 to May 1 this year amounted to Rs.16,500, which was an increase of Rs.4,300, or £290, over the corresponding period of 1909. As regarded the lighting section, the receipts each month so far had shown a satisfactory increase, which appeared likely to be maintained. A satisfactory agreement had been made with the Delhi Municipality for the lighting of Delhi for a period of three years, and the directors were in negotiation with a department of the Government of India for a large extent of lighting, which they fully expected to bring to a successful conclusion. Mr. T. W. Stratford-Andrews seconded the motion, which was agreed to.

PARA ELECTRIC RAILWAYS AND LIGHTING.

The report for the year ended November 30 last, to be presented to the meeting on the 11th inst., states that the receipts for the year amounted to £225,916, showing an increase of £20,605. The expenditure in Para was £120,309, as against £152,637 in 1907–8, the net earnings, subject to London expenses, being £105,606, as against £52,674 in 1907–8, an increase of £52,932. After providing for the London expenses, Debenture interest and sinking fund, there remains a balance of £60,589, to which has to be added the amount of £9,863 brought forward, making a total of £70,453. Out of this sum the dividend for the year on the Preference shares has been paid, amounting to £17,498, and the directors have added £15,000 to reserve for depreciation and renewals, and £10,000 to the reserve for contingencies, leaving a balance of £27,954. Out of this amount it is proposed to pay the arrears of cumulative dividends on the Preference shares for the years 1906 and 1907, which amount to £27,000. This dividend was paid to the shareholders by the Works Construction Co. under its guarantee, and, therefore, is now payable to the guarantor. After making this payment there will be a balance carried forward to next year's accounts of £954. It will be seen that if it had not been for the exceptional charge of £27,000 for the arrears on the Preference shares, referred to above, there would have been a substantial surplus upon the year's working available for dividend on the Ordinary shares. In the summer of 1909 the shareholders were called together to authorise an increase of the share capital by the issue of 8,000 additional Ordinary shares to enable this company to purchase shares in the Compagnie d'Enterprises Electriques de Para. This operation has been carried out, and practically all the shares of the latter company have been purchased. The result of this will be that in future the two companies will be able to work more economically and efficiently than was possible hitherto. The financial advantage, however, will appear in the next accounts. The net earnings in Para for the four months since December 1, 1909, show an increase of £13,842 compared with the receipts for the corresponding period last year. The directors consequently look forward with confidence to a continuance of the prosperity of the company.

JOHNSON & PHILLIPS.

The directors, in submitting the audited accounts for the year ending December 31, 1909, state: It will be seen by the profit and loss account, that the profit for the year on trading accounts, etc., after making provision for bad and doubtful debts, and after charging to revenue upwards of £3,691 for maintenance of buildings, plant, etc., amounts to £15,359 7s. 6d.; add balance brought forward from 1908, £681 2s.; total, £16,040 9s. 6d. Deduct: Remuneration of directors, auditors' and trustees' fees, £1,503 15s. 8d.; interest on debenture stock to December 31, 1909, £7,850 13s.; reserve *re* debenture sinking fund, £5,059 11s. 6d.; interest on second debentures to December 31, 1909, £684 1s. 2d.; total, £15,098 1s. 4d. Carrying forward to next account a balance of £942 8s. 2d. The directors have to report that the business of the company during the year under review was adversely influenced by the depression in trade throughout the country. The disinclination generally shown to place large orders, and consequent active competition, kept prices low, while the cost of raw materials ruled high. In October, the compounding shop was destroyed by fire. While the company incurred no direct loss, considerable difficulty was occasioned to the cable department, and it was necessary to equip temporary premises to avoid delay in the execution of contracts. The capital account has been increased only by the comparatively small amount of £869, while substantial improvement has been effected, and paid for out of revenue. As will be seen, the profit for the year shows an increase of £5,322 over the preceding year. Should the electrical trade improve, of which there seems to be some indication, the directors believe that the company is in a position to secure its full share of any business increase. Mr. Frank Sydney Paterson, since the date of the last general meeting, retired from the board, and the directors, pursuant to powers vested in them by the Articles of Association, appointed Mr. Walter Claude Johnson and Mr. Thomas Dence as additional members of the board.

CALCUTTA ELECTRIC SUPPLY CORPORATION.

The thirteenth report, for the year 1909, states that during the year 7,856,383 units of electricity were sold, compared with 6,765,792 units in 1908, an increase of 1,090,591 units. The number of houses connected at December 31 last was 5,078, compared with 4,396 at the same date in 1908, an increase of 682, and the equivalent connections in 8 c.p. lamps show an increase of 73,437. A considerable demand has arisen in the northern districts of Calcutta for electrical energy for power purposes, and the board were advised that steps must be taken without delay to meet this demand. In order to do this, and at the same time to economise the cost of production, it was proposed to erect a large high tension generating station at Cossipore. To meet the capital outlay required for this scheme the board invited, in July last, subscriptions for the remaining 80,000 preference shares. Of these 40,350 shares have been subscribed for and allotted, at the date of this report. Mr. Jenkin (of the firm of Sir Alexander Kennedy & Jenkin, electrical engineers) has visited Calcutta, at the request of the board, to advise what shall be done, and on his recommendation the board has decided to place at once some additional plant in the Ultadangha station of the company, which plant will be ready to commence supply in the northern districts by September 1 next. Messrs Kennedy & Jenkin approve the proposed construction of the high tension station, both for economical reasons and to meet the constantly growing demands for current. Some delay has been experienced in getting possession of the land, the site for the proposed new station, but arrangements have now practically been completed for the purchase. Sir Alexander B. W. Kennedy, LL.D., F.R.S., M.Inst.C.E., M.I.E.E., has been appointed consulting engineer to the

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company. The net profits for the year 1909 amount to £67,023 14s. 11d. (compared with £58,188 0s. 4d. in the previous year), to which has to be added the balance brought forward from 1908, £3,303 13s. 8d., and after deducting the interim dividend at the rate of 6½% per annum paid in November, 1909, on the ordinary shares, and the dividend paid and accrued on the preference shares, together with the other items set out in the net revenue account, there remains an available surplus of £46,134 5s. 11d., compared with £41,668 13s. in the previous year. The directors recommend that a sum of £17,000 be placed out of profits to the credit of the depreciation and renewals account, and that a final dividend for the second half-year, at the rate of 9½% per annum, be paid on the ordinary shares (making 8% for the year), which will leave a balance of £5,492 1s. 3d. to be carried forward, after providing for the directors' extra remuneration of £1,277 10s. There is no diminution in the flow of applications for current, as is proved by the additional connections equivalent to 73,437 8 c.p. lamps during last year, compared with 57,972 in the previous year. There is everything, therefore, to justify the belief in the continuance of the prosperity and success of the company.

CALLENDER'S CABLE AND CONSTRUCTION.

The report for the year ending December 31, 1909, to be submitted at the fourteenth annual general meeting of the company, states that there is a balance at the credit of profit and loss account for the year's working of £54,362 5s. 9d., to which has to be added the balance brought in from 1908, of £45,884 10s. 7d., making together £100,246 16s. 4d. From this must be deducted: (1) Interest on Debenture stock £13,500, (2) dividend on Preference shares £10,000, (3) appropriation for depreciation of buildings, plant and machinery £8,294 6s. 6d., making £31,794 6s. 6d., leaving an available balance of £68,452 9s. 10d. It is proposed to deal with this in the following manner: (1) By the payment of a dividend on the Ordinary shares at the rate of 10% per annum (less income tax), being 10s. per share, whereof 5s. (less income tax), was paid on November 1, 1909, and 5s. (less income tax), will be paid on May 28, 1910, £17,500; (2) by the payment of a bonus of 5s. per share (less income tax), to be paid also on May 28, 1910, £8,750; (3) by carrying forward to next year's account, £42,202 9s. 10d.; total £68,452 9s. 10d.

The value of the business done by the company during 1909, showed a considerable reduction as compared with that of recent years, but, seeing that 1909 was unfavourable to nearly every branch of the electrical and engineering industry, the directors are of opinion that the results now shown cannot be considered other than satisfactory. At no time for many years past have the conditions under which the company's operations are carried out been more difficult than in the period under review. The quantity of work available was even less than usual, and the struggle for orders was, consequently, severe. This was especially the case in the home trade, where no new contract of any magnitude was carried out, and where even the orders for extensions to existing mains were less in number and smaller in value than customary. Whilst this was doubtless due in part to the extended use of metal filament lamps, it was greatly intensified by the universal depression which prevailed, and by the uncertainty in the financial outlook throughout the country generally. It is, therefore, with considerable satisfaction that the directors notice the improvement in trade which has taken place since the beginning of this year, with the consequent increase in orders which have been placed with the company.

Although foreign and colonial business was not so extensive in 1909 as in previous years, it has not suffered to the same extent as the home trade. Arrangements have been made for the representation of the company's interests in several markets hitherto untouched. Whilst the operations of the company on the Continent, carried on through the German company, have been quite satisfactory, it is the intention of the directors to extend the usefulness and activity of that office during the coming year. Satisfactory relations have been established in Belgium, which, during the last twelve months, have resulted in several important contracts having been secured in face of strong Continental competition. The company's engineering department has been considerably extended, and its business increased. A satisfactory connection is now being built up in the South of England in foundry and general engineering work, entirely outside the cable business. The Anchor Cable Co., Ltd., has again done well, and in spite of the extraordinary rise which has taken place in the price of rubber, has been able to show even better results than in 1908. The factories, both at Erith and Leigh, have since the beginning of this year been well supplied with orders, and unless unforeseen events happen in the political or commercial situation, there is, in the opinion of the directors, a more promising outlook for business than has been the case during the past two years. The great disaster which has befallen the Empire by the death of His Majesty King Edward VII., may modify to some extent these hopeful expectations, especially in regard to the immediate course of business. The machinery, plant, and appliances, both at the factories and on the outside contracts at home and abroad, have, as usual, been maintained in a thoroughly efficient condition, and the cost of so doing has been charged against the year's accounts.

COMPANIES REGISTERED.

De Laval Igniter Co.—Capital £1,500, in £1 shares, to carry on the business of manufacturers of and dealers in dynamos, electrical motors, switchboards, controllers, resistances, general switchgear appliances, controllers, accumulators, etc., and to adopt an agreement with R. E. Bentley. The subscribers are R. E. Bentley and H. Matthews, Birmingham. Private company.

British Electric Automatic Machines.—£150,000 (£1) (25,000 Pref.). To acquire, deal with, and turn to account any invention relating to automatic postage, ticket-vending and printing machines, automatic letter boxes, automatic stamp-affixing and registering machines, etc., and any invention relating to postal or railway appliances, etc., whether worked by hand, electricity, or other power. Minimum cash subscription, seven shares. First directors (not less than two nor more than eight): N. von Nettebladt, Captain J. P. Wood, and H. Limebeer. Qualification of first directors, £10 each; of other directors £150. Remuneration (except managing directors), £200 each per annum. Caxton House, Westminster.

FINANCIAL NOTES.

Carlisle Tramways Co.—Early this week the shareholders of the Carlisle Tramways Co. received a circular from the directors recommending the sale of the undertaking. The profits of last year were not sufficient to meet the interest on the Debenture Stock. The board have been engaged in negotiations for the sale of the undertaking, and an agreement has been made for sale, subject to the Debenture debt of £41,000, for £7,000. The purchaser offers to buy all the shares from the existing shareholders at 2s. 2d. per £1 share. The loss on the past year's working, after providing for Debenture interest, was £59. The share capital of the company is £60,000.

Provincial Tramways.—The Ordinary shares of the Provincial Tramways Co., Ltd., having been reduced by resolution of the shareholders, confirmed by the court, from £10 to £5 by writing off £5, the remaining £5 will be divided into five shares of £1 each. The secretary announces that, in order to prepare the new certificate for the £1 shares to be exchanged for the old certificates, the register of transfers of the Ordinary shares will be closed from Monday until the 18th inst. inclusive.

Welsbach Light of Australasia.—The accounts for the year 1909 show a net profit of £896, to which is added the sum of £7,728 brought down, making a total available sum of £8,624. The directors recommend a dividend of 1s. per share (100%), carrying forward a balance which will be required for working capital.

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PATENTS.

Junction Boxes for Electric Fittings.

7995.—1909. SIMPLEX CONDUITS, LTD., & L. M. WATERHOUSE, Birmingham. The box has a series of screwed inlets which are made to receive closing plugs. The cable sheathing is jointed to the plugs, which have bores of different diameters, whereby the cable sheathing is housed but prevented from entering the box. A nut and plastic washer secures the sheathing to the box.

Electric Clocks.

8123.—1909. F. SCHNEIDER, Fulda. This is an improvement in clocks of the type in which provision is made of an electro motor for driving the winding and striking trains. A movable contact spring is carried by a lever which also carries a downwardly directed spring. This latter spring abuts against a stop carried by the ratch, and prevents the contact springs from coming together until the ratch is released.

Electric Conductors.

8419.—1909. R. K. GRAY, London, E.C. A protective device is provided for induction coils arranged along the length of electric cables. The covering consists of one or metal cylinders, the ends of which are cut away and bent to a conical form.

Magneto Electric Machines.

8489.—1909. F. BURKS, Manchester. This improved miniature magneto electric machine consists of a cast-iron horse-shoe magnet which is fastened at its poles to a circular wooden base. Extending from pole to pole on either side are stamped brass plates, held in position by small screws. Between the poles an armature is rotatably mounted, the axis of which takes its bearings in the plates. Fast upon one end of the armature axis is a circular boss which forms a commutator, and a square boss which forms a circuit breaker. A spring blade, with a forked free end, is secured to the base. One of the forks presses against the commutator, and the other fork presses against the circuit breaker. A toothed wheel is provided for rotating the armature.

Filaments.

8781.—1909. BRITISH THOMSON-HOUSTON CO., LTD., London, E.C. The filaments are prepared from a plastic mass which is produced in the form of a precipitate by adding an organic acid to a solution of an alkaline compound of a refractory metal. From this mass the filaments are shaped and treated to produce homogeneous bodies of refractory conducting material.

Wireless Telegraphy.

10586.—1909. J. RYMER-JONES, Blackheath Hill, S.E. The apparatus is designed and constructed in a way that shall enable the several transmitting and receiving instruments to be placed successively in momentary electrical connection with their respective serials for the purpose of diplex-duplex or multiplex-duplex wireless telegraphy or telephony.

Meters.

11634.—1909. SIEMENS SCHUCKERTWERKE, G.m.b.H., Berlin. This is an improvement in astatically arranged continuous current meters of the watt-hour commutator type provided with fixed coils, and consists in connecting the fields across one or more shunt resistances having small temperature co-efficients. The shunt resistances are in series with the main current conductors. The fixed field coils, the leads connecting them to the shunt resistances, and also the brake disc, are constructed of materials having the same temperature co-efficient.

Electric Motor Meters.

12878.—1909. AKTIENGESELLSCHAFT KÖRTINGS ELEKTRICITATS-WERK, Berlin. A coned or stepped cylindrical collector is provided in combination with spring brushes applied on either side of the collector. The parts of the brushes are relatively movable in the axial direction of the collector by displacement of one of them under the influence of the variations of the strength of the current whereby both the contact surfaces between the brushes and the collector are varied.

Incandescent Electric Lamps.

26006.—1909. H. J. JAEGER, New York. The lamp has a metallic filament, a stem with leads and filament supports, an arbor fused to the stem, and a number of elastic anchors at the top of the arbor. The filament loop support consists of a glass bead on each anchor. The inner ends of the anchors are twisted to form one rod portion.

Electric Lamps.

14675.—1909. J. SEAR, Kingston-upon-Hull. Conductor strips are arranged on the ends of the drum on which the cord is wound in such manner that they project above the edges of the drum. Contact pieces are fitted in line with the flanges of the drum so as to make contact with the strips at certain points in the rotation of the drum. The height of the lamp can be varied at will without the employment of weights for counter-poising purposes.

Electric Brakes for Cranes.

15544.—1909. B. & E. THOMAS, Hulme. An electro-magnetic device is employed in connection with brakes, having springs to cause the brakes to be normally applied, to give approximately uniform tractive effort in all working positions of the crane for the same excitation. The device is arranged to oppose the springs to remove the brake. A control switch and resistance vary the degree of excitation of the electro-magnetic device, and provide a graduated control over the release of the brakes.

Process for Forming Carbonised Metal Filaments.

16065.—1909. W. HEINRICH, Charlottenberg. The container in which the filaments are to be formed is washed out with illuminating gas, and finally exhausted down to a pressure of 5 mm. of mercury. A small quantity of ammonia gas is admitted into the illuminating gas in the container. The quantity of the admitted ammonia depends on the percentage of the heavy and light hydrocarbons contained in the gas. Not the slightest trace of carbon passes into the filament, as this is prevented by the ammonia. The cheapness of illuminating gas renders the cost of forming much less than the hitherto known process.

Electro Magnetic Clutch.

16095.—1909. C. W. HILL, Westminster. The object is to construct clutches for the purpose of transmitting power from one shaft of machinery to another, operated electro-magnetically, and capable of transmitting considerable forces by magnetic pull only, and not by the friction of surfaces drawn together by an electro-magnet. Upon each shaft is mounted a wheel carrying teeth upon its periphery, forming pole-pieces. The wheels are so placed that the pole-pieces of one are as near as is practicable to those of the other. An exciting coil is provided on one wheel, and this, when energised, magnetises the pole-pieces, and so couples the two wheels together by their magnetic attraction.

Arc Lamps.

16855.—1909. ELECTROTECHNISCHE G.m.b.H. & J. GYURIS, Berlin. The two electrodes and arc-producing rod are combined with a brake, which permits the formation of a slightly conductive passage between the terminals of the electrodes and the rods when the lamp is in circuit, but secures the movable parts in their position when the circuit is closed.

Switch Mechanism for Illuminating Signs.

24190.—1909. L. MILLER, Brownwood, U.S.A. A vibrating frame, carries circuit-breaking devices operated by a gravity-moving means, and adapted to travel on the frame and throw the lamps forming the sign into circuit. The travelling means operates switches, which energises the motive means for rocking the frame, and thus throws certain shunt connections through the lamps into circuit to keep the whole sign illuminated for a short time, and then to cause the lamps to be extinguished.

Suspending Telephonic Microphones.

1794.—1909. V. TARDIEU, Arles sur Rhone. The microphone is fixed to a breastplate by means of two semi-circular arcs of aluminium, fixed to the breastplate by means of screws, and of insulating tubes, which are themselves insulated by a washer. The connections are effected by means of terminal screws.

Telephone Exchanges.

2608.—1909. SIEMENS & HALSKE, A.G., Berlin. When the plug is inserted in the jack, the circuit by which the disconnecting relay is excited includes two contacts, one of which is closed only when the call relay is excited, while the other is opened when ringing current is passing to the subscribers' line. The calling relay closes the first contact as soon as it becomes energised by the ringing current, but this does not affect the disconnecting relay because the second contact has already been opened.

Electro Magnetic Brakes.

4171.—1909. WESTINGHOUSE ELECTRIC, LTD., London, W.C. The brake comprises a brake-magnet provided with a series energising winding supplied with current from the motors of the vehicle operating as generator and a shunt energising winding supplied from the trolley conductor of the system or other source of current separate from the motors. The series wind is used either alone or in combination with the shunt winding for ordinary service application of the brake, and the shunt winding alone for emergency application.

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TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns per week.			Increase or decrease.		Miles of track open.		Accounts for past year.							Cost per car mile.
	Ending	1909-10.	1908-9.	Week.	Current year.	1909.	1908.	Ending	Total receipts.	Passengers carried.	Car miles run.	Receipts per Passenger.	Car mile.	Mile of track.	
		£	£	£	£				£						
Aberdeen Corporation	May 4	1,452	1,304	+ 147	— 680	27½	27½	May 31	71,930	17,517,304	1,566,119	·98	11·02	4,940	5·88
Ayr Corporation	Sept. 18	671	562	+ 108	—	8	8	—	—	—	—	—	—	—	—
Baker Street and Waterloo Ry.	Nov.	8,141	6,070	+2,071	—	4·25	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	May 1	1,014	1,011	+ 3	— 286	24·003	13·52	—	—	—	—	—	—	—	—
Birmingham Corporation	May 4	6,622	6,490	+ 132	—	56·792	58·52	—	—	—	—	—	—	—	—
Blackburn Corporation	Oct. 6	1,100	1,293	— 173	—1,036	24·53	28·3	—	—	—	—	—	—	—	—
Blackpool Corporation	Aug. 26	2,152	2,050	+ 102	+ 732	—	—	—	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams	„ 8	2,304	2,309	— 24	—	—	—	—	—	—	—	—	—	—	—
Bolton Corporation	Oct. 10	2,416	2,337	+ 79	— 259	42	42	Mar. 31	117,799	25,492,902	2,492,147	1·1	11·34	2,804	6·10
Bournemouth Corporation	July 21	1,681	1,723	— 42	— 23	29½	29½	„ 31	86,225	13,991,328	1,766,068	1·47	11·71	2,912	7·22
Bradford Corporation	April 30	4,848	4,633	+ 215	—1,708	98	54·81	„ 31	235,258	47,839,569	5,331,007	1·17	10·59	2,378	—
Brighton Corporation	May 1	835	844	— 9	— 694	9·5	—	—	—	—	—	—	—	—	—
Bristol Tramway Company	April 29	5,429	5,159	+ 270	—	57	51½	Dec. 31	265,362	46,652,389	5,756,842	—	—	—	—
Burnley Corporation	May 7	1,268	1,262	+ 6	—	19½	19½	Mar. 31	64,261	12,355,958	1,202,330	1·23	12·83	6,971	7·22
Burton Corporation	May 1	258	253	+ 5	— 70	6½	6½	„ 31	14,918	3,221,595	430,913	1·04	8·30	1,460	9·46
Cardiff Corporation	April 3	2,000	1,957	+ 43	—	—	—	„ 31	109,979	25,058,146	2,497,169	—	10·57	—	—
Carlisle Tramways Company	June 19	170	175	— 5	— 89	—	—	—	—	—	—	—	—	—	—
Central London Railway	April 30	5,647	5,575	+ 72	+ 372	6·32	6·32	Dec. 31	360,150	41,898,373	1,456,781	2·01	5·769	55,404	30·254
Charing X, Euston, & Hamp. Ry.	Nov.	6,822	6,092	+ 730	—	7·75	—	—	—	—	—	—	—	—	—
City and South London Railway	May 8	3,175	2,957	+ 218	— 174	7·26	7·26	—	—	—	—	—	—	—	—
Colchester Corporation	July 14	200	219	— 39	—	8	—	Mar. 31	10,983	2,308,721	349,539	1·09	7·74	1,477	6·91
Cork E. T. and L. Company	May 5	493	—	+ 493	+ 795	9·89	9·89	Dec. 31	24,044	5,737,478	896,945	—	6·43	—	6·42
Croydon Corporation	April 22	1,575	1,445	+ 130	— 307	11½	—	Mar. 31	74,132	16,277,418	1,884,137	1·06	9·56	3,703	7·10
Darwen Corporation	Oct. 1	239	256	— 17	— 201	7·23	7·23	„ 31	13,899	2,557,654	245,584	1·30	13·68	1,922	9·40
Dover Corporation	Sept. 18	230	252	— 22	— 395	7	—	„ 31	11,593	2,697,672	316,754	·98	8·78	—	—
Dublin and Lucan Electric Ry.	May 6	147	134	+ 13	+ 37	7	7	—	—	—	—	—	—	—	—
Dublin U.T.	April 29	5,061	5,256	— 195	+ 2,950	54½	54½	—	—	—	—	—	—	—	—
Dundee City Tramways	Oct. 6	1,332	1,305	— 27	— 569	—	26½	May 15	60,573	16,367,911	1,281,552	·876	1·9	2,371	7·08
East Ham Corporation	May 7	996	1,012	— 16	— 152	15	15	Mar. 31	47,430	15,355,703	1,091,586	·73	10·26	—	6·88
Glasgow Corporation	April 30	17,882	17,413	+ 469	+ 3,105	192½	189	May 31	907,494	226,948,290	20,766,722	·96	10·49	5,090	6·85
Gloucester Corporation	Oct. 6	395	425	— 30	+ 535	15	—	—	—	—	—	—	—	—	—
G.N., Piccadilly and Brompton	Nov.	13,429	9,354	+ 4,075	—	9·25	—	—	—	—	—	—	—	—	—
Halifax Corporation	—	—	—	—	—	52·574	37	Mar. 31	81,872	20,378,672	1,786,390	11·40	11·13	1,528	9·8
Huddersfield Corporation	Dec. 4	1,613	1,357	+ 256	+ 2,663	28	28½	„ 31	84,704	16,200,020	1,960,329	1·29	10·37	2,421	5·13
Hull Corporation	May 7	2,659	2,381	+ 278	+ 98	29	26	„ 31	128,722	30,964,254	3,022,844	1·	10·22	—	6·94
Ilford Corporation	Feb. 12	451	391	+ 60	+ 1,969	10	10½	„ 31	25,328	6,385,466	634,446	·87	9·58	2,066	6·42
Ilkeston Corporation	May 4	126	118	+ 8	— 85	4	4	„ 31	7,214	1,968,850	198,415	9·1	7·9	1,803	7·94
Kirkcaldy Corporation	Sept. 8	259	266	— 7	—	7½	7½	May 15	14,993	4,874,199	459,066	·711	7·838	1,856	5·28
Lancashire United Tramways	May 4	1,249	1,275	— 26	— 73	39	39	Dec. 31	68,904	12,554,593	2,244,344	—	—	—	—
Leeds Corporation	Sept. 18	6,896	6,624	+ 272	+ 3,662	108	96½	Mar. 31	340,368	75,734,083	7,694,989	1·06	10·62	3,527	5·51
Leicester Corporation	Sept. 11	2,162	2,130	+ 32	—	—	—	—	—	—	—	—	—	—	—
Liverpool Corporation	Nov. 19	10,803	10,687	+ 116	— 1 977	109	104	Dec. 31	572,822	124,043,239	12,231,799	1·108	11·24	5,508	7·94
Liverpool Overhead Railway	May 1	1,427	1,292	+ 135	+ 160	6·65	2·40	June 30	79,004	11,171,515	1,106,386	—	—	—	—
London County Council	April 23	40,938	35,696	+ 5,242	+ 13,283	132½	123½	Mar. 31	1,274,660	279 166,461	25,591,028	1·08	11·74	—	6·79
Lowestoft Corporation	Dec. 11	155	150	+ 5	+ 30	3½	—	Sept. 30	11,399	2,645,206	370,320	1·03	7·86	2,279	6·12
Maidstone Corporation	Mar. 6	157	100	+ 57	—	7·4	—	—	—	—	—	—	—	—	—
Manchester Corporation	Sept. 11	15,631	15,297	+ 334	— 2,871	183	181	—	—	—	—	—	—	—	—
Metropolitan District Railway	May 7	10,911	9,891	+ 1,020	+19,336	24	24	—	—	—	—	—	—	—	—
Metropolitan Railway	May 8	16,605	16,079	+ 526	+ 10,127	24½	24½	June 30	680,357	99,846,735	—	1·46	—	—	—
Nelson Corporation	Oct. 16	151	131	+ 20	+ 7	2½	2½	Mar. 31	7,362	2,060,712	204,740	·85	8·63	1,907	—
Newcastle-on-Tyne Corporation	April 30	3,840	3,841	— 1	— 1,762	60½	59½	„ 31	211,085	46,203,164	4,411,745	1·10	11·48	3,504	9·38
Newport (Mon.) Corporation	Oct. 9	663	638	+ 25	— 311	14½	14½	„ 31	35,531	8,174,003	798,029	1·04	9·89	2,460	7·21
Oldham Corporation	Jan. 24	1,778	1,516	+ 262	— 386	—	—	—	—	—	—	—	—	—	—
Portsmouth Corporation	Oct. 10	2,046	1,809	+ 237	—	28½	28½	Mar. 31	97,741	21,247,048	2,309,439	1·10	10·15	—	—
Reading Corporation	May 5	588	567	+ 21	— 190	13½	13½	„ 31	32,769	7,933,572	915,481	—	8·93	—	6·48
Rochdale Corporation	Dec. 26	1,240	1,126	+ 114	+ 746	20·9	20·93	„ 31	56,558	10,196,148	1,252,926	1·32	10·83	2,693	6·47
Rotherham Corporation	Feb. 4	565	587	— 32	—	—	—	—	—	—	—	—	—	—	—
Salford Corporation	Sept. 27	4,096	4,662	— 66	— 3,326	78	74½	Mar. 31	244,065	45,771,611	5,486,150	1·25	10·67	3,185	—
Scarborough Tramways Co.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Sheffield Corporation	May 1	5,911	5,615	+ 295	+ 954	39½	37	Mar. 25	289,745	17,568,686	7,065,380	·896	9·842	4,225	5·99
Southampton Corporation	April 27	981	1,007	— 25	— 186	18	18	„ 25	52,647	10,121,887	1,157,451	1·25	11·33	—	7·30
Southend-on-Sea Corporation	Aug 21	995	557	+ 438	+ 1,483	—	—	—	—	—	—	—	—	—	—
Stockport Corporation	—	—	—	—	—	25	25	Mar. 31	52,004	9,155,172	1,335,911	1·34	9·342	1,930	6·73
Sunderland Corporation	Jan. 27	1,310	1,336	— 26	— 7,984	—	—	—	—	—	—	—	—	—	—
Swindon Corporation	April 27	129	121	+ 8	—	—	—	—	—	—	—	—	—	—	—
Torquay Tramways	Aug 26	630	647	— 30	—	8·41	—	Dec. 31	15,065	2,880,420	353,297	1·40	1·023	—	—
Wallasey U.D.C.	April 30	840	855	— 15	— 569	12·68	12·45	Mar. 31	43,823	8,331,038	891,540	1·2	11·79	3,453	7·72
Warrington Corporation	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
West Ham Corporation	April 28	2,322	2,294	+ 28	— 519	27	14·7	Mar. 31	122,881	35,502,836	2,556,854	·789	10·95	4,417	6·79
Wolverhampton Corporation	Nov. 3	841	823	+ 18	— 206	21½	—	„ 31	44,432	9,440,369	975,714	—	10·929	2,190	6·80

a Train Miles. h Half-year's figures.

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NOTES.

Is Water an Electrolyte?

In his discussion on Professor James Walker's paper on "The Constitution of Water," read before the Faraday Society, Professor P. Walden, of Riga, propounded the question, "Is Water an Electrolyte?" He described a number of observations that had been made in order to determine whether water when dissolved in a medium possessing powerful ionising properties might not itself become an electrolyte. To secure an adequate answer to this question, it was considered necessary to make use of media of which the specific inductive capacity was greater than that of water. The liquids selected were hydrogen cyanide (HCN), formamide ($H{\cdot}CO{\cdot}NH_2$), nitrosodimethylamine ($(CH_3)_2N{\cdot}NO$), formic acid ($H{\cdot}CO{\cdot}OH$), and sulphuric acid, the first two solvents being characterised by a specific inductive capacity greater than 84, the value for water. In passing, it may be noted that Professor Walden's discovery of the use of formamide as a solvent represents a "find" of extraordinary importance, which even if it stood alone would form an adequate recompense for the labour involved in his masterly survey of the wide field of organic liquids; this solvent appears to reproduce nearly all the valuable qualities of water, including its convenient freezing-point and boiling-point and its powerful ionising properties, but will mix freely with important groups of compounds which do not dissolve to any marked extent in water.

Hydrogen Cyanide and Electrolysis.

Hydrogen cyanide, he pointed out, with its high sp. ind. cap. and great fluidity, provides ideal conditions for electrolysis, was found when used as a solvent for water to give molecular conductivities of the order of 0·009 as contrasted with 300 for a salt such as potassium iodide; the low molecular conductivity of the water dissolved in hydrogen cyanide finds a parallel, however, in the low conductivity of hydrogen cyanide dissolved in water. Formamide, with a similar sp. ind. cap. but much smaller fluidity, gave for the molecular conductivity of water values (about 0·016) only slightly higher than in the case of hydrogen cyanide. In the case of formic and sulphuric acids the sp. ind. cap. is lower than that of water, sulphuric acid being further handicapped by its extraordinary viscosity, but both solvents gave increased values for the molecular conductivity of water, namely, about 0·17 in formic acid, but rising in the case of sulphuric acid as high as 74. From these observations it is clear that the conductivity attributed to the water does not depend on the *physical* qualities of the solvent, but on some *chemical* relationship between solvent and solute. It was suggested by the author that water, acting as an amphoteric electrolyte, could form a salt when mixed either with a strong acid or with a strong base, and that the high conductivity of mixtures of sulphuric acid and water, and the slight conductivity of mixtures of formic acid and water, were due neither to free acid nor to free water, but to the presence of an oxonium sulphate or formate in the liquid. The absence of conducting power in mixtures of water with hydrogen cyanide or formamide was attributed to the weakness of their acidic and basic qualities and the impossibility of combining them with water to form a salt-like electrolyte.

Waste Energy.

At the Conference of the Iron and Steel Institute, the discussion on Mr. Selby Bigge's paper, referred to in our last week's leading article, produced a valuable discussion in which a certain conflict of opinion was evident. Mr. T. Westgarth was chiefly concerned with what had been done in Great Britain to utilise waste energy. At Barrow alone the installation of gas plant for utilising waste heat had, he estimated, resulted in an annual saving of £50,000 in coal. Messrs. Bolckon, Vaughan & Co. used the waste energy at their works in low pressure turbines generating electricity; at Messrs. Hickman's the waste energy operated gas engines; while Messrs. Samuelson sold their exhaust steam to an electric power company. Referring to new iron and steel works, Mr. Westgarth said that at Skinningrove the whole of the plant was to be driven electrically, and at Frodingham the waste energy from the large steam engines laid down was to be taken to accumulators.

Economical Considerations.

Mr. A. Lamberton said the real difficulty lay in providing condensing plant of high class; with a vacuum of 28½ in. it was quite possible to recover a large quantity of heat units. In this Mr. Illtyd Williams agreed. He said that at Eston Works they used exhaust steam to generate electricity, and had no difficulty in maintaining the necessary high vacuum, satisfactory results being achieved. Mr. C. H. Merz was inclined to criticise the figures given by the reader of the paper. He maintained that it was the desire to retain old steam plant in service that was responsible for devices to utilise exhaust steam and mixed pressure turbines. As regards costs, he thought Mr. Bigge's 12% for depreciation was too low, and he thought the cost of production per unit would work out at 0·5d. instead of 0·2019d. On the other hand. Mr. W. C. Mountain gave actual figures from collieries with waste installations which provided power respectively at 0·146d. and 0·329d. per unit.

Rolling Mills.

Mr. E. G. Schmer and Dr. R. Drawe, of Saarbrucken, had read a paper on "Economy and Design of Modern Reversing Rolling-mill Steam Engines," in which they criticised the use of turbines and advocated modern reversing engines. To this Mr. C. A. Ablett replied that while the most favourable figures quoted for steam driving were 4·379d. per ton rolled, in an electric mill, where the prime movers were gas engines running on blast furnace gas, the cost was about 2d. per ton, which more than counterbalanced the higher capital outlay on electrical plant.

Industrial Reform.

At the annual meeting of the Association of Trade Protection Societies of the United Kingdom, Mr. G. M. Chamberlin, D.L., J.P., presided, and many reforms were discussed. One of the weak spots in our commercial equipment dwelt upon by the President was our consular service. There were far too many aliens in the service, and far too few trained business men. This is a matter upon which

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we can all agree, but it is absurd to appoint so many military men, or travel-exhausted King's Messengers to important posts; or, on the other hand, as is largely the case in Germany and Switzerland, appoint natives of those countries, men, too, in business, to represent us. Another subject broached by the President was the necessity for a Minister of Commerce, and many speakers advocated more business men and business methods in our Government Departments. One phase of this latter problem, by the way, is dealt with in our leader page this week.

Tyndall Mining Bequest.

At a Council meeting of the Royal Society, it has been decided to offer the income from the Tyndall Fund, amounting yearly to £35, as a studentship endowment, such studentship to encourage scientific research or work tending to benefit miners. The studentship is open to all British subjects living in the United Kingdom, but they will be able to continue their avocations and may study abroad. The studentship is to be for one year, renewable at the pleasure of the Royal Society. It will, of course, be open to electrical mining students.

German Enterprise.

Reports of two of the leading firms of German electrical manufacturing engineers recently issued give some idea of the conditions prevailing on the Continental markets. The burden of the Berlin General Electric Co.'s complaint is that while business was fairly abundant, prices ruled low owing to keen competition from outside. As against this drawback, there has been a reduction of the cost of production, partly as the result of lower prices for raw materials, but more particularly as the reward of more perfect organisation. The company are now building electric locomotives up to 1,800 h.p., and a new factory is going up for the construction of high voltage transmission machinery. It appears that orders on the books exceed 18 million marks above the level of this time last year. The Bergmann Electrical Works, of Berlin, having paid 9% on one-third of their capital of 21 million marks, and 18% on the balance, have found it necessary to make a fresh issue of 8 million marks capital to meet extension expenditure. They are chiefly busy in constructing turbines and in electrifying tram lines and light railways, their new single-phase alternating current, with a periodicity of 50, having proved successful.

Cable Work.

Although the British cable companies complain of a lack of big orders, and generally an average increase in price of raw materials (the slight ease in copper being counterbalanced by the higher price for rubber), the German firms have been fairly successful in rather more than maintaining their output. The Berlin General Electricity Co., indeed, have done well in this way, and now high voltage cables are the rule, 30,000 volts being the normal, with a marked tendency upwards. This is no doubt due to the Rand orders and also the electrification of coal and iron districts at home. As regards our own enterprises, it is satisfactory to find that one company, the Telegraph Corporation and Maintenance, has increased its remuneration to capital from 15 to 17½%, and at the same time increased its carry over by more than £7,000; two maintain their dividends at 15%—Callender's and W. T. Henley, the former with an increase of £7,000 in its carry over, and the latter with a reduction of £3,700; two are paying 10%—the India Rubber and Gutta Percha and Telegraph, with an increase of £3,000 in the carry over, and the British Insulated and Helsby Cable, of a little over £8,000; the Craigpark Electric Cable maintains its 6% distribution with a slight fall in cash in hand; while W. J. Glover & Co. pay the usual 5% and have £500 more in hand. With industrial revival and increased electrification, and renewed activity in the telephone world, the cable companies may look forward to a profitable time.

TESTING BY MAGNETIC BALANCE.

By A. C. Jolley.

A paper on "The Magnetic Balance of MM. Curie and C. Cheneveau, by C. Cheneveau, with an Appendix by A. C. Jolley," was read by Mr. A. C. Jolley before the Physical Society of London. He pointed out that this balance is intended for the determination of the co-efficient of specific magnetisation, susceptibility, and permeability of feebly paramagnetic and diamagnetic bodies. The body under investigation is suspended from one arm of a torsion balance, which measures the force exerted on the body when it is placed in the non-uniform field of a permanent magnet. The torsion balance is formed by a horizontal rod suspended by a long fine platinum wire and carrying at one end a hook from which the substance under investigation can be suspended in a small enclosing glass tube. On the other end of the torsion arm a copper sector is fixed which moves between the poles of an auxiliary magnet, and thus provides efficient damping. A second branch arm is also provided upon which may be placed suitable counterweights to balance the specimen. The suspension carries a mirror, and the movements are read on a translucent scale in the ordinary way. The magnetic field is that of a large circular permanent magnet mounted in such a way that the vertical gap may be made to describe a semi-circle of radius equal to the length of the torsion arm, and the movements of this magnet are controlled by the observer at the screen by means of cords. An empty containing tube is first mounted on the balance, and the maximum deviation of both sides of the zero is obtained by bringing up the magnet towards each side of the specimen. The tube is now filled to a given mark with a known mass of pure distilled water, and the variations observed as before. The water is now replaced by a known mass of the substance to be examined occupying the same volume or the same vertical height, and again the deviations are observed. The author went on to indicate how the value of K may be calculated from these observations, and he gave tabulated results of experiments performed with various metals and alloys.

Discussion.

Mr. A. Campbell said that for certain experiments and in the construction of certain instruments it was essential to know that the materials used were non-magnetic; and he thought the author's instrument would be useful. It was very difficult to obtain non-magnetic brass.

Mr. W. Duddell asked if the specimens used were specially cleaned, as the oxides and sulphides of many metals were magnetic. It would also be necessary to keep them clean to get trustworthy results.

Mr. D. Owen expressed a doubt as to the accuracy of the results attainable by this apparatus used as described by the authors in the paper. Theory requires that the specimens of the standard substance and that under test should be exactly equal in size and shape, and similarly situated in the variable magnetic field when the observation of maximum force is taken. In many ways this condition may be departed from in the experiments described. The size of the test-tube used to hold the specimen is a considerable fraction of the interpolar space, and, excepting in the case of liquids, it would be difficult to ensure identity of form of the samples in the correlated pair of experiments. Absence of coincidence between the axis of rotation of the magnet and the axis of the torsion wire would cause an error of position varying with the deflection of the balance-arm. Again, the magnetic pull parallel to the balance-arm will cause movement of the specimen to an extent depending on its susceptibility and its density, though the effect is likely to be very small. These causes may account for the authors' observations of apparent dependence of K on the mass and length of specimen.

The authors were also asked whether they had any experimental data as to the independence of K with respect to temperature.

Dr. Russell regretted that the author had not explained more fully how the magnetisation of the specimen under test was maintained uniform. Any lack of uniformity would seriously affect the accuracy of the results. He thought that the great discrepancies found by Mr. Jolley

in the apparent value of the co-efficient of the specific magnetisation of copper for specimens of different lengths must be due to an uneven distribution of the magnetic field. When the specimens were very feebly magnetic, he considered that it was legitimate to make the assumption that the intensity of the magnetisation was proportional to the field. He did not see, however, how the balance could be employed to test strongly magnetic substances. He suggested that the specific magnetisation of water might vary largely with temperature. It was interesting to find that the discrepancies between the calculated and the observed values of the inductance of a certain brass conductor had been traced to the magnetic qualities of the brass. In his opinion, errors in the computed values of inductance standards, due to the permeability of the conducting material differing from unity by a very small fraction, would in general be negligible.

The Secretary read a letter from *Dr. C. V. Drysdale*, in which he stated that Mr. Jolley's experiments with the magnetic balance proved its value, both scientifically and commercially, as a means of rapidly estimating the composition and purity of alloys and other materials. The instrument enabled the magnetic qualities of materials to be obtained as easily as the specific gravity measurements which are usually employed as an aid to practical analysis, and it formed a kind of magnetic hydrometer which gave the specific magnetisation instead of the density of the substance as compared with water. The displacement principle of Poisson and the derivation of the force as the slope of potential were both of great importance, and an apparatus such as the authors', which showed the practical application of these principles, was welcome.

Mr. C. W. S. Crawley drew attention to the fact that if the brass rods were cut with steel shears they would be rendered magnetic. Brass tubes prepared by drawing through steel dies were generally magnetic. He asked if the variation of the value of K for copper was due to impurities.

Mr. R. S. Whipple asked if the author had performed any experiments on wood or ebonite, and, if so, with what results.

Mr. Jolley, in reply, said he could fully endorse Mr. Campbell's remarks concerning the difficulty of obtaining non-magnetic brass which seemed to be quite rare. In reply to Mr. Duddell's point concerning the cleaning of the specimens, a fair amount of care was taken to keep the specimens clean; they were handled with ivory forceps, and in most cases they were bright new samples of rod and wire, which to the eye certainly did not seem in any way oxidised; and if any such oxide or other salt were present, unless it were very highly magnetic it would not be sufficient in quantity to account for the high values of K generally obtained.

Mr. Owen raised a point in connection with the theory, which would be of importance if the maximum deflection were obtained with the specimen in the interpolar gap, but, as a matter of fact, the maximum deflection as indicated in the paper is always obtained when the specimen is considerably out of the gap of the magnet, and, consequently, the position of the specimen does not become so important. An excellent datum is, however, provided by the damping sector, which has to be accurately between the poles of its magnet for perfectly free rotation, and when this is so the tube is rightly centred relatively to the gap of the deflecting magnet. No experiments have been made either as to side pull, which, however, in feebly magnetic bodies must be very slight indeed, or as to temperature.

With regard to the uniformity of magnetisation of the specimen raised by Dr. Russell, he believed that some experiments on this had been made by MM. Curie and Cheneveau, but the point would have to be referred to M. Cheneveau before anything definite could be said. With regard to Mr. Crawley's point as to the cutting of the specimens and the presence of iron from the tools employed in manufacture, they had no special method of cutting the lengths, and had to resort to the usual workshop processes. The experiments with acid treatment show that although in some part the magnetic quality is a surface effect, this is by no means accountable for all, and the amount of magnetic material left on the surface from tooling was far too small to account for the values of K found. With regard to copper, the value of K certainly was due to impurity, but it is considered that the magnetic balance gives indications of the presence of such impurity with far greater reliability than any chemical test for such minute quantities.

In reply to Mr. Whipple, both wood and ebonite had been tested but not tabulated. In both these cases the results were variable, and it was practically impossible to free the material from the effects of tooling; in any case, the results always showed the specimens to be very magnetic.

TELEPHONE PRACTICE IN MINES AND ON RAILWAYS.

In mines it is an enormous advantage if the electric signalling system is supplemented by a special telephone service. This is made compulsory in some of the States of America, and Mr. E. O. Munson describes an excellent system, which is made use of not only in case of disaster, but for transmitting ordinary instructions from the ground level underground, and to chief points along the underground works. As he points out, the cost of constructing lines underground is less than on the surface, because is not necessary to erect poles. The wires are usually run through the rifts and down the shafts on standard wood brackets, equipped with regular glass insulators. In a large number of mines, rope haulage is used to convey ore to the surface. Where such is the case, a metallic signal-line is usually run along the side of the entry to transmit signals to the engineer, usually located at the surface entrance. If such a condition exists it is only neces-

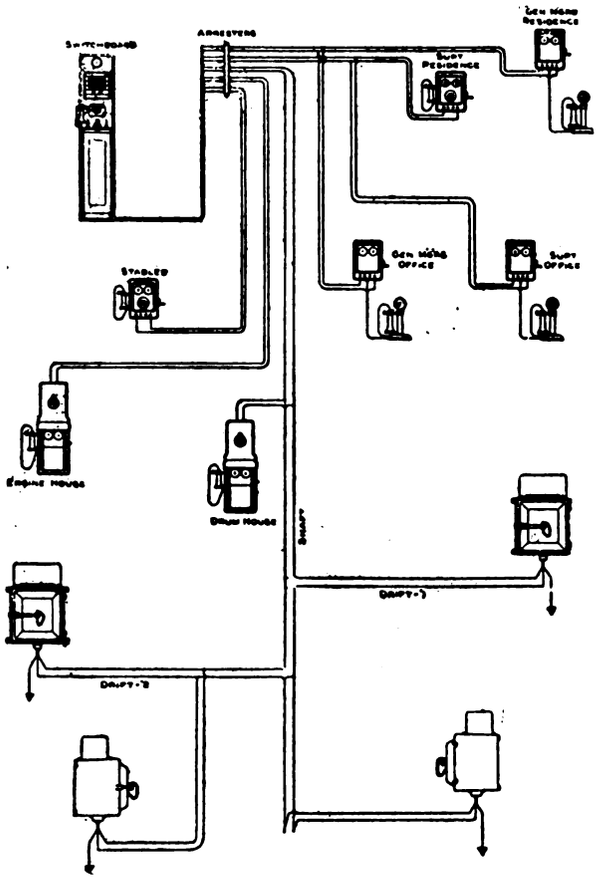

FIG. 1.—CIRCUITS OF A MINE TELEPHONE INSTALLATION.

sary to connect any required number of bridging telephones to the circuit, the haulage strand and the signal wire. In this case no expense is incurred beyond the first cost of the telephone and the cost of connecting them to each station. The expense of maintenance is usually very light because the lines, being underground, are not subject to atmospheric conditions that are present outside, and trouble from lightning is, of course, unknown.

Although ordinary iron line wire has been used with success in some mines, the safest construction can be furnished at little additional cost by supplementing rubber-covered wire for all underground circuits which are in any way subject to moisture or dampness from contact with

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fresh earth and timbers used as supporting members in rifts. In some mines conditions are so uncertain that it is considered good practice to use lead-covered cable, providing the installation warrants the expense. In any event, this part of the equipment should not be slighted, and the best is always the cheapest. By installing a cable an increased degree of certainty is assured.

Herewith is shown a wiring diagram of a complete mine telephone system. The telephone used in the mine is of far different construction from the instrument used in ordinary telephone work. The mine telephone made by the Stromberg-Carlson Co., for example, consists of a complete magneto equipment, compactly assembled in a comparatively small, strong, cast-iron box, coated with a special enamel finish, which acid fumes and moisture cannot penetrate. All of the talking and signalling apparatus is accessibly arranged inside of an inner compartment, temporarily sealed tight by a door having a wide overlap covered with felt cloth gasket, as shown in the illustrations. The inner compartment is made sufficiently roomy to allow any part to be removed without interfering with the general assembly.

All openings through the inner case for the ringer cores and the generator crank must be sealed by gaskets and felt washers. The terminal box mounted on the bottom side of the telephone shown here conceals three terminal posts for the incoming line-wires, and is threaded to receive an iron pipe for bringing the line-wires from the ground to the telephone. The ringer armature and gongs are under

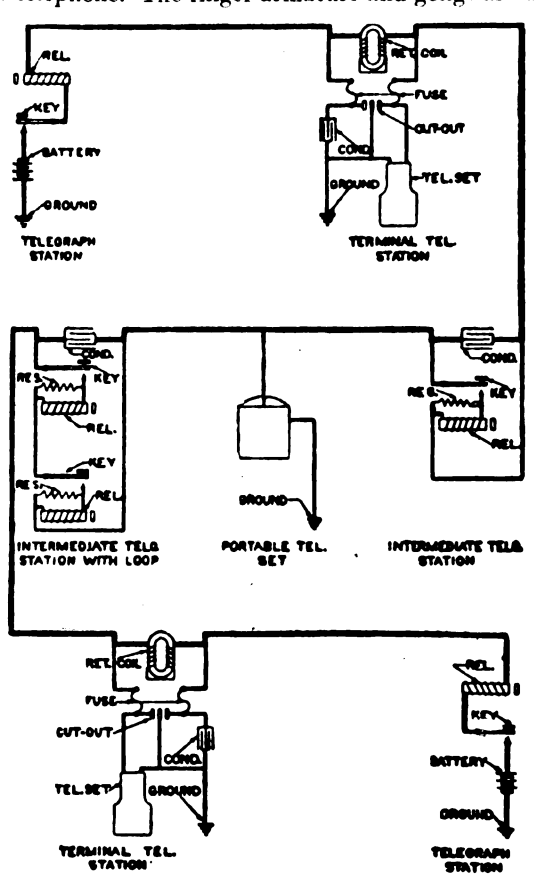

FIG. 2.

the hood on top of the telephone, and are accessible for adjustment from the outside of the inner compartment, causing no reason for this compartment to be opened at any time except when replacing batteries, which is very seldom. Opening the outer door exposes the receiver and weather-proof cord, transmitter mouthpiece and generator crank, which are the only parts of the telephone necessarily required to be instantly accessible.

As an additional protection from atmospheric conditions, all insulated wire windings should be specially insulated and boiled in oil. The metal parts, necessarily of steel or iron, are zinc or copper-plated, while other parts, such as screws, are made of brass to prevent corrosion and rust.

The telephone is also being largely used for working American railways. In some instances a composite telegraph and telephone is used. Mr. Martin J. Ryan explains in the *Telephone Engineer* that this method was specially devised for the purpose of enabling telephone and telegraph messages to be transmitted simultaneously over grounded telegraph lines. It is adapted to simple Morse circuits where interruptions in the telegraphic current are of comparatively low frequency and where the change in potential of the current due to the operation of the telegraphic apparatus is not excessive. Except under favourable conditions, it is not suitable for use on duplex or quadruplex lines, or where machine sending is employed.

The arrangement of a grounded line telegraph system equipped with telephonic apparatus is shown in Fig. 2, which represents the general plan of a whole or part of a telegraph system thus equipped.

It will be noted that on the composited portion of a line there may be three kinds of telephone stations: terminal stations, located at each end of that part of the telegraph line used for telephonic purposes; intermediate stations, located between the terminal stations; and portable stations, intended to be carried on a train for emergency use between the terminal stations while the train is at a standstill.

To adapt a telegraph system to telephone operation requires no change in the telegraphic apparatus or in its operation. All that is necessary is to bridge the apparatus at each telegraph station with a condenser and a resistance, and at the telephone stations to connect the telephonic apparatus between the line and ground. A condenser in each telephone set prevents the telegraphic current from passing through the apparatus to ground.

Telephone signalling is accomplished by pressing a button which places high frequency current on the line by means of an interrupter and induction coil, as shown at

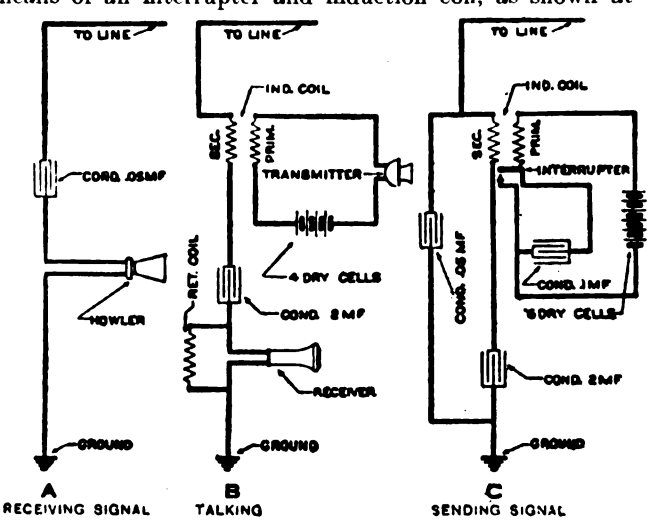

FIG. 3.

C, Fig. 3. This current at the signalled station passes through a condenser and howler to ground as at *A*, Fig. 3, causing the howler to produce a sufficiently loud sound to be readily heard in the station. The talking circuits are shown at *B*, Fig. 3. Regular local battery talking is used, and a condenser is joined in series with the receiver, which itself is shunted by a retardation coil.

Each telegraph station on the composited portion of the line is, as already stated, provided with a condenser and a resistance coil. The former is bridged across the telegraph station apparatus outside of the peg switch, thus providing a by-path for the telephonic talking and signalling currents, which otherwise would be seriously reduced by the impedance of the relays and interrupted by the operation of the keys. The latter, a coil of high non-inductive resistance, is bridged across the telegraph relay so that when telephonic signalling current is applied to the line, any of this current flowing around the condenser will pass through the resistance and so prevent a chattering of the relay.

At each terminal telephone station is located a telephone set, a protector, a condenser, a retardation coil and a one-microfarad condenser. The retardation coil is joined in series with the line, and the condenser is bridged to ground from that portion of the telegraph line which is not composited. The retardation coil prevents the telephonic currents from passing to ground over the telegraph line beyond the telephone station, but does not impede the telegraphic currents, because these are of much lower

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frequency than those generated by the telephones. This coil and condenser combined prevent the impulses of the telegraphic current from producing annoying disturbances in the telephonic instruments. The condenser also aids in the dissipation of any disturbing currents that may reach the telegraph lines from inductive or other causes. Batteries are installed in all the telephone stations for providing signalling and talking current.

The protective devices installed at each telephone station not only protect the telephonic apparatus from

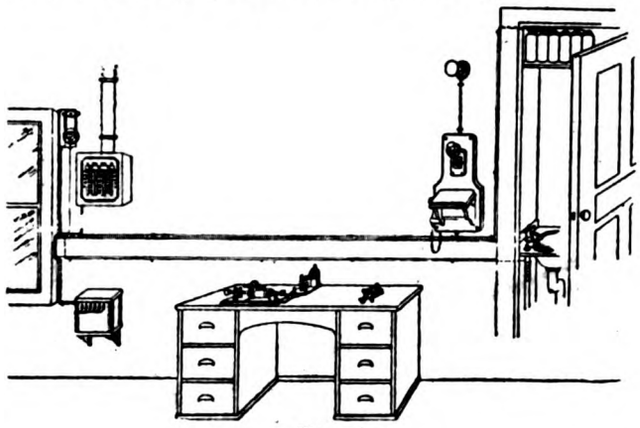

FIG. 4.

lightning and abnormal currents, but, owing to the fuses, prevent a permanent ground at the cut-outs from interfering with the telegraph service. The protector should be connected in circuit with the fuses next to the line. At intermediate telephone stations only one side of the protector is used, as there is only one wire connecting the telephone to the line.

The length of telegraph line and the number of stations with which this composite system can be successfully employed depend largely upon the character of the telegraph line. On a short line, service will be better and more stations can be operated than on a long line; the length, gauge, material of the line wire, and the amount of wire in cable are the more important features which govern the perfect operation of the system.

In arranging a line for composite service, it must be remembered that iron wire is much inferior to copper wire of the same size when used for telephonic transmission, and also that conductors in cable are much less efficient than open wires. Furthermore, paper insulated wires in cables are more efficient than wires of the same size in rubber insulated cables, on account of the high electrostatic capacity of the latter.

Owing to the many different conditions governing the use of railway composite apparatus, and the variation in these conditions for each particular line, it is impossible to give inflexible rules applicable to every case regarding the length of line over which service can be successfully obtained, or regarding the number of stations which can be successfully operated on a single line. Each particular telegraph line must be considered separately before a definite statement can be made regarding its adaptability for telephone service.

As a general indication of the possibilities of the system, however, it may be stated that successful operation should be practicable over ordinary telegraph lines up to 100 miles in length, and with as many as five intermediate telegraph stations.

The apparatus must be properly installed, or trouble will be experienced in the operation of the system. The small additional cost of properly installed apparatus over poorly installed apparatus is soon counterbalanced by the lower cost of maintenance.

A terminal telephone station and an intermediate telephone station, properly equipped with apparatus and wired for railway composite work, are shown respectively in Figs. 4 and 5.

The telephone set should be mounted so that the mouthpiece of the transmitter will be adapted to the height of the users. It should be placed where doors or movable furniture will not come in contact with it, and where it will not interfere with persons passing through the room. Damp walls and vibrating partitions should be avoided as a support for the set, and any location within 2 ft. of a window that is liable to be opened is undesirable. For unavoidably noisy locations, telephone booths are advantageous.

The telephone set must be securely fastened to the wall. If it cannot be placed flush with the surface on account of projections, it should be blocked out from the wall with wooden strips, the strips being fastened to the wall with screws, toggle or expansion bolts, and the set afterwards screwed to the strips.

In fastening the telephone set to a brick, cement or stone wall, holes are first drilled in the wall at the proper position for the screws. Wooden plugs are then driven securely into the holes, and the telephone set screwed to these plugs. Care must be taken in plugging the holes in the wall to see that thoroughly dry wood is used, and that the plugs are large enough to hold securely. Another method consists in first fastening a board or two wooden strips to the wall, as just explained, and then screwing the telephone set to this support. As an alternative to these methods, expansion bolts may be used. To mount the telephone set on a hollow tile wall, holes should be drilled through the tiles and toggle bolts used.

The howler used in connection with the wall telephone set may be located in any convenient place where its operation will attract attention. It is advisable, however, to mount it at a sufficient distance from the set so that it will not be handled by persons telephoning, and its adjustment thereby altered. The condensers should be located as near to the telegraph line or the peg switch as possible, care being taken to avoid damp locations and places where they would be exposed to mechanical injury. The resistance should be mounted at some convenient point near the telegraphic apparatus, such as beside the telegraph relay on the table, under the table, or on the wall. The protector should be mounted upon the inner wall of the building as near as possible to the point where connection is made with the telegraph line. An asbestos mat should be placed beneath it. The battery should be placed near the set in some out-of-the-way place, unexposed to mechanical injury and dampness, but accessible for inspection and renewals. The cells should be connected in series, that is, the carbon of one cell should be connected to the zinc of the next throughout the battery.

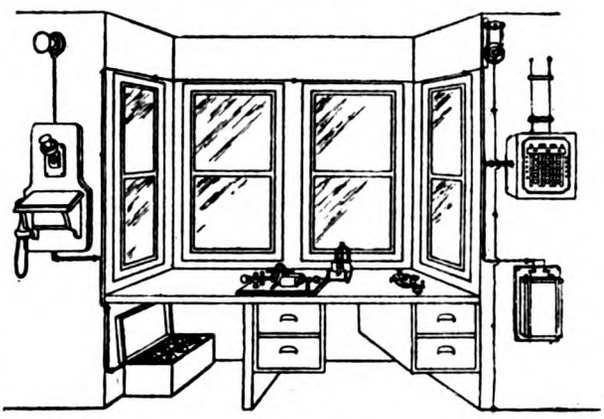

FIG. 5.

With the exception of the ground wire from the protector, all interior wires from the telegraph line or the peg switch to the telephonic apparatus should be of rubber covered and braided copper, not smaller than No. 19 B. & S. gauge. The ground wire from the protector should be of copper, not smaller than No. 18 B. & S. gauge, and should be rubber covered and braided; if exposed to mechanical injury, it should be of No. 14 B. & S. gauge, rubber covered and braided.

All inside wires should be installed in a neat, safe and workmanlike manner. Where it is impossible to conceal the wires, they should be run along the door or window casings against the plaster in the moulding, or in the groove at the top of the baseboard. The wires should not be run across the ceiling unless absolutely necessary, and when placed on the wall they should run either vertically or horizontally, for the sake of appearances. If it be necessary to instal wires in the basement or where they are

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exposed to mechanical injury, care must be taken to protect them by some suitable means, such as moulding or conduit. Damp localities should be avoided for all inside wires.

Where necessary to run the wires across pipes or other conducting materials, they should be protected by tubing, or by two wrappings of insulating tape for a distance of at least 1 in. beyond each side of the pipe or conducting material. Whenever practicable, the wires should be run above pipes rather than under them.

Where it is necessary for the telegraph or telephone wires to cross any exposed electric light or power circuits, they should at least be 6 in. distant from them, unless encased in porcelain tubes, circular loom, or similar conduit. If the telephone or telegraph wires be thus encased the conduit should project at least 6 in. on either side of the electric light or power wires, and should be firmly secured with tape to prevent it from slipping out of place.

The wires should be fastened so as not to injure their insulation. Fibre cleats, insulated staples, or "Milonite" nails driven between the insulated wires may be used. Each insulated staple should enclose but one wire, and care must be taken not to drive the fastener through the insulation. Uninsulated staples should not be used. Under no circumstances should coils or knots be made in any of the wires.

Splices in interior wires should always be soldered. A resin flux should be used in place of acids or paste, because of the injurious effect of the acid or paste upon the wires. After the joint is made, it should be carefully wrapped with rubber tape, the thickness of the wrapping to be at least as great as the regular insulation on the wire. When joints are made in twisted pair wire, there should be at least 4 in. lengthwise along the pair between the joints in the two wires.

Where a telegraph equipment is already installed in an office, the ground wire of that equipment may be used for the telephone set and protector, connection with it being usually made at the peg switch. Where no telegraph equipment is installed, it will be necessary to run a ground wire. This wire, as previously stated, should be either No. 14 or No. 18 B. & S. gauge copper wire; it should be free from spirals, coils, knots, or sharp bends, and should be run as directly as possible to the ground connection, which may be either a metal rod driven into permanently damp earth, or a water or gas pipe connected to the street mains which are in service.

When a ground rod is used, it must be sufficiently long to extend above the earth level, so that the ground wire can be soldered to it. When ground connections are made to pipes, the point of contact should be made as near the mains as possible, and water pipes should be chosen in preference to gas pipes. In case it is necessary to use gas pipes, the connections should be made between the meter and the street mains.

Water or gas pipes which are to serve as ground rods should be thoroughly cleaned and tinned at the part where the ground wire is to be attached, after which the wire should be wrapped tightly around the pipe and soldered to it.

If it be difficult to secure a good soldered connection, the pipe should be thoroughly cleaned and a ground clamp used; this must be securely fastened to the pipe at the cleaned portion and the ground wire attached to it.

Careful maintenance of the apparatus used for railway composite service is as important as proper installation, if good service is to be rendered. When repairs are needed, either in the apparatus or in the wiring, it is important that they be made promptly and permanently. Rush work, short cuts, skimped material, and other attempts to hasten the completion of repair work at the expense of thoroughness should be avoided. Temporary makeshifts necessitate frequent additional repairs and changes; they are a source of continual trouble, interrupted service, and in the end prove very expensive.

ERECTION AND MAINTENANCE OF ELECTRICAL PLANT ON A GOLD MINE.

By W. Elsdon Dew, M.I.E.E., Vice-President S.A.I.E.E.

[In the following brief paper Mr. W. Elsdon Dew, vice-president of the South African Institute of Electrical Engineers, deals with various phases of practical work on a gold mine. Although intended for local guidance on the Rand, the hints are largely of general application, and coming from an electrical engineer of such experience, cannot fail to be of value.]

The generating plant on a mine, up to within the last few years, has not been of such large dimensions as it might have been, and now owing to the electric current supply being about to be taken from the large power company, many generating plants are being scrapped. Many a lesson can be learnt from the old plants, however, and I will call attention to points on which experiences would be interesting.

The continuous current generator of past years (say 10 years ago) no doubt calls to your mind nightmares which you hope never to see again, yet it has been only in the details of design and the consideration of finding the position of sparkless commutation, that now finds this machine as reliable as any. One can still look around and see generators of the old types in operation, that have brush gear requiring most careful and regular adjustment to secure reliable service. Peculiar contrivances that have been adopted can also be seen which, though not universally known, have given better service than before their adoption. The development of the carbon brush and brush-holder has brought forth a reliable means of collecting the current that was a source of trouble formerly. I can call to mind an instance where, though it was possible to get sparkless operation with wire gauze brushes, yet the cost of the constant and skilled attention necessary was prohibitive, and I have found also that with carbon brushes there would have been trouble on account of there not being enough rubbing contact to allow of carbon being used. This is an instance where special carbons might have succeeded.

It has come to your notice no doubt, that the greater resistance in carbon brushes causes a slight voltage reduction, and this resistance is taken advantage of in the development of the graded carbon. In this way certain manufacturers of carbon brushes now profess to be able to make carbon brushes which will overcome all sparking in the worst of machines, if the commutator is suitably built for carbon brushes, that is, the insulation between segments must be suitable.

There are causes of sparking, and development of sparking, which must not be overlooked, one of which is vibration, for even the joint in a belt has been the cause of a developed sparking. Vibration also has most detrimental effects in the jointing up of the windings to segments. Slack connections and irregular collection of brushes on multipolar machines are not to be overlooked as a cause of sparking. Continuous current armatures subject to momentary overloads may develop faults due to the shifting of coils and binders. Instances where damaged armatures have been repaired and coils cut out and kept in use may be forthcoming. The successful operation of shunt wound generators working on parallel is perhaps an old subject, but it has happened that some trouble has not been traced, and a fault has developed through a faulty switch gear and the arrangement of the same, that allow of an irregular sequence in operation. Some of the young members will, I am sure, like to hear experiences of such things.

The alternator as a single unit will give but little trouble in itself, if the exciting current is reliable and under control, but when worked in parallel there are points that are not quite apparent to most. It has no doubt been the cause of trouble to some to find that the alternator was not doing any more work although the exciting current was increased, and incidentally, the apparent load as indicated by the ampere meter. Such a condition would cause trouble if the operator did not realise that the alternator is quite different to the continuous current generators, and that voltage regulation was not all that was necessary for taking up or putting off load. It has, no doubt, been brought to your

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notice that though a number of continuous current generators can be successfully operated in parallel when driven off of one line shaft, in the case of alternators, operation of these in similar manner is anything but successful, if the loads on the machines are to be varied, and if machines are to be taken out or put into service as the whole load varies. This point I would like fully discussed, as the reasons touch an important factor in alternating current work.

The prime mover in the case of the generating plant is, perhaps, the cause of more trouble than is at first apparent, and also in having governors that do not respond to sudden changes. Further, if the prime movers are not working in unison or sympathy with one another, the irregularity of service may be so bad as to cause interruptions. When the governors of the prime mover are not responsive to sudden changes, it may even be necessary to resort to the artificial loads which are cut out of use when the motor comes into work, so that the whole plant is not disturbed. This is not an expensive way of overcoming such difficulties when the prime mover is driven by natural sources of water power, but in the case of steam or other sources of power, it may be considered out of the question, and an equaliser, either in the shape of a heavy fly wheel or storage battery, may be necessary, if the governor trouble is insurmountable, a point which I do not confess to be at all possible.

It is no doubt quite apparent that it is advisable to have the prime mover of the generating plant independent of other machinery, for a hanging up of the electric supply through causes that may be quite out of the control of the attendant is likely to cause serious trouble to the other plant, and more especially if the underground pumping is dependent on it.

The advisability of recording instruments for the successful operation of the whole plant is a subject that is worthy of much thought, and if the plant is large enough, these instruments will soon pay for themselves. Successful operations under adverse conditions may result from the observation of records which would not otherwise be observed by the attendant. The Tyrrell regulator has done much for the successful regulation of plants, but as these regulators are expensive, their adoption is not always necessary if the supply does not necessitate very close regulation. I have found a kafir at 7s. 6d. a month not a bad regulator during times of intermittent loads. The use of earth detectors on the main switch board is not to be neglected, for besides indicating any changes, they can be used for tracing the fault in individual feeders. The power factor instrument also can be used to advantage, and should not be neglected. It is perhaps unnecessary to speak of the necessity of placing continuous current instruments out of the influence of stray magnetic fields, but these are matters which in the days when less was known of the subject that caused trouble. There are no doubt other instances of corresponding effects that some may be able to recount.

Through the use of current transformers, some of the troubles in switch-boards incidental to the use of alternating current, have been somewhat overcome, but the placing of wires without sharp bends, and also so fixed that there can be no drawing together through overloads, must not be overlooked. Such instances have been perhaps the cause of many troubles, and have not always been traced at once. The effects of surges, even in small plants, might also have been noticed, as this is a subject on which little has been written and there is still a great deal to learn. On the subject of lightning arresters and potential alleviators, information has still to be gained, and it is possible there may be someone amongst the members who could bring forward a paper on this most important subject.

The subject of motors and their application to work is one on which a variety of opinions may be obtained. Taking first the C.C. motor, we are confronted with the various types in use such as shunt wound, series wound, and compound wound. I had the pleasure of seeing through the workshops of the Natal Goverment Railways recently, and there the application of the C.C. motor is a lesson in itself. There are in those shops over 450 motors, and by having voltages of 50, 110, 220, 330 and 440, which are obtained by the use of balancers for the supply of different voltages, a variety of speeds for the tools that is at once most useful and economical is obtained, and they are an object lesson in simplicity of working. I made special enquiry as to the number of staff necessary for the upkeep of such a large number of motors, and was informed, that in addition to the native cleaners, there were but two electricians and two or three learners, who kept the whole plant and wiring in order, and did all armature winding.

The series motor has advantages peculiar to itself has placed it in the most successful operation of electric motive power, such as the propelling of tramcars, and for use in hoists, etc., where starting torque is of such great importance.

The successful operation of all continuous current motors necessitates careful attention to the field, for from the neglect of this may arise difficulties in the armatures which may ultimately result in failures. The devices in operation for the protection of the windings caused by the breaking of the current in a highly inductive circuit will be of interest, and are not always appreciated by the manufacturers.

The three-phase motor has forced itself to the front by its simplicity in construction, yet there are quite a variety of styles of winding with which one is meeting, that the opinion of those who have to work with them will be of value.

The squirrel cage motor, where it can be kept constantly moving, is hard to beat for simplicity and mechanical strength, but the objection to the starting current necessarily precludes it from certain work where stopping and starting is continually going on, and where the load is such that the current necessary to get the motor under way is excessive. The introduction of auto-starters at once reduces one of the chief advantages that is claimed for the squirrel cage motor, and any means of introducing resistance into the rotor circuit at once brings down the efficiency to such an extent that the wound rotor will easily show up to greater advantage in comparison. The jerk that accompanies the starting of squirrel cage motors is also an objection on a small plant, and is so detrimental to the driven machinery, that I do not doubt that the subject of maintenance generally will be seriously affected. In referring to the auto-starter, which is a means of distorting the phases for the sake of obtaining greater torque, the disturbance that this has caused to the power factor of the system has no doubt been brought to your notice. The induction motor with wound rotor is now extending its sphere of operations, so that the most difficult problems are being tackled, and yet it is still to be proved if due allowance has been made in the rotor windings for heating effect while starting is taking place. There are, no doubt, peculiar experiences in this direction which would appeal to us very forcibly, if they could be submitted to the Institute. The liquid starter has placed the induction motor with wound rotor in a position for competing with other motors which the advocate of three-phase work has long since recognised, and with special work by a combination of connections, one can obtain most excellent work from this type of motor. The system of many motors in cascade and multiple series for special work do not offer a difficult problem. We have, perhaps, but few slow-speed motors, which is to be regretted, for the successful operation of slow running machinery should not be handicapped with this extra loss through speed reduction by means of belts or gearing.

With reference to the upkeep of motors there is so much to be said that I will leave this point to be brought out in the discussion. I must call to your attention that the heating of motors is of such importance that the causes should be specially looked into, and the necessary precautions adopted. The motor panels, and the instruments with which they are equipped, deserve a little more consideration, and a three-phase motor having a trip coil on one phase only for overload is not having the protection it deserves. The question of vibration is one of the chronic diseases that a motor is subjected to by being erected on insecure foundations.

ELECTRICAL TERRITORIAL SPORTS.

The Electrical Engineers (London Division) will hold their Corps' Sports and Championships, at the London County Athletic Grounds, Herne-hill, on Wednesday, May 25, at 6.30 p.m. Events: 100 yards, 440 yards, 880 yards, and 1 mile running; ¼ mile, 1 mile, and 5 mile cycling; long jump; high jump; 120 yards hurdles; and inter-Company tug-of-war.

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ELECTRO-PLATING PLANT.

A Model Lay Out.

Of late we have heard so much about electro-plating that it is worth while considering the modern plant laid down by the National Cash Register Co. at Dayton, Ohio, U.S.A. Nearly all the metal work used in connection with cash registers is plated, the outisde of the cabinet for appearance's sake and the interior mechanism for protection against rust.

The Layout.—The plating department is on the fifth and top floor of one of the buildings, and occupies a floor space 540 by 60 ft. The sides of the building are composed mostly of windows 8 by 8 ft. each, and these, together with the elevation, give abundance of light and ventilation. The latter is further improved by 10 powerful exhaust fans in the side walls and four in the ceiling of the dip room.

In the main room are 105 plating tanks, each equipped with individual rheostat, voltmeter and ammeter, thus giving absolute control of the pressure and the current. Ninety-three tanks are devoted to " wire work "—that is, the plating of comparatively large pieces, rods, plates, etc., which are hung suspended by copper wires twisted around the cathode rod. The other 12 tanks are fitted with wicker-work baskets, which are slowly revolved in the electrolyte. Each basket has capacity for two or three pailfuls of small inside parts, bolts, nuts, etc.

In addition to the plating outfit, several cleaning tanks are provided. These are connected direct to the line, without meters or rheostat. The castings to be cleaned are cathodes, as in the plating process, and the violent bubbling of hydrogen speedily loosens up the oil, polishing powder, scale, and other discolourations. Iron and steel only are treated in this way, as an automatic method for satisfactorily cleaning bronze does not yet seem to have been discovered. Bronze castings are soaked in soapy water, scrubbed with a hand brush, and dipped in weak lye water.

The acid dipping room, 20 by 60 ft., contains one elliptical dipping tank, at which two gangs of men can work simultaneously, and one straight tank for one gang.

Pickling tanks for hydrofluoric, sulphuric and muriatic acid pickles are in a smaller room set apart from the other sections, and the fumes are carried off by fans.

The laquer room, 120 by 60 ft., is used in coating the register cabinets or outside casings. It contains 10 glass ovens 7 by 20 ft., steam heated, for baking the laquer.

A complete chemical laboratory in another building has rendered valuable service in the plating department, and has also effected a considerable economy in the operation of the entire works.

Solution for Various Finishes.—The following plating solutions are employed :

For nickel, the double sulphate of nickel and ammonia is used, 30,000 gallons being in use.

For copper, (a) copper cyanide and (b) copper sulphate are employed, the quantities being 2,600 and 6,000 gallons, respectively.

For silver, the cyanide of potassium and chloride of silver is used, 800 gallons being the amount of solution.

For zinc plating, 4,000 gallons of commercial sulphate of zinc acidulated with a little sulphuric acid are used.

For cleaning, crude potash and carbonate of potash and carbonate of soda are employed.

The total amount of standard solutions in use is 47,200 gallons, besides several hundred gallons of other solutions which are maintained for experimental purposes.

Notes on Methods.—The method of running through a piece is about as follows : The finished casting is received from the machines shop and dipped in a mixture of sulphuric and nitric acid to remove the scale and stains ; then, if a cabinet part, it is sent to the polishing room to be scratch-brush polished and buffed. It is then returned for plating.

Nickel plate can be applied direct to any metal without a preliminary coating of copper, as was formerly thought necessary.

A very low voltage is being used for nickel plating, 1¾ volts on wired work. This is to avoid pitting, and to make a softer coat which will take the polish better. The time needed is from one hour on cabinets to three hours on interior parts which receive considerable wear.

Zinc, on the other hand, can be put on very rapidly, 6 volts being used on wired work and about 10 minutes being required.

One tank of zinc plating work will keep one man constantly busy. Eight to 10 bolts are used on barrel galvanizing.

Copper plating requires first a cyanide solution to act as a " binder " that is to form a preliminary alloy to which the first coating will adhere. This goes on slowly, but about one minute on brass castings will be enough for the coat. Iron and steel take longer.

A transfer is then made to the faster acid sulphate solution for the heavy run.

When the copper is to receive an oxidized finish the piece, after removal from the sulphate tank, is washed in clear water and dipped in pentasulphuret of potassium (the commercial " liver of sulphur ") long enough to get a blue-black colour.

It is taken out smutty, and is then scratch-brushed with a brass brush in order to bring out the lustre of an oxidized finish.

The high parts of the work are then finally relived with a felt or cotton buff wheel so as to bring out the contrasting copper effects.

Silver plating is used largely on the counter wheels to give a greater contrast with the black lettering. The silver coating is put on in about five minutes, after a heavy base coat of nickel of some half-hour's time has been deposited.

Low-Voltage Generators.—The electrical equipment to supply the large amount of current needed is rather interesting, as it includes machines of various makes and different age.

Six direct-current motor-generator sets are used, the line voltage running 225 volts and the speeds from 450 to 850 r.p.m. on the different sets.

The latest addition to the equipment, as well as the largest and most recent in design, is a 4,000-amp. machine. The overload capacity of this unit is 50%, which brings the output to 6,000 amps. There are several interesting features connected with this machine which may be mentioned.

The set, together with switchboard and control apparatus, is installed in a small frame housing erected especially for it on the roof of the main building, where it is removed from the acid fumes and has a generous supply of fresh air. The arrangement has proved so satisfactory that the other machines are to be moved up also. The motor-generator set is constructed in three sections, a 100 h.p., 225-volt motor driving the two generators, one on either side, through flexible leather couplings. The normal rating of each generator is 2,000 amps. at 6 to 12 volts, and it is compound wound. This winding has been found more satisfactory than straight shunt, as it is impossible to locate all the supplied tanks near enough to the generators to prevent a considerable voltage drop on full load.

A few advantages of the double generator arrangement are the following :

Better efficiency on light loads, as one section may supply all the current and the other run with the field off, so that the latter then remains unloaded.

Two voltages furnished, which is necessary when work of different classes, such as zinc and nickel, is being done.

High voltage obtainable. The two machines may be conveniently connected in series to furnish 24 volts. This may be useful in cleaning wood, though as at present arranged 12 volts is used and considered satisfactory.

When the rearrangement of the various generators is completed, it is intended to use one end for cleaning and the other for plating operations.

PERSONAL.

Mr. F. W. Clements, general manager of the Melbourne Electric Supply Co., Ltd., and Chief Engineer of the Adelaide Electric Supply Co., Ltd., is now in London to meet the directors in connection with the business of those companies.

Mr. R. Ellis, foreman of the Electrical Branch, Royal Laboratory, Woolwich Arsenal, has retired after 33 years' service. He received a handsome presentation from his brather foremen of the Arsenal, and also from the men of the Electrical Department.

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Displayed Advertisements intended for insertion in the current week's issue, and alterations for standing advertisements, must reach the offices by 9 a.m. on Monday if proofs are required.

Contracts, Patents and Small Advertisements by 9 a.m. on Wednesday.

Terms for displayed advertisements may be had on application.

Second-hand Plant and Machinery Advertisements, 24 words 1s. per insertion, three insertions for 2s. 6d., each additional line of eight words 4d.

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Municipal Central-Station Engineers and Tramway Managers are invited to send advance notes of new work being undertaken by them, and of successful results obtained from the undertakings under their charge.

Secretaries and Managers of Companies are asked to furnish Notices of Meetings, Issues of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers.

Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

Contractors can make use of our columns to obtain the names of the makers of any specialities they require in their business.

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A BOARD OF TESTS AND STANDARDS.

A useful suggestion thrown out in a letter to *The Times* on "The Local Government Board and Engineering Materials," and subscribed "An Engineering Firm," appears to have been allowed to pass almost unnoticed. Yet it is too important—offering a practical solution to a difficult problem—to be thus neglected. While the correspondent is concerned with the control the Board exercises directly, or indirectly, through its supervision of local authorities and their bye-laws, in the choice of constructional materials for building, as well as engineering purposes, yet the general scheme laid down would apply to a wider sphere and to the Board of Trade as well. Briefly, recognising that it is well that the Board should have the power to overlook the choice of local authorities in regard to materials used, it is the method of exercising such powers that is criticised. The Local Government Board, like other great departments, does certainly occasionally call in outside expert advice, and even calls upon the National Physical Laboratory for help in particular cases; yet, in the main, the whole policy is shaped by a few permanent officials. These men, however high their professional reputations and abilities, necessarily get somewhat out of touch with the progressive side of their profession, and, at all events, must always betray individual bias. As a result of this, we do find the Board pursuing a prejudiced policy occasionally, as civil engineers have notoriously had good reason to complain of in the matter of the Board's attitude towards reinforced concrete. Now, the suggested remedy is this: that an Advisory Committee should be attached to the Board, on which the engineering branches of the Board of Trade, Post Office, War Office, and Admiralty should be represented equally with the Local Government Board, and to these members should be joined in a consultative capacity the presidents of the Institutions of Civil, Electrical, and Mechanical Engineers, Iron and Steel Institute,

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Gas Institute (or elected professional members of such bodies where the presidency was an honorary position). Such a body as this, with, perhaps, certain specially appointed members, so as to embrace non-attached experts, would no doubt represent the interests of the whole community. The principle could easily be extended to other departments, notably the Board of Trade, in which electrical engineers are more directly concerned. The principle is by no means new on the Continent. In France, notably, most of the large Government departments have such Consultative Committees composed of members of the various Academies and professional Corporations, and gentlemen eminent in their respective walks of life, who are given these honorary appointments. These Committees do real work, and practically shape much of the administrative activities of such departments, as, for instance, the Ministry of the Interior in the matters of hygiene, the Ministry of Public Works, and so on. It works well with our neighbours, and the system should give even better results with us. For one thing, it might lead to more general utilisation of the National Physical Laboratory, which ought to be better endowed with public funds and considerably extended. In electrical matters, a Consultative Committee, such as above outlined, assisting the Board of Trade, would be of immense service both to the industry and the public. The very changeable nature of the Committee would prevent too hard and fast tests and standards being adopted; we could secure elasticity without the bewildering diversity of methods which we laughed at a few months ago in these pages when considering the specifications for electrical machinery and appliances as put forth by Government offices in the United States of America, a chaotic condition of affairs that appertains in quarters far nearer home. There is, we are convinced, much to be said in favour of the institution of such Consultative Committees, which co-operate permanently, while at present the advice of outside experts (as bodies or as individuals) is only sought for spasmodically and erratically.

CORRESPONDENCE.

All communications intended for the Editor should be addressed "The Editor, 149, Fleet Street, London, E.C." Anonymous communications will not be noticed. Letters should reach the Editor not later than Tuesday afternoon to be included in that week's issue of the Journal.

The Editor is not responsible for, nor does he necessarily endorse opinions advanced by correspondents.

I.E.E. COUNCIL ELECTIONS.

Sir,—Along, I presume, with other members of the Institution, I have received a letter signed by Mr. W. A. Chamen, asking for my "vote and interest" on behalf of Mr. H. Faraday Proctor for the forthcoming Election for the Council of the Institution of Electrical Engineers.

I think that, with certain safeguards, the practice of the Institution nominating members for the election of the Council is one that has many advantages, but I am strongly of opinion that the innovation of circularising the general body of the members in favour of a particular candidate, however eminent that candidate may be, is one that cannot be too strongly condemned, and I sincerely trust that for the well-being of the Institution, the present unfortunate attempt to influence the members by circular may receive such a set-back as may prevent any recurrence of it in the future.

If this practice is allowed to take root and grow, then I fear it will cause a rivalry between the members of the various local sections with regard to representation on the Council that will seriously detract from the usefulness of the Institution.

I do not say that the method adopted by the Council of putting forward a bare list of the names necessary to fill the vacancies on the Council is an ideal one, but I think that in nominating three prominent members of local sections they have taken a step in the right direction, and one that is likely to commend itself to the general body of the members.

I have no personal feeling with regard to Mr. Faraday Proctor, who, I believe, would make an extremely good member of Council, but I do think that this attempt to influence members is one that will seriously affect the influence of the Institution, and I trust, therefore, that it will not receive the support of the general body of the members.

Yours, etc.,

THOS. L. MILLER.

709, Tower-buildings, Water-street, Liverpool,

May 14, 1910.

A REVOLUTION IN CABLING.

Relay Principle adapted to Submarine Telegraphy.

From Our Own Correspondent.

New York.

Nothing short of a revolution in the transmission of messages by the submarine cable is promised by the successful issue of the experiments which have just been carried out in connection with Dr. Kitsee's new invention. It is well known that the application to submarine cables of the automatic repeating principle so long in use over long-distance land lines has hitherto been impossible since the action of the repeating sounder can only be brought about when the current is steady. In cable telegraphy, the current is always fluctuating and there are always electric ripples, so to speak, moving the movable part or tongue of the receiving device from one place to the other, and the impulse which arrives at the receiving station is always fluctuating in itself, and the tongue, therefore, moves sometimes a greater distance and sometimes a lesser distance. Such action is called the "moving of the zero" and it is obvious that with such moving of the zero, an instrument with stationary contacts cannot be used. Therefore, on submarine cables, the employment of sounders, repeating sounders or relays, such as are used on land lines, is out of the question with the cable system of to-day. The Kitsee system, however, effects a radical alteration in the conditions. It changes the "moving zero" into a "stationary zero" and makes possible the employment of sounders or repeating sounders and thus repeating may be carried on for as many sections as desired. The tests referred to were made between the city of New York and Canso, in Novia Scotia, and the messages were transmitted in the Morse code over the 800 miles by means of the ordinary telegraph key and received with the sounder, the speed being 35 words per minute.

How It Is Done.

The system by which this revolution is effected is lucidly described this week in the *Electrical Review and Western Electrician*. At the transmitting station two sets of batteries, one set of about double the electromotive force of the other set, are connected in opposition as to each other and in series with the cable. The set of higher electromotive force is provided with a shunt, this shunt being provided with an ordinary telegraph key. For all practical purposes,

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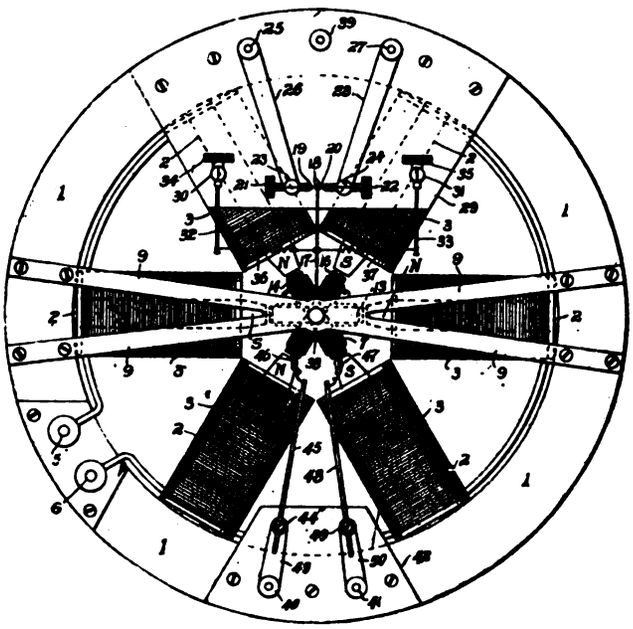
the operator manipulates his telegraph key in the same manner as he manipulates his key on land lines. He closes the key for a short time to transmit a dot and for a longer time to transmit a dash. Through this arrangement, impulses of opposite direction—true reversals—are transmitted over the cable. At the receiving station, a condenser is inserted in the cable and the cable is then grounded with the interposition of an impedance. The line relay is not connected directly to the cable, but is connected in a shunt around the impedance. This shunt embraces: First, the relay and then a capacity. To this relay is connected a highly wound polarised relay of the Siemens type. Each forward stop of the line relay is connected to a source of current, one source in opposition to the second source. These sources are connected together and their junction is connected with the interposition of a condenser to one terminal of the coil the polarised relay. The second terminal of the polarised relay is connected to the tongue of the line relay. Condensers overbridge the circuits of the tongue and forward stop of the line relay. The tongue of the polarised relay is connected with the interposition of a battery with one terminal of the coil of a telegraphic sounder of the regulation type. The second terminal of the coil of this sounder is connected to one of the forward stops of this relay . The circuit is shunted with the aid of a condenser and resistance.



RELAY USED IN THE KITSEE SYSTEM.
(Reproduced from "The Electrical World," New York).

THE LINE RELAY.

The line relay is of a peculiar type and consists of a circular yoke of iron and secured thereto are six radially extending cores alternately with opposite poles. Upon these cores are disposed windings connected in series with each other and the terminals of these windings are connected to binding posts for the purpose of joining the same with a suitable exciting circuit. Disposed between these pole pieces is a stationary core of iron supported by brass screws to the frame proper. Upon the top of the yoke is secured a bridge or bracket of brass and upon the underside is secured a similar bridge or bracket. At their centres, these brackets support carefully ground jewels and in these jewels are journaled the supports for three movable coils. These three coils are disposed of at an angle with respect to each other. Their terminals are connected to binding posts resting on the frame and are adapted through these binding posts to be connected to the cable. The support of the three coils carries a tongue or arm, and in proximity to the end of this tongue are stationed two contact points. The invention, as will readily be gathered from this description, is one of the very first importance to the future of cabling, and will be the means of bringing about a material improvement in the rate of transmission and therefore of making possible a largely extended use of submarine telegraphy.

SICILIAN HYDRO-ELECTRIC STATION.

A hydro-electric undertaking of a remarkable character is being carried out in the valley of Cassibili, near Syracuse, Sicily, by the Sociéta Electrica della Sicilia Orientale, which has already done so much to supply the towns and districts of Messina, Catania and Syracuse with electricity. Particulars of this notable extension are given by our contemporary, *The Engineer*, from which we extract the following details. At a point in the hills, 9 kilometres from their base, a masonry dam has been built, and from this a canal has been constructed, following the contours of the sharply sloping hillside for a distance of 8,700 m. Where the irregularities of the ground have made an ordinary canal impossible, tunnels have been substituted, aggregating 4,700 m. in length. To prevent interruptions from the canal being blocked by boulders or slips it has been lined and covered with masonry through a great part of its length.

At 8,350 m. a storage reservoir has been provided, a peculiar feature of which is that a large portion of it is underground. The sharp slope of the hillside has made an open reservoir impossible except at great cost. It was therefore decided to make a portion of it under the hill. The soft limestone, which is so conspicuous a feature of the last 300 m. of the canal is in tunnel, terminating in a small underground feed reservoir, with which the pipes leading to the power-house below are directly connected.

The following are a few details of interest:—Available flow of water in Cassibili River, 800 to 1,500 cu. metres per minute, according to season; head of water through pipes, 270 m.; total length of canal, 8,700 m.; total length in tunnels, 4,700 m.; average sectional area of canal, 2·50 sq. metres; fall of canal, 1½ per 1,000; average horse-power developed, 3.000; cubic contents of reservoir, 18,000 cu. metres; length of piping, 620 m.; diameter of piping, 0·80 m.; date of commencement of work, July, 1908; date of completion (probable), May, 1910. From Cassibili a high-tension line of 45,000 volts is to be taken through Syracuse and Catania to Messina. The pipes and turbines have been supplied by Messrs. Escher, Wyss & Co., of Zurich, and the electric plant is to be provided by the Milan branch of Messrs. Brown and Boveri.

ARGENTINE ELECTRICAL OUTLOOK.

A foreign consular report well worthy of careful study by British manufacturers is that issued by the Belgian Legation at Buenos Aires, which states that the Argentine Republic undoubtedly deserves the very best attention of manufacturers desiring to develop trade in electrical goods. This country already imports 15,000,000 fr. value of electrical materials, and the use of electricity is becoming more and more general throughout the country. The Republic offers excellent opportunities for articles of all kinds for lighting, traction, telephones, telegraphs, industrial motive power, etc., and in the Province of Cordoba and the districts of the Andes the utilisation of water-power for electric lighting and motive force is becoming more and more general. Germany, Great Britain, and United States have effectively worked the market up to the present. Local production may be said to be nil. The proportions of the trade held by the various countries are as follows: Germany, 491 per 1,000; Austria, 3 per 1,000; Belgium, 14 per 1,000; Denmark, 1 per 1,000; United States, 98 per 1,000; France, 36 per 1,000; Italy, 33 per 1,000; Norway, 1 per 1,000; Holland, 1 per 1,000; United Kingdom, 312 per 1,000; Sweden, 8 per 1,000; Switzerland, 2 per 1,000. The moment appears to be opportune for endeavours to obtain further trade.

ELECTRICAL ENGINEERS TERRITORIALS (London Division)—Orders for week ending May 28: Monday, May 16, "A" Company, Recruits' Infantry Drill, 6 to 6.45 p.m.; Company Drill, 7 to 9.30 p.m.; Tuesday 17, "B" Company, Company Drill, 7 to 9.30 p.m.; Wednesday 18, Gymnasium, 6 to 9.30 p.m.; Thursday 19, "C" Company, Recruits Infantry Drill, 6 to 6.45 p.m.; Company Drill, 7 to 8 p.m.; Technical Drill, 8.45 to 9.45 p.m.; Friday, 20, "D" Company, Recruits' Infantry Drill, 6 to 6.45 p.m.; Company Drill, 7.15 to 8.30 p.m.; Technical Drill, 8.45 to 9.45 p.m.—(Signed), P. H. CAMPBELL, Capt. R.E., Adjutant.

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PUBLICITY.

In this Section of "The Electrical Engineer" we give Publicity to New Inventions and Specialities.

"ONEWATT" BATTERY LAMPS.

Messrs. Siemens Bros. Dynamo Works, Ltd., have brought out a new illustrated list of their "Onewatt" metal filament battery lamps, which gives particulars of many types from 2 to 16 volts. While these lamps, as we have reason to know from actual inspection and tests, are

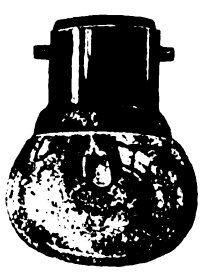

FIG. 1. "PIPLESS."

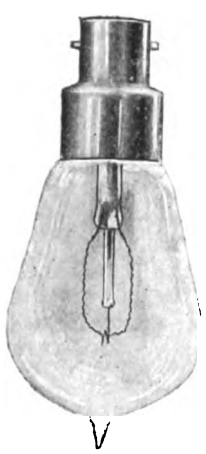

FIG. 2. "BELL-SHAPE."

of first-class construction, having drawn wire filaments, and burning at an efficiency of about one watt per candle-power, giving a high efficiency, they are most reasonably priced, with excellent trade discounts. The lamps listed include the "pea"-type, from 1·3 to 5·5 volts, ¼ to 1½ c.p.; "flame" candle lamp, from 2 to 5·5 volts; pipless (Fig. 1) round bulbs, and "mushroom" with side pip, specially suited for certain forms of illumination; spherical, from 2 to 16 volts, and 1½ to 16 c.p.; Bell shaped (Fig. 2), from

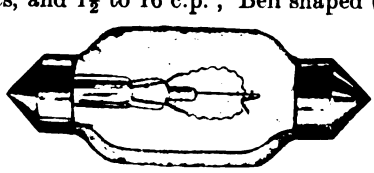

FIG. 3. "FESTOON."

8 to 16 volts and 5 to 16 c.p.; tubular, from 4 to 8 volts, and 3 to 6 c.p.; and festoon (Fig. 3), from 4 to 8 volts, and 3 to 8 c.p. (six patterns). The tubular, festoon and mushroom are specially intended for motor-car and yacht lighting, although having a wider application. It is a wonderful range of battery lamps, and some of our readers will be glad to learn that Messrs. Siemens are bringing out single sheet lists, to be overprinted with the dealer's name and address.

THE JOINT PUBLICITY SCHEME.

The Electric Supply Publicity scheme has now got well under weigh. The Joint Committee's aim is to issue publications which will finally cover the whole area of supply possibilities. The first step was taken by issuing a poster and showcard dealing with the use of the supply for general lighting, together with a typical circular with the same bearing; the whole of which was given most gratifying and widespread support by various undertakings, both London and provincial.

This has now been followed up by the present issue of a poster and showcard, which deal with electric ironing, forming the first of a series dealing with the uses of the supply for domestic purposes. The poster (40 in. × 25 in.), lithographed in five colours, is of a design to make an effective display on the hoardings. The showcard is smaller (15 in. × 20 in.), but of identical design and colouring, and of a most tasteful character, and thus eminently suitable for display in showrooms, offices, shop windows, estate agents' offices, etc.

Further, as an extension of the foregoing, a handy sized and illustrated four-page folder has been got out, which, while compact enough to be slipped into the ordinary envelope enclosing accounts or correspondence, is yet comprehensive enough to touch on all the domestic uses for lighting, heating and cooking, onwards.

With the same end in view, of developing these auxiliary uses of the supply, a mail card has been designed, dealing also with electric ironing. This is in a size for enclosing with correspondence (thus ensuring that it really gets into consumers' hands), and bears an apposite illustration reproduced in colours by high-class three-colour process.

The present issue should be of the greatest service to supply undertakings, since it provides material for most useful advertising without incurring any expense in distribution. In fact, it marks, we think, a distinct step in advance of anything previously done, since we do not know of any similar circular or pamphlet got out by supply undertakings themselves, in which the three-colour process has been used, as same is, of course, usually considered too expensive for matter on a small scale. However, with the big issues which the Joint Publicity Committee can make, we may probably look forward to seeing further high-class productions in this method, since it is so eminently suited to the needs of the case.

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Electrical Contractors' Section.

A Survey of New Things and Business Prospects.

NOTICE.

Contract and Miscellaneous Advertisements should reach this Office by Mid-day on Wednesday. For rates apply to the Manager, 149, Fleet Street, London, E.C.

CONTRACTS.

COUNTY BOROUGH OF NEWPORT.

TENDERS FOR ELECTRICAL PLANT.

The Electricity Committee of the Corporation of Newport invite TENDERS for the Supply, Delivery and Erection of the following PLANT:—

Two 400 kw. Motor Generators, three-phase to direct current.
One 600 kw. Motor Generator, three-phase to single-phase.
One bus bar Three-wire Booster.

Specifications, General Conditions, and Form of Tender, etc., may be obtained from the undersigned on payment of a deposit of £3, which will be returned, if a *bona fide* Tender is sent in as soon as the Committee and Council have adjudicated upon the various Tenders.

The Specification will contain the usual labour clause.

Extra copies of specification can be had for the sum of 5s. each, such sum not being returnable.

Sealed Tenders, endorsed "Tender for Plant," must be delivered in the envelope provided, addressed to the Town Clerk, duly sealed and endorsed, on or before the first post on Tuesday, May 31, 1910.

The Corporation do not bind themselves to accept the lowest or any Tender.

H. COLLINS BISHOP,
Borough Electrical Engineer
and Tramways Manager.

Town Hall,
Newport, Mon.
May 10, 1910.

URBAN DISTRICT OF FINCHLEY.

ELECTRICITY WORKS—WELL SINKING.

The Council is prepared to receive TENDERS for the SINKING and EQUIPMENT of a DEEP TUBE WELL.

Conditions, Specification, and Form of Tender may be obtained at the Office of the Electrical Engineer to the Council (Mr. E. Calvert), Electricity Works, Squire's-lane, Finchley, N., on payment of £1 1s., returnable on receipt of a *bona fide* Tender.

Sealed Tenders, marked "Electricity Works, Section XLIX.," to reach me, the undersigned, not later than 11 a.m. on Saturday, the 28th instant.

The Council does not bind itself to accept the lowest or any Tender.

E. H. LISTER,
Clerk of the Council.

Council Offices,
Church End,
Finchley, N.
May 7, 1910.

CLACTON URBAN DISTRICT COUNCIL.

TENDERS FOR ANNUAL SUPPLIES.

The above Council invite PRICES for the Supply of the following GOODS and MATERIALS during the ensuing year:—

Engine Oils.
Cotton Waste.
Gas Barrel.
Bitumen.
Electrical Service Fittings.
Electrical Joint Box Compound.
Gas Mantles, etc.
Cement.
Ballast.
Hoggin.
Disinfecting Fluid, Powder, etc.
Water Stop-Cock Covers.

Tenders must be sent on the prescribed form, which can be obtained of the undersigned, to whom the Tenders must be delivered, not later than noon on Monday, May 23 next, under sealed cover, endorsed "Tender for Annual Supplies."

The Council do not bind themselves to accept the lowest or any Tender.

Dated this 6th day of May, 1910.

GEO. T. LEWIS,
Clerk to the Council.

Town Hall Buildings,
Clacton-on-Sea.

CONTRACTS OPEN.

HOME.

BATLEY.—Corporation Electricity Works.—One lighting and traction switchboard. (Specification, £1 1s., Borough Electrical Engineer.) June 1.

BECKENHAM.—Council invite tenders for the electric wiring of houses in the district. Particulars from Mr. J. E. Tapper, Electricity Works, Beckenham. May 23.

BELFAST.—Corporation invite tenders for supply of motor boosters and switchgear and for extension of lighting switchgear. Particulars from Mr. T. W. Bloxam, City Electrical Engineer. May 23.

BELFAST.—Borough Tramways and Electricity Committee.—Contract No. J. 7, motor boosters and switchgear. Contract No. J. 8, extension of lighting switchboard. (Specification, £1 1s. each, City Electrical Engineer, East Bridge-street, Belfast). May 23.

CLACTON.—Urban District invite tenders for annual supply of (1) engine oils, (2) cotton waste, (4) bitumen, (5) electrical service fittings, (6) electrical joint box compounds. Particulars from Town Clerk. May 23.

CORK.—Cork Electric Tramways and Lighting Co.—(1) Steam boiler, evaporative capacity of 18,000 lb. p.h. from and at 212° F., and fitted with a superheater capable of delivering steam with a superheat of 110° to 120°; (2) electrically-driven feed pump, having a *minimum* capacity of 6,000 gallons p.h. (Particulars, Engineer and Manager.)

COVENTRY.—City Electrical Department.—(*a*) One 2,500 kw. turbo-alternator, complete with surface condensing plant, etc., (*b*) four water-tube boilers (straight tube type), (*c*) two fuel economizers. (Specification, £2, Engineer and Manager.) May 30.

CROYDON.—Borough Council.—Lighting two isolation pavilions and administrative block (additions). May 26.

DARLINGTON.—Borough invite tenders for one cooling tower, one electrically-driven centrifugal pump, one electrically-driven air pump, one boiler feed pump. Particulars from the Borough Electrical Engineer. May 25.

EGREMONT.—Wallasey Urban District Council.—Two years' supply of alternating current transformers. (Particulars, Electrical Engineer, Seaview-road, Liscard). May 30.

FINCHLEY.—Urban Council invite tenders for sinking and equipment of deep tube well at electricity works. Particulars from Electrical Engineer, Squire's-lane, Finchley, N. May 28.

LEICESTER.—Corporation Tramways Committee.—Contract (a) one mixed pressure steam turbine, direct coupled to a 750 kw. direct current generator, together with condensing plant, switchboard, etc. Contract (b) two Lancashire boilers, fuel economiser, steam feed, blow off, and drain pipes, etc. (Specification, £2, Tramways Engineer, Belgrave-road Station). May 28.

LONDON: ST. PANCRAS.—Borough Council, 21 flame arc lamps, 20 iron cradles. Particulars from Electrical Engineer. May 23.

LONDON: ST. PANCRAS.—Borough Council invite tenders for twelve months' supply of Welsh steam coal to Regent's-park and King's-road Electricity Works. Specifications from Electrical Engineer. May 23.

LONDON.—L.C.C. Tramways. Tenders invited for the road-work and platelaying required for the reconstruction, on the underground conduit system of electric traction, of the Councils existing horse tramways in Tooley-street, Bermondsey; Dock-head, Parker's-row, Jamaica-road, Union-road and Evelyn-street, Deptford; and the construction on the same system, of the authorised tramway in Creek-road, Bridge-street and Church-street, from the terminus of the existing horse tramway in Evelyn-street to a junction with the existing conduit tramway in Nelson-street, Greenwich; also for the paving works of the street widenings on the above route. About 8·16 miles of single track. Specifications from the Chief Engineer of the Council, County Hall, Spring-gardens, S.W. May 31.

MANCHESTER.—Corporation.—Tramways.—Block tin; also steel girder tramway rails, gear, and pinion wheels. May 24.

MANCHESTER.—Corporation.—23 tons of 30 lb. steel rails, fishplates, etc., and 2,100 creosoted sleepers. (Particulars, Superintendent, Cleansing Department.) June 1.

NEWPORT.—Corporation invite tenders for the supply, delivery and erection of the following plant: Two 400 kw. motor generators, three-phase to direct current; one 600 kw. motor generator, three-phase to single-phase; one bus-bar three-wire booster. Specifications (£3) from Town Clerk. May 31.

PLYMOUTH.—Electricity Department invite tenders for supply of 7,500 tons of clean high-grade steam coal. Specification, (20s. deposit) from the Borough Electrical Engineer. May 31.

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PATENTS.

S. SOKAL, Chartered Patent Agent,
AND
Certified Austrian Patent Attorney (Patentanwalt), Specialist for German Patents and Patent Litigation.

55, CHANCERY LANE, LONDON, W.C.

THE PROPRIETORS of the PATENT, No. 17601 of 1901, for "Improvements in Apparatus and Devices for Controlling Electric Currents," are desirous of entering into arrangements by way of license and otherwise on reasonable terms, for the purpose of exploiting the same and ensuring its full development and practical working in this country. All communications should be addressed in the first instance to: HASELTINE, LAKE & Co., Chartered Patent Agents and Consulting Engineers, 7 and 8, Southampton-buildings, Chancery-lane, London, W.C.

THE PROPRIETORS of the PATENT, No. 28159 of 1897, for "Means for Use in Lighting Railway Cars or Carriages by Electricity and for Regulating the Current for the Same," are desirous of entering into arrangements by way of license and otherwise on reasonable terms, for the purpose of exploiting the same and ensuring its full development and practical working in this country. All communications should be addressed in the first instance to: HASELTINE, LAKE & Co., Chartered Patent Agents and Consulting Engineers, 7 and 8, Southampton-buildings, Chancery-lane, London, W.C.

THE PROPRIETOR of the PATENT No. 16962 of 1902, for "Improvements in Electrical Switches or Cut Offs," is desirous of entering into arrangements by way of license and otherwise on reasonable terms for the purpose of exploiting the same and ensuring its full development and practical working in this country. All communications should be addressed in the first instance to HASELTINE, LAKE & Co., Chartered Patent Agents and Consulting Engineers, 7 and 8, Southampton-buildings, Chancery-lane, London, W.C.

THE PROPRIETORS of the PATENT No. 17314 of 1905, for "Improvements in Automatic Regulators or Rheostats for Electric Currents," are desirous of entering into arrangements by way of license and otherwise on reasonable terms for the purpose of exploiting the same and ensuring its full development and practical working in this country. All communications should be addressed in the first instance to HASELTINE, LAKE & Co., Chartered Patent Agents and Consulting Engineers, 7 and 8, Southampton-buildings, Chancery-lane, London, W.C.

THE PROPRIETORS of the PATENT No. 15243 of 1903, for "Improvements in Means for Automatically Regulating Electric Currents Generated by Dynamos," are desirous of entering into arrangements by way of license and otherwise on reasonable terms for the purpose of exploiting the same and ensuring its full development and practical working in this country. All communications should be addressed in the first instance to HASELTINE, LAKE & Co., Chartered Patent Agents and Consulting Engineers, 7 and 8, Southampton-buildings, Chancery-lane, London, W.C.

THE OWNER OF BRITISH PATENTS Nos. 7286 of 1905, and 7286A of 1905, entitled "Improvements in or relating to electric motors and means for preventing sparking in same," and "Improvements in or relating to variable speed electric motors," granted to M. Pfatischer, is desirous of disposing of the patents or entering into a working arrangement under license with firms likely to be interested in the same. The owner would, in the alternative, be open to consider proposals to manufacture the inventions to fill any requirements of the market in Great Britain on terms to be arranged.

The Patents cover inventions interesting to Electrical Engineers and Motor Manufacturers.

Detailed information as to the inventions will be found in the patent specifications, of which copies will be supplied to any interested party on request.

Full particulars can be obtained from and offers made (for transmission to the owner) to MARKS & CLERK, 57 and 58, Lincoln's Inn Fields, London, W.C.

THE PROPRIETOR of the PATENT, No. 10187 of 1905, for "Improvements in Electric Couplings," is desirous of disposing of the patent rights, or of negotiating for the granting of licences to work thereunder. For particulars apply to G. F. REDFERN & Co., Chartered Patent Agents, 15, South Street, Finsbury, London, E.C.

THE ELECTRICAL ENGINEER REPRINTS.
New Series No. 1.
JUST PUBLISHED.
"LIGHTNING CONDUCTORS,"
By ALFRED HANDS, F.R.Met.S.
Author of "Scientific Protection," "A Guide to the proper Application of Lightning Conductors," "Lightning and the Churches," etc.
PRICE THREEPENCE.
Post free, Threepence Half-penny.
THE ELECTRICAL ENGINEER, LTD., 149, Fleet Street, London, E.C.

Ammeters Voltmeters

The Latest and Most Novel Patterns.

The Best and Cheapest in the End.

For Lists and Particulars apply to

The Leysner Electrical Instrument Coy., 12, Lime St., LONDON, E.C.

HEATHMAN FIRE SETTLER

Works with Chemicals 28/-

Charges 4/6 for 3.

HEATHMAN FIRE ESCAPE Co., Parsons Green, LONDON, S.W.

ROCHDALE.—Borough Council.—Contract A.46, accumulators, reversible booster, switchboard panels. (Specifications, £3 3s. Electrical Engineer, Dane-street.) May 25.

RHYL.—Urban District Council.—Triple concentric cable (830 yards of ·125 and 370 of ·2). (Particulars, Engineer, Electricity Works.) May 23.

SOUTHAMPTON.—Borough Council.—One 1,000 kw. generator boiler, alternator, and motor alternator. (Particulars, Borough Electrical Engineer, Western Shore Works). May 24.

TURTON.—Urban District Council.—374 yards steel rails for portable tramway. (Specification from V. W. Laithwaite, Bromley Cross, near Bolton.) May 25.

OVERSEAS.

ADELAIDE, S.A.—Postmaster-General.—Cordless switchboards (Specification No. 3,381.) July 6.

ANTWERP.—Lower Scheldt Works.—Electric lift for vehicles on floating pier. Dep., £320. Specification No. 19, 2d., plans 1s. 5d., Direction du Service Spécial de l'Escaut Maritime. June 16.

BUDAPEST.—H.M. Consul-General at Budapest (Mr. Esme Howard, C.V.O., C.M.G.) reports that tenders are invited by the Municipality of Pécs for the building and working of an electric railway in that town. Tenders will be received up to noon on June 6, by the "Pécs varos gazdasagi tanacsnokanak, Varosi Székhaz," Pécs, Hungary, from whom also detailed conditions and forms of tender may be obtained at a cost of 2 kronen (1s. 8d.). The plans and other documents can be examined on personal application at the Engineering Office of the town of Pécs.

CAIRO.—Department of the Interior.—For electric lighting plant for Assiut. July 30.

TENDERS ACCEPTED.

DARTFORD.—Urban District Council have accepted the following tenders: Messrs. Johnson & Phillips, Ltd., for lead covered paper insulated cable, 900 yds. ·15 sq. in., lead covered paper insulated cable, 450 yds. ·07 sq. in., £141 9s. 9d.; Messrs. The Universal Electrical Manufacturing Co., for one 12-way feeder pillar, £31 5s.

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Continental Manufacturer and Expert in the manufacturing process of Wolfram-Metal and Wolfram Filaments for Glow-lamps

is ready to teach and train responsible gentleman in the best methods of establishing plants in the U.K. and render such services as may be necessary for the successful conducting of this marvellous, highly profitable business. Charges reasonable. Negotiations through—**Alfred Schellhase, 220, Old St., London, E.C.**

PLANT FOR SALE.

Advertisements under this heading: Twenty-four words, 1s. per insertion; three insertions for 2s. 6d.; or each additional line of eight words, 4d.

FOR SALE, 2 ELECTRICAL OVERHEAD CRANES, 15 and 20 tons, 37½ feet span, by Sunderland Forge Co.; 1 Pintel and Scarfing Machine; 1 48in. Iron Saw; 1 20-ton Steam Forge Crane; 2 50-horse motors; 1 4½ Carter Disintegrator; 1 Special Steam Hammer for Sternframes.—Apply, ALEXANDER, Iron Merchant, Sunderland.

ELECTRIC MOTORS (10, 5, 2½-h.p.), in stock.—GEO. DIXON, Electrical Engineer, Popham-street, Canal-street, Nottingham.

EIGHTY MOTORS AND DYNAMOS for sale or hire.—MARTIN, 320, Witton-road, Birmingham.

FOR SALE, 20 h.p. Suction Gas Plant and 14 b.h.p. Engine; also 10 h.p. Vertical Boiler and 6 h.p. Vertical Steam Engine.—Box C.E., c/o THE ELECTRICAL ENGINEER, 149, Fleet-street, London, E.C.

ELECTRIC MOTORS.—Two 15 h.p., 500 volts; one 20 h.p., 100 volts; one 10 h.p., 460 volts; tramway controllers.—Box W.G., c/o THE ELECTRICAL ENGINEER, 149, Fleet-street, London, E.C.

FOR SALE, Three Generating Sets, 100 kw. 125 volts.—THOMAS JOHNSON, Prescott-street, Wigan.

FOR SALE, Two Willan's Three-crank Triple Expansion Engines, 825 I.H.P., 180 lbs. press., 270 revs.; only run about 1,000 hours; work triple or compound; bargains.—THOMAS JOHNSON, Prescott-street, Wigan.

PLANT WANTED.

PLATINUM UTENSILS, SCRAP, LAMP TOPS.—Best prices given by DERBY AND CO., LTD., 44, Clerkenwell-road, London, E.C. N.B.—Platinum Sold.

WANTED.—A small, Second-hand, Electric Motor Pump, in good condition, about 2½ h.p., 210 volts direct.—Apply stating price to J. MARCHAM, Ranelagh Club, Barnes, S.W.

SECOND-HAND 5 H.P. ELECTRIC MOTOR, 440 volts, slow speed preferred.—Particulars to WHITING, LIMITED, 334, Euston-road, London, N.W.

MISCELLANEOUS.

FOR SALE.

COMPLETE VOLUMES of THE ELECTRICAL ENGINEER for years 1906-7-8, bound in neat red covers; also for 1909 (half-year), unbound, with loose cover. All in very good condition. What offers?—Box M, 45, c/o THE ELECTRICAL ENGINEER, 149, Fleet-street, London, E.C.

SITUATIONS VACANT.

SHIFT ENGINEER, with experience in a Central Station and accustomed to taking an eight-hour shift on a three-wire system, wanted at once. Salary to commence, 25s. Applications, stating age, and giving full particulars of previous experience, together with copies of not more than three testimonials, to Box No. S.E., c/o THE ELECTRICAL ENGINEER, 149, Fleet-street, London, E.C.

SITUATIONS WANTED.

ELECTRICAL and GENERAL ENGINEER requires situation, station or private plant.—W. WINTERBURN, 192, High-street, Harlesden, N.W.

HAMPSTEAD.—The Corporation have accepted a tender for a 350 k.w. "Disc and Drum" type turbine, from Willans & Robinson, Ltd., Rugby. The turbine is intended for working both with exhaust and high pressure steam.

LONDON.—The London County Council have received the following tenders for the installation of electric lighting at the Camden-street School, St. Pancras, E.: Central Motor Engineering Co., 71–77, Parkhurst-road, Holloway, £206 19s.; E. Lawrance & Sons, Ltd., Wharf-road, City-road, £251 (accepted); Johnson & Phillips, Ltd., Charlton, £270 16s.; E. Newbald & Co., Court-road, Sutton, £283; F. A. Glover & Co., Ltd., Vine-street, Clerkenwell-road, £290; G. Weston & Sons, Ltd., 153, Fenchurch-street, £290 2s.; Garby & Wade, 125, Balham-hill, £298 16s. 4d.; Tredegar & Co., 56, Victoria-street, £310; British Westinghouse Electric & Manufacturing Co., Ltd., 3, West-street, Charing Cross-road, £552 19s.

NEWPORT (Mon.)—Tenders were received by the Corporation from the following firms for turbo alternators: Willans & Robinson, Parsons & Co., Dick Kerr & Co., Ltd., General Electric Co., Ltd., Howden, Ltd., British Thomson-Houston Co., Ltd., and British Westinghouse Co., Ltd. The tender for 1,500 kw. turbo alternator and condenser by Willans & Robinson and General Electric Co., Ltd., has been accepted.

NORWICH.—The Corporation have accepted a tender for a 500 kw. "Disc and Drum" type turbine, from Willans & Robinson, Ltd., Rugby. The turbine is intended for working both with exhaust and high pressure steam.

STAFFORD.—Electricity Department have accepted the tender of Messrs. Mobberley & Bayley, Stourbridge, for the supply during the ensuing twelve months of retorts and fire-bricks.

NOTES.

Glasgow Sewage Works and Electricity.

Glasgow has brought to a successful issue one of the biggest sewage schemes in the world, a success largely due to the work of the contractors, Messrs. Lowden Bros. & Co., of Dundee and Glasgow, who had charge of the installation of the mechanical and electric power plant, as well as the electric lighting and ozonising equipment. At the Shieldhall Output Works a splendid array of machinery has been laid down, and it is confidently expected that the waters of the Clyde will be greatly improved thereby. At the opening ceremony Mr. R. Anderson, convener, turned on the electric power, and was presented by Mr. E. J. B. Lowden with a crystal electrolier and flower stand by way of souvenir.

Improved Electric Theatres.

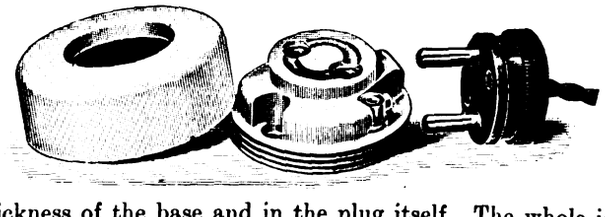
Messrs. Charles Urban and G. Albert Smith have introduced a greatly improved equipment for electrically controlled cinematograph theatrical representations. It is known as the Kinemacolor system. By this method vibration is reduced to a minimum, and, apart from the question of natural colour effects, the results are very life-like.

New Branch.

For the convenience of their customers in the south-west of London, the Hart Accumulator Co., Ltd., have opened a branch at 36, Victoria-street, Westminster, S.W., and have appointed as their representative, Mr. W. Howard Tasker, M.I.E.E. The branch is in telephonic communication with their works at Stratford, and all enquiries will receive immediate attention.

Two-Pin Plug.

Messrs. Marsh, Son & Co., Ltd., have brought out a new two-pin plug, which we illustrate herewith, as being specially worthy the attention of dealers and contractors. The special feature of this plug is its flatness—both of the



thickness of the base and in the plug itself. The whole is entirely of English manufacture. It is extremely easy to wire, and has standard dimensions of pins, and centre to centre distances between these. It will be at once seen

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SITUATIONS WANTED—continued.

FOREMAN WANTS SITUATION with Arc Lamp firm; well up in Theory and Practice of Mechanics and Electricity; 32 years of age, and 17 years' practical experience.—Box W. E., c/o THE ELECTRICAL ENGINEER, 149, Fleet-street, E.C.

ELECTRICAL ENGINEER desires berth in Central Station, or charge of private installation.—Box C., c/o THE ELECTRICAL ENGINEER, 149, Fleet-street, London, E.C.

WANTED, SITUATION as DEPOT SUPERINTENDENT, or take charge of Private Installation.—Box 43, c/o. THE ELECTRICAL ENGINEER, 149, Fleet-street, London, E.C.

WIREMAN WANTS WORK, 12 years' experience; screwed conduit.—G. H., 14, Sterndale-road, West Kensington.

that such a design lends itself to all kinds of work—for places where high-class decoration demand the subordination of these accessories, and for shops, warehouses and factories where projections on the walls are most undesirable. We understand that the prices are quite right for the dealer and his clients.

A Tumbler Switch.

Another speciality of Messrs. Marsh, Son & Co., Ltd., is a new tumbler switch, which is remarkable for the fact that in designing it they have endeavoured to produce a really reliable 10-ampere tumbler, the special feature being that they have kept the break very large, and all metal parts amply heavy enough to carry a considerable overload over the 10 ampere. The make and break are quick and positive; the wood screws are well insulated from the "live" portions of the switch; and the two copper contacts, which are of the double contact type, are well separated by insulating walls. This switch has been prepared for looping-in, having a special recess at the back of the porcelain.

New Address.

On and after June 22 the Edison & Swan United Electric Light Co., Ltd., Newcastle stores and offices will be removed to more convenient and commodious premises at Swan-buildings, St. James'-street, Leazes Park-road, in the same building as Messrs. Chas. Churchill & Co., the well-known American tool people. The management of this branch will still be in the capable and energetic hands of Mr. H. Smith.

CONTRACTS WORTH WATCHING:—

Acton.—Mr. F. A. Everitt, secretary, Education Department, Council Offices, Acton. New Schools for 850 children.

Auckland.—Mr. F. H. Livesay, architect, Bishop Auckland. Lighting by electricity and heating by hot water new Infirmary; also supply of pump and apparatus for fire extinction. May 25.

Bath.—Postmaster, Head Office, Bath. Adaptation of house for Labour Exchange.

Bolton.—H.M. Office of Works, Storey's-gate, Westminster. Adaptation of two dwellings for a Labour Exchange.

Bradford.—Messrs. W. J. Morley & Sons, architects, 269, Swan-arcade, Bradford. New Hall and alterations to Chapel.

Bridgend.—Mr. R. H. Cox, Clerk, Union Offices, Bridgend. New Board Room and Offices.

Bristol.—Mr. E. H. L. Barker, architect, 101, Leadenhall-street, London, E.C. New Church.

Croydon.—Mr. F. L. Lloyd, Town Clerk, Croydon. Two Isolation Pavilions and additions to administrative building.

VULCANITE

TURNED & MOULDED GOODS TO PATTERN.
RODS, SHEETS, AND TUBES.
F. CARSON & EVANS.
34 Fenchurch Buildings
LONDON, E.C.

EBONITE

Dublin.—Mr. G. T. Moore, M.Inst.C.E.I., 1 and 2, Foster-place, Dublin, invites tenders for (a) general contractors' work; (b) shop fitting; (c) electric installation; (d) decoration of premises, Sackville-street. Separate sealed and endorsed tenders for each section will be received not later than June 4.

Dunstable.—Messrs. Gotch & Saunders, architects, Kettering. Schools.

Liscard.—Mr. H. W. Cook, Clerk, Public Offices, Egremont, Cheshire. Public Library.

London.—Messrs. Wallis Bros., Ltd., Maidstone. New buildings for Royal Academy of Music, Marylebone-road, W., to cost £50,000.

Manchester.—Mr. E. H. L. Barker, 101, Leadenhall-street, London, E.C. New Church.

North Shields.—Black Bros., proprietors. Borough Theatre.

Pudsey.—Messrs. Jowett, Kendall & Sons, architects, South-parade, Pudsey. Alterations and extensions to Town Hall.

Stanhope.—Mr. W. M. Egglestone. Isolation Hospital.

Welshpool.—Mr. R. W. Davies, architect, Severn-street, Welshpool. Drill Hall.

West Derby.—Mr. C. H. Lancaster, Brougham-terrace, West Derby, Liverpool. Hospital for Guardians.

Windsor.—Messrs. Edgington & Spink, architects, 52, High-street, Windsor. Converting houses for Children's Homes, for Guardians.

STANDARD ELECTRICAL WORKS.

ELECTRIC TRACTION. By ROBERT H SMITH, Assoc. M.I.C.E., M.I.E.E. Demy 8vo. Illustrated. 9s. net; 9s. 6d. post free. [621]

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ELECTRICITY AND MAGNETISM FOR BEGINNERS. By F. W. SANDERSON, M.A. 2s. 6d. [506]

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The ELECTRICAL ENGINEER, 149, Fleet Street, LONDON, E.C.

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Electrical Progress at Home & Abroad.

A Review by our Special Correspondents.

TYNESIDE.

NEWCASTLE-ON-TYNE.

The Bandy patent variable speed single-phase motors are being introduced into the north-eastern counties by Messrs. Bergtheil & Young, Ltd., for lift purposes. These motors are of the commutator type, with a special winding and a strong mechanical governor regulating the position of the brush rocker, so that practically constant speed at any load is maintained without change from induction to repulsion. Some very interesting test figures were recently obtained on a 5½ h.p. motor of this type running at 950 r.p.m. on a 200-volt circuit, and operating a lift by means of a push-button attachment, which are as follows: The torque when passing full load current was 1·3 times the full load torque; while when 30% more than full load current was passing the torque was 1·7 times the full load torque. The efficiency of the motor at full load and full speed was 70%, while the power factor under these conditions was ·7. The power factor at the moment of starting the motor against 1·7 times the full load torque was ·32. These figures are in themselves sufficiently impressive without further comment.

The Newcastle Corporation Tramways.

The annual financial statement concerning the Newcastle Corporation Tramways undertaking has been issued, and some of the more important engineering features are as follows: On the item of motor men and conductors there is a considerably increased expenditure, and this also applies to car cleaning. A saving has been made on general maintenance and repairs, and particularly on the permanent way. The expenses are reduced from £122,609 in 1908–9, to £117,593 in 1909–10. The revenue has decreased to a slighter extent in the same period—from £204,123 to £203,948. A net profit of about £15,130 has been taken to reserve and renewals account. The reserve fund at the beginning of the financial year stood at £62,699 5s. 10d., and the aim of the Tramways Committee is to gradually increase this to £100,000.

The New Generating Station at Dunston.

The new generating station of the County of Durham Electric Power Co. and its allied companies at Dunston-on-Tyne, is nearing completion, and when finished and fully equipped will probably outrival even the mammoth generating plant belonging to the same group of companies at Carville. One interesting feature regarding the building construction is the use of Terrano flooring, of which Messrs. London & Clark are the local representatives, for the switch-house and generating station floor. This comprises 600 or 700 sq. yds. of jointless and dustless floor laid ¾ in. thick over the ordinary materials of building construction. The junctions between the floor and the walls are finished with hollow angles so as to facilitate utmost cleanliness.

A New Development at Armstrong College.

An interesting development in the scope of teaching at the Armstrong College, Newcastle-on-Tyne, which is likely to have a direct bearing upon electrical engineering and other allied industries in this area, is the decision of the College Council to accept an offer from Dr. G. B. Hunter of £250 per annum for a term of years, to provide a lectureship in commercial and industrial economics. Two of the conditions attached to the gift are that the syllabus of the lectures to be given is to be submitted to Dr. Hunter, and that a lecturer can be found whose qualifications peculiarly adapt themselves to making him capable of special appeal to the actual artizans in this area. As regards the first question, Dr. Hunter's special knowledge of such subjects renders him a peculiarly fitting judge, while it is to be hoped that the workmen of this district are sufficiently alive to their own interests to give the lecturer selected careful and intelligent support.

THE MIDLANDS.

BIRMINGHAM.

The three great trading departments of the Birmingham Corporation, namely, the Gas Department, the Electric Supply and the Tramways, all show a very successful year's trading in the accounts that have just been made up to the end of March, 1910. As in past years, the largest contributor in aid of the rates is the Gas Department, which shows a surplus available for this purpose of £72,492. The Electric Supply has made a gross profit of £93,588, and after meeting all charges for interest and sinking fund there remains a balance of £19,255 10s. Of this sum, it is proposed to carry £9,000 to renewal fund account, leaving a surplus for the year of £10,255 10s., which it is proposed to pay to the credit of the Improvement Rate. The tramway accounts show a gross profit for the year of £111,909. The net traffic receipts have increased by £13,791, while the expenses have increased by £7,095. The whole of the increased expenditure is due to reduction of working hours of the traffic staff from 60 to 54 hours per week. It is claimed that the working conditions of the department are now equal to the best in the country. After paying interest and sinking fund charges of £56,442, the profit and loss account shows an increase over last year's profits of £5,402. It is proposed to place the sum of £23,528 to the reserve fund, which will then stand at £104,328. The surplus £32,994 will be carried to the Borough Fund. The capital expenditure of the tramways has been increased during the year by £21,817. Of this sum, £11,300 is in respect of the partial reconstruction of the Bristol-road tramways.

Summer Lane Station and Extensions.

The installation of the additional plant at Summer-lane station and various sub-stations, for which a loan of £194,081 was sanctioned in June, 1908, is approaching completion, but in view of the great growth of the output, further additions are proposed. It is estimated that by the end of the year 1914 the demand will reach 27,000 kw. This estimate includes the current that will be required next year for working the Hockley and Bristol-road tramway routes. It is proposed to install 11,000 kw. of generating plant at Summer-lane, bringing its generating capacity up to 31,500 kw. This addition will complete the equipment of the station. The original estimate of its capacity was 26,500 kw., and the installation of 5,000 kw. of additional plant is rendered possible by the adoption of exhaust steam turbines. There will also be available at Water-street station a capacity of 2,000 kw., giving in 1914 a total for the whole undertaking of 33,500 kw. The extensions proposed also include the building of a small sub-station at Harborne and its equipment with 400 kw. distributing plants. This will meet the demand which has been very loudly expressed during the last few months for the supply of this large suburban district. Other additional distributing plant is also to be provided and the total estimated cost of the proposed extensions is £143,250.

Restricted-Hour Charges.

Among the other recommendations of the committee is one for the appointment of a secretary to relieve the engineer (who acts also as manager of the department), of the commercial, secretarial and accountancy side of the undertaking. For this a salary of £600 is proposed to be offered. Another proposal is to modify the conditions for restricted hour supplies. These at present are subject to a five years' guarantee, to a minimum consumption of 15,000 units per annum, and to 80% of the current used being taken between 6 p.m. and midnight. It is proposed to extend these hours by making them from 6 p.m. to 6 a.m.

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LANCASHIRE.

MANCHESTER.

The much advertised Manchester Industrial Exhibition has been opened in the large new building put up by International Trade Exhibitions, Ltd., near the site of the 1908 electrical exhibition. The building itself has been very well designed for its purpose, and Manchester now has a real exhibition hall to comfortably hold a general or large trade exhibition. Although the show is described as "industrial," it inclines rather to the combination of a produce exhibition and one devoted to the home. Not a single electrical firm has a stand, but the gas interests have some eight or ten representatives in different lines. With the exception of a few stalls lit by air gas, electricity is used throughout. General lighting is by flame arcs, with incandescents on the stalls. Messrs. Collier & Co., of King-street, West Manchester, are responsible for the electrical installation. A few of the stands have working exhibits, such as toffee boiling, weaving, combing yarn, working sewing machines, and printing; these are all driven by motors of electromotor's make working with Berry-Skinner switchgear. One of the local hospitals has a large stand fitted up as a model ward, and is making money rapidly out of its enterprise, with the help of X-ray demonstrations and other attractions.

Aeroplanes—Electric.

Another very interesting exhibit, and one which is continuously surrounded by a crowd, is A. V. Roe & Co.'s stand, where the first all-British aeroplane which was actually able to fly, is on view. It is noteworthy that this triplane has flown very successfully on hundreds of occasions with only a 9 h.p. twin cylinder cycle engine. With only such a small power needed, surely something in the way of a serious attempt at electrically driving an aeroplane could easily be made? In this connection it should be noted that aviators are anything but enamoured of the various forms of petrol engines in use, and they look eagerly forward to the day when some simple rotary form of motor will be available. If some enterprising engineer would make a start with an electromotor, on a real aeroplane, and not a toy balloon, some real knowledge would be gained and perhaps electricity would find a new outlet.

Reaching the Public.

With reference to my remarks in these columns on previous occasions as to the great educational value of exhibitions and, consequently, their indirect business value, apart from the mere number of orders booked, it may be interesting to note that the N.W.S.P.U., the militant suffragist organisation have a very prominent stand, at which literature relating to their movement is on sale, and, of course, they are doing a good deal to educate public opinion to their point of view. We want some of the enthusiasm in the electrical ranks with which that organisation is inspired, and we want some such body to persistently preach electricity and awaken the interest of the man in the street in it, using all the popular means to do so, even street corner meetings if necessary. Such a society and such white-hot enthusiasm would be irresistable, and station engineers would find their loads growing—not necessarily running to peaks, but growing in a way to improve the financial position. If only the present number of consumers were increased by 50% in a year's time, an enormous amount of extra work would be found for the manufacturers and contractors, and could be put through in a reasonable volume, instead of in the trickling way, extension orders have of coming in now. Engineers interested in converting the general public to electricity might learn much by studying the methods of peaceful propaganda ...etised by the N.W.S.P.U. with such huge success. Any ...y which in four years can awaken the whole world ...existence, and all on an initial capital of £5, must ... have some golden method to teach.

Vulcanised Fibre.

... (Crumpsall), Ltd., have a stand on ... of electrical fibre is displayed. This ...ie only one in this country making ...rms, in successful competition against Continental and American products. The firm's works cover four acres, and they produce 45 tons per week at present, although this has to be increased immediately to keeping with the orders. An enormous amount of material of all sizes is stocked, and special stuff can be made quickly. Anyone who has had the painful experience of being held up on rush orders because the agents of the American firms—the only supplies formerly—had no suitable fibre in stock, will be glad to know that there is now a firm here who appear to be cutting out the American altogether in this material. The firm also make paper, as well as steel cans, for holding wool, flax, etc., in textile machines, and all kinds of fibre goods, such as gear wheels, brake shoes, rollers, insulating handles for cooking utensils, hydraulic packing, etc. Many firms show office appliances and devices for advertising, etc., but nothing of special interest to electrical engineers. While the exhibition is well worth a visit, and is a fine show, it must be admitted that it is essentially a popular one, and is in no way a trade exhibition, as its name might imply.

SCOTLAND.

GLASGOW.

In discussing, at the Institution of Electrical Engineers, Glasgow Local Section, Mr. Gerrard's paper on "The Progress of Electric Braking on Glasgow Corporation Tramways," Mr. John Ferguson, of the Glasgow Tramways Department, said in Glasgow they had ascertained roughly the average number of times an electric brake is applied in the course of a day with a car running 120 miles is almost one application per mile. Applications of the electric brake amount to about 18,000,000 times. The number of reports received during 1909 of defective electric brakes in connection with the work of the Glasgow Corporation Tramways Department amounted to some 17 and the greater proportion of these were not really defects in the brake, but in the application of the brake. A number of other members took part in the discussion, but the points taken up were mostly those referred to when the paper was read and discussed by the parent body.

Electricity and Purification.

Much has been written and spoken about the part which electricity has played, and will continue to play, in connection with the purification, but so far practically nothing has been said of one phase of electricity's influence on water purification. It is a hackneyed saying that the river Clyde has made Glasgow, and it is equally true that Glasgow has unmade the Clyde. In recognition of the latter fact, it has long been the devout aspiration of the Glasgow Corporation to restore their beloved river to its pristine purity. The opening of the Shieldhall Outfall Works in connection with Glasgow main drainage the other day by the Lord Provost of Glasgow, was another important milestone on the way back to a purified Clyde. In looking through the official descriptive booklet issued in connection with the opening of these works, one is struck with the large part which electricity is responsible for in the sum total of the machinery installed. The generator house, 57 ft. 6 in. long by 40 ft. wide, contains three 150 kw. "Howden-Crompton" steam electric generators, generating energy at 250 volts for lighting the buildings, grounds and works, and also for the 42 electric motors (averaging 400 b.h.p.) throughout the works. Each of the generators is capable of developing 220 b.h.p. when running at 435 r.p.m. The main switchboard and main power distribution board are erected on the north wall. The former is of enamelled slate 2 in. thick, 20 ft. long by 6 ft. high, and is composed of eight panels—four dynamo panels, two power panels, and two lighting panels. On each dynamo panel is mounted one Whip & Bourne automatic circuit breaker, Everett Edgecumbe & Co.'s ammeter, voltmeter, 800 amp. D.P. switch and fuses, shunt-breaking switch, igranic shunt regulator, and Everett Edgecumbe watt-hour meter. The instruments on the power panels are by the same makers. An 8-ton travelling crane, by Messrs. Carrick & Co., of Edinburgh, is erected, and serves both the generator house and the pump house. The boilers,

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by Messrs. Babcock & Wilcox, are three in number, each with 2,255 sq. ft. of heating surface, and capable of evaporating 10,000 lbs. of water per hour. There are two duplicate sets of Mirrlees Watson "Independent" surface condensing plants, and two Weir boiler feed pumps, Edmiston feed water filter and an oil tank. The engines are by Messrs. Howden & Co., of Glasgow, the electric motors by Messrs. Wright & Wood, the centrifugal pumps by Messrs. Drysdale & Co., the feed pumps by G. & J. Weir, and the valves by Hopkinson & Co. The cables are by W. T. Glover & Co., and the motor control panels by Hamilton Brothers. The electric lighting includes 24 5 amp. arc lamps working two in series, and 220 40 c.p. metal filament lamps. The total length of the cabling, power and lighting is 14 miles. The ventilating fans are by Keith & Blackman. Messrs. Lowdon Bros. & Co., of Dundee and Glasgow, were the contractors under the scheme for the water tube boilers, with all accessories, nine steam engines, three electric generators, and the complete lighting installation. The consulting engineer was Mr. W. D. Hamilton, of Glasgow, to whose designs and specifications the whole was carried out.

Edinburgh Corporation and Foreign Cables.

The Electricity Committee of the Edinburgh Corporation have recommended the acceptance of an offer by the Lahmeyer Electrical Co. for a supply of cable for the year from May 16. In moving approval of the recommendation, Mr. Stevenson said that the nearest offer by a British firm was for £5,866, or about £600 above the German offer. In moving the acceptance of the lowest British offer, viz., that by the Western Electric Co., Mr. Rawson said they had no proof that the German firm would be paying the standard rate of wages. The home offer, however, only got 9 votes, as against 23 for the German article.

Smoke Abatement Exhibition.

The prospectus of the forthcoming exhibition under the auspices of the Glasgow Corporation has now been published. The exhibition will be open to the public from September 16 till October 8. Having regard to the demonstrated importance of smoke abatement in towns, the Corporation are quite justified in having thought it desirable to bring before the citizens of Glasgow the latest and most scientific devices in connection with smokeless heating and lighting, embracing the most up-to-date methods and contrivances for the complete combustion of fuel, as well as the most modern developments in heating, lighting and ventilation by means of gas and electricity." The structure chosen for the holding of the exhibition is said to be admirably adapted for the purpose and the gas and electrical energy required by exhibitors will be supplied free of charge to a reasonable amount. There will be a nominal charge for admission, but exhibitors will be allowed to send out admission tickets to their own clients. It only remains to add that the Exhibition offices are at 270, Sauchiehall-street, Glasgow.

Electricity in Mines.

An accident at an Uddingston colliery the other day has given rise to much comment here. A runaway hutch knocked out a prop supporting an iron girder. The latter fell and in its descent split an electric cable running along the wall. A miner, anxious to clear the obstruction, endeavoured to move the girder, which, however, had become charged with electricity, and he was instantly killed. If nothing further in the way of fixing the plant can be done, surely some little elementary knowledge of the laws of electricity might be imparted to the men, who even in an emergency may be called upon to work with live wires.

GERMANY.

BERLIN.

The Berlin police have a plan for electrically printing notices of robbery, offers of reward, etc., in such a way that the notices leave an automatic electric typewriter ready to be posted up. In two or three minutes after a robbery has been announced at one station, descriptions of the thieves, or whatever information is to be communicated, can be on the notice board of every station in the city and suburbs. The danger to criminals here introduced is fairly obvious. The *Elektrotechniker* publishes a facsimile of a notice offering 1,000 marks reward for the arrest of a man who robbed a lady in an express train. The notice is very clearly printed, entirely in Roman capitals, but is rather too small. It would not be legible at a range of more than 7 or 8 ft.

The Pupin Telephone System.

The *Elektrotechnische Zeitschrift* for April 28, 1910, has an interesting and valuable article on the above subject showing the results of German researches into the measurements of the constants concerned. The article shows how reliable measurements of the conductivity, *i.e.*, the reciprocal value of the actual isolation resistances of telephone cables can be obtained. It has proved that the cable used by the Siemens & Halske A.G. for Pupin-lines are inferior in conductivity, especially with thick-copper-wire cables. It has also been shown that there is an agreement between the measurement and the calculation of the damping constants for Pupin-cables. Hence it is possible to lay down Pupin cables to carry conversation 621 miles without any copper conductors more than about 3 mm. thick. This enables us to put the important telephone lines of Germany into cables, whether for long or short distances.

Electric Threshing.

Some interesting experiments have taken place at Cothen with a threshing machine driven by a 10 h.p. motor. In one experiment 76 cwt. of oats were threshed in 3½ hours at a cost of rather more than a halfpenny per cwt. In another 53 cwt. of the same crop were threshed in 2¼ hours, at practically the same cost per cwt. Threshing with a steam engine cost 1d. per cwt. of oats, but as this included the hire of the engine, which was much the heaviest item in the expenditure, depreciation charges and interest on capital must be added to the above figures, which are for power only. This is obviously a very difficult thing to do, as the motor can be used for other purposes when it is not required for threshing. It is estimated that if the motor is used for threshing only the cost is about 5d. per cwt. The case is very different when the motor is used for other purposes as well, such as chaff cutting, pumping water, churning, etc. The motor need never be idle on a farm. It will be found with proper management that the actual cost of the threshing is about 2½d. An example of a farm of 160 acres is quoted in "Helios," about 45 acres being ploughland. In the winter months current cost £10 for two motors, one 7½, the other 2 h.p. The harvest yielded 244 cwt. of wheat, 30 of rye, 450 of oats, and 72 of beans, giving a total threshing of 800 cwt. The motors also pumped up 100,000 gallons of water, chopped all the food and litter and separated and churned 4,400 gallons of milk. Thus the expenses for six months were £10, and for the same period £20 had to be written off for interest and wear and tear. It would be impossible to do the work above detailed by steam for £5 a month.

Oil Motors in Electric Stations.

Some results of comparisons between Diesel motors and steam engines for driving dynamos will be of interest. At St. Polten the 800 h.p. Diesel motors used only 290 grammes of crude oil per kw. hour at a load of 350 kw., and in running at three-quarters of the nominal load, the average cost for oil was 1·08 heller per h.p. hour, as against 3·65 heller per h.p. hour for a steam engine, which, nevertheless, burnt only 1·26 kg. of coal per hour. 10 heller = 1d. The efficiency co-efficient of the Diesel motor was 31%, that of the steam engine 6·8%. Very favourable results were also obtained at Pressburg, where two Diesel motors, one of 300 h.p., the other of 500 h.p., gave an oil consumption of 288 grammes per kw. hour at full load, at a cost of 2·51 heller per kw. hour. The coal for a compressed air motor cost 4·4 heller per kw. hour. At the Jaslo electric station a Diesel motor of 375 h.p. gave the extraordinary low figure of 190 grammes of fuel per h.p. hour, as against 600 burnt by a steam engine of the same power fired with oil. In conclusion, the saving in storage room in the case of all oil motors is

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almost too obvious to need mention. It is computed that a year's stock of coal for a 1,000 h.p. steam engine takes up half an acre, while oil can be put underground, and takes up no useful space at all.

Make Your Own Gas !

Hopfer has been telling the Leipzig engineers that it is cheaper to make your own oxygen and hydrogen for blow-pipe purposes by electric batteries. He reckons on a daily consumption of 60 cubic metres of hydrogen and 15 of oxygen, and estimates the cost of purchasing these quantities at 93 marks. These are the proportions of gas found most economical for welding purposes. Hopfer's alternative proposal is to home-make the oxygen, but only half the quantity of hydrogen, replacing the other half of the hydrogen by purchased acetylene. He puts the cost of such a proceeding as follows :—

Cost of making 30 cubic metres H and 15 c.m. O	Marks.
(390 h.p. hours)	11·70
Compressing expenses (30 h.p. hours)	0·90
6 cubic metres of acetylene	6·00
Labour	1·50
Interest, etc.	6·50
	26·60

This means a saving of 66·40 marks a day, say £1,000 a year

UNITED STATES.

NEW YORK.

The progress which electrical drive is making in the textile mills of this country and the extent to which it is superseding steam found striking illustration at the annual meeting at Boston of the National Association of Cotton Manufacturers. One of the most interesting of the large number of papers presented on this subject was one by Mr. M. H. Merrill, whose earlier address formed the subject of a recent comment in these Notes. Dealing with detailed motor applications, Mr. Merrill observed that individual motors are now used with notable success on pickers, with the advantages of subdivision of power, absence of shafting, better location of machines and localisation of failures. In the latest work the motor has no shaft or bearings, but the rotating element is mounted on the beater shaft, the stator being attached to the machine by a bracket. This arrangement saves first cost, the motor shaft, coupling, two bearings and housing being omitted, and less space is required. In the card-room practically nothing has been done in the direction of the individual drive, largely on account of the low operating speed of the cards. Carding is practically a continuous operation. The use of direct drive on drawing frames has not been pushed. On fly frames the individual drive is coming into use on new work. Mule spinning is still a group-drive proposition. The group drive takes up the inequalities of power demand better than does an individual installation of motors. The ring frames present greater opportunities for individual driving than do any other machines used in the mill. Early driving by gears was rather crude and noisy. The directly-connected system now generally used has a motor shaft of sufficient length to extend within the cylinder, the end bearing of the latter being omitted, that on the motor serving for both. This drive is less expensive than one using gears, and far more satisfactory. The only objection is that it is impossible to spin a wide range of counts. Where a change in speed is needed the use of the silent chain drive is effective, combined with suitable pinion sizes at the motor. It is easy to keep this drive clean. The motor is controlled by a special switch connected with the shipper handle of the frame.

The Relative Cost.

Referring to the question of comparative expense, Mr. Merrill called attention to the advantages of what is known as the "four-frame drive." This equipment, he pointed out, requires no shafting, and the motors are less in number and larger in size than with the individual system, thus effecting a considerable saving in first cost. The arrangement consists in mounting one motor on the ceiling with sufficient shaft extension on each end to accommodate two pulleys, four frames being driven by one motor. This plan eliminates nearly all the friction load and gives a fairly positive drive. The loss due to belt slip is confined to one belt for each frame. This drive allows better subdivision of power, improved control, steadier speed, absence of shafting, and is in every way an advance over the group drive. The cost is frequently less than with the group system using several large motors. The actual cost of both systems taken from a large mill just built, with 160 ring frames of 300 spindles each, where both were considered and the four-frame outfit installed, was as follows: For the group drive bids were received from contractors covering shafting, pulleys, hangers, etc., delivered and erected. To complete the drive five 150 h.p. motors were required on which bids were received. A combination of the lowest bids represented a cost of 224 cents per spindle for the 48,000 spindles required. With the four-frame drive it was decided to install forty 20 h.p. motors operating at 1,150 r.p.m. The cost of these motors, delivered and erected, taken from the bids, was 189 cents per spindle, giving a saving of about $1,680 in the spinning frame equipment. If motors of 1,700 r.p.m. had been used the saving of the four-frame drive would have been $2,300.

The Edison Storage Battery.

Mr. Walter E. Holland, of the Edison Laboratory, has a noteworthy article in the *Electrical World* on the pre-eminent fitness of the Edison storage battery for vehicle service, in which he points out that the "A" type Edison cell is the outcome of nine years of costly experimentation and persistent toil on the part of its inventor and his associates. Developed by the slow process of elimination, it has survived thousands of other thought-of types—the fittest in its chemical nature, in mechanical construction and in electrical worth. The Edison invention, he proceeds, involves the use of an entirely new voltaic combination in an alkaline electrolyte in place of the lead/lead-peroxide combination and acid electrolyte characteristic of all other commercial storage batteries. Experience has proven that this not only secures durability and greater output per unit-weight of battery, but in addition there is eliminated a long list of troubles and diseases inherent in the lead-acid combination, which have hitherto hindered the full application of the original storage battery idea. "The principle on which the action of this new battery is based is the oxidation and reduction of metals in an electrolyte which does not combine with, and will not dissolve, either the metals or their oxides; and an electrolyte, furthermore, which, although decomposed by the action of the battery, is immediately re-formed in equal quantity and, therefore, in effect is a *constant* element, not changing in density or in conductivity. A battery embodying this basic principle will have features of great value where lightness and durability are desiderata. For instance, the electrolyte being a constant factor, as explained, is not required in any fixed and large amount as is the case with sulphuric acid in the lead battery; thus the cell may be designed with minimum distancing of plates and with the greatest economy of space that is consistent with safe insulation and good mechanical design. Again, the active materials of the electrodes being insoluble in, and absolutely unaffected by, the electrolyte, are not liable to any sort of chemical deterioration by action of the electrolyte, no matter how long continued. Those who have had experience with lead batteries know what attentive care is required to prevent 'sulphation'—that 'white plague' of the lead-cell world, which is caused by chemical action of the electrolyte on the active materials. They will also appreciate that such a disease-free battery as this, is the augury of a beneficent revolution in electric-vehicle practice. The electrolyte of the Edison battery is a 21% solution of potassium hydrate having in addition a small amount of lithium hydrate. The active metals of the electrodes—which will oxidise and reduce in this electrolyte without dissolution or chemical deterioration—are nickel and iron. These active elements are not put in the plates *as metals*, but one, nickel, is the form of a hydrate, and the other, iron, as an oxide."

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Advantages Summed Up.

Summing up the main points of his article, Mr. Holland thus enumerates the essential points of the new battery: 1. The perforated-container construction prevents loss of material by disintegration, doing away with sediment short-circuits and the necessity of cell washing. 2. A steel containing can has very obvious mechanical advantages over a hard-rubber jar, and the expensive delays and trouble caused by jar breakage in lead batteries are thus eliminated. 3. The steel-and-copper connectors used in connecting cell posts are easily removable, and make it possible to disconnect or replace any cell of a battery in a very short time without the employment of skilled labour, such as a "lead-burner." 4. The steel-and-nickel construction of the plates makes "buckling" impossible; even a dead short-circuit of the poles will not affect the condition of the plates in the slightest. 5. The simplicity of the care required enables one garage man to look after a large number of batteries, or makes it possible in private service for anyone to care for and operate his own pleasure vehicle with little trouble and most satisfactory results. 6. The materials used in the cell being exceedingly durable by nature and the construction being very rugged, a cell will stand an almost unlimited amount of vibration and shock without injury. 7. Freedom form "sulphation" or any kind of chemical corrosion eliminates a very insidious source of trouble and depreciation. 8. Lack of corrosive fumes prevents destruction of the metal work of vehicles and of the garage equipment. 9. The light weight of the battery in comparison with lead batteries gives it many evident advantages. The wear on tires is reduced; the vehicle can be built lighter; the cost of battery and of charging current required for moving unprofitable load, *i.e.*, the weight of battery and vehicle, is much reduced, or, in other words, a much larger percentage of the total weight transported will be *paying load*. This characteristic of lightness also makes possible the building of machines of exceedingly high mileage capacity. 10. The crowning feature of the Edison battery, however, is its *great durability*. This renders it a dependable piece of apparatus and not a makeshift which has to be humoured, coaxed and doctored. It is safe to say that this feature alone would have insured the battery's success without the many attendant advantages which it possesses. 11. The so-called efficiency of the Edison battery is low, being normally about 60%, where a lead battery, if new and in good condition, would give 75% to 80%. By this is meant that of the energy actually used in charging only about 60% will be recovered on the discharge. If charging current were the principal item of expense in vehicle operation this fact might be serious, but it is universally recognised that cost of charging current is an insignificant item and of no practical account in comparison with the other factors of care and maintenance. All these points, says Mr. Holland in conclusion, are not speculations but proved facts.

British and American Patent Law.

Mr. Charles L. Jordan, who is well-known in electrical circles in New York, sends to the *Electrical World* the following letter, which will doubtless be read with interest in England: "The Ilgner British patent case," he writes, "furnishes an occasion for contrasting British and American methods of procedure in patent litigation. The issue involved was apparently considered one of much importance, judging from the eminent counsel and technical aid arrayed on the two sides. Nevertheless, the complete presentation of the case occupied the court only two days, January 27 and 28, and the able and lengthy opinion of the judge was rendered a month later, on February 28. Another noteworthy point is that those who gave testimony in the case were men of the highest professional authority, among the number being Messrs. Ferranti, Swinburn, Mordey and Parshall; and, moreover, all were examined and cross-examined in open court at the second and concluding session. As a contrast, reference may be made to a recent American patent case involving a relatively minor technical issue, which required five years to reach a decision in the lower court, the presentation of which was accompanied by a record of over 15,000 pages, and one stage in the litigation marked by the submittal of a list of more than 1,700 questions drawn up by one set of experts for answer and rejoinder by the opposing set. In comparison with the British method of administering justice in patent litigation, the methods which have grown up in our courts are simply preposterous and a disgrace to American jurisprudence. The manner in which such causes in this country may be drawn out amounts, owing to the expense entailed, to a practical denial of the use of patent courts to all inventors who have not behind them, directly or indirectly, powerful manufacturing interests; and the procedure with respect to technical testimony has led to a condition under which such testimony is usually given by experts without authority in the profession or art concerned, and whose essential qualification appears to be skill in befuddling the issue upon which the courts will have to pass—of expertness in the arts of *suppressio veri* and *suggestio falsi*."

Voltage and Illumination.

In a paper read at the recent gathering at Sioux City of the Iowa Electrical Association, Professor L. B. Spinney, of the Iowa State College, offered some considerations on the subject of voltage regulation and illumination. He observed that it was contended by some central stations that an increase of voltage always results in an increase of light, and he pointed out that while this is true of new lamps for a short time, it is also true that under excessive voltage the incandescent lamp rapidly falls off in candle-power. Excessive voltage also results in increased power consumption. To show the effect of excessive voltage on the life of a lamp the following figures were presented: An increase of one per cent. above normal voltages reduces the life of the lamp to 79% of its normal life; 2% reduces the lamp to 61%; 3% above normal reduces the lamp to 49% of its life; 4% reduces the life to 40%; 5% reduces the life to 34%, and 6% above normal reduces the life of a lamp to 29% of its normal life. Regarding the effect of excessive voltage on illumination, Professor Spinney said that the characteristic of the incandescent lamp is such that a small change in the voltage at which it is operated results in a relatively large change in its candle-power, and, therefore, in the illumination derived from it. For example, a 2% increase of voltage increases the candle-power 12%, and a voltage of 5% in excess of normal increases the candle-power 31%. Considering the several sources which contribute to poor regulation, Professor Spinney said, the first was the regulation at the switchboard, as a variation in the switchboard regulation effects the regulation at all points on the line. The second source of variation was the line itself. If insufficient copper had been used in the construction of the line there would be an excessive pressure drop during the period of heavy load. The third source of variation was the transformer. The first step towards improving the regulation of a plant was to make an exploration of the various lines with a voltmeter. The individual line effects should then be corrected by adding copper or by redistribution of line loads. When this had been done, and lamps of proper voltage had been placed on the various parts of the system, due attention to switchboard voltage would insure results.

A Personal Note.

Electricians on both sides of the Atlantic will be interested in the announcement that Dr. Morton Lloyd, of Washington, D.C., is to be technical editor of the *Electrical Review and Western Electrician*. Dr. Lloyd has long been a well-known and highly-respected writer in the technical press and he is a member of the American Electrochemical Society, the American Institute of Electrical Engineers, the American Physical Society, the American Association for the Advancement of Science, the Société Francaise de Physique, the Philosophical Society of Washington, and other scientific institutions. He graduated with honours at Pennsylvania University, was appointed Hector Tyndale fellow in physics, and for three years pursued graduate studies in physics, mathematics and chemistry at Pennsylvania and Harvard, and in Germany. During summer vacations he worked for the Cutter Electrical Company, the New York Telephone Company, the Electric Storage Battery Company, the Baldwin Locomotive Works, and in other manufacturing institutions. He was instructor at the University of

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Pennsylvania from 1899 to 1902. In 1902 he was appointed laboratory assistant at the Bureau of Standards, Washington, D.C., and was promoted to the post of associate physicist in charge of the section of magnetic testing. The University of Pennsylvania has conferred upon him the degrees of Bachelor of Science, Doctor of Philosophy, and Electrical Engineer.

Electric Railroads and Development.

A striking instance of the importance of the electric railroad as a factor in State development is afforded by the present position of the Buffalo and Lake Erie Traction Company. This incorporation operates a high-speed passenger, freight and express line over a track nearly 100 miles in extent, and runs its services with such punctuality and such freedom from mishap as to commend the confidence alike of the travelling public and the merchant and manufacturer. The Buffalo and Lake Erie Company constitutes one of the most extensive electric traction propositions in the world. Its cars are luxuriously appointed, the rolling-stocks run smoothly over a well-laid track and the services are engineered to suit the convenience of the passenger instead of that of the operating staff, and the officials. At the time of writing numerous "non-stop" services are being arranged; Dunkirk, for instance, being reached from Buffalo in 80 min. and Westfreed in 2 hours, the intermediate stops being only at special points. Another direct, non-changing, quick service is between Buffalo and Hamburg. Americans in London will also appreciate the new freight and express services which have just been brought into operation. At a convenient point in Buffalo there has been erected a large brick and steel terminal, with ample facilities for doing a large business in handling merchandise of all kinds. There will be found at this freight house from early morning until midnight, an agent to receive and deliver such freight and express matter as may arrive or be sent to or from that point. Cars of the latest design for this class of work, operating with marked despatch, run from the freight terminal in Buffalo to a corresponding terminal in Erie, Pennsylvania, rendering to the two terminals and to the entire intermediate territory, an efficient and prompt freight and express service. From contracts already made it is assured that as this line operates through the greatest berry and grape belt in the world, there will be handled tremendous volumes of this class of business. It will offer to all of the farmers, berry and grape growers throughout this 92 miles of fertile territory, a prompt and efficient means of bringing to the Buffalo market their produce in a modern, high-speed electric car, rendering to the consumers of Buffalo, prompt delivery. In the past this has been largely handled by farmers driving in with wagons, which has resulted either in the fruit having to be picked unnecessarily early, or else arriving at the market late, and the method of transporting has been to the detriment of the produce. The new service will effect in this matter nothing short of a revolution.

Boys and the Strenuous Life.

Significant of the seriousness with which young America approaches modern scientific development is the announcement in the daily Press that at Washington last week, W. E. D. Stokes, of New York, the fourteen-year-old president of the Junior Wireless Club of America, appeared before a Committee of the United States Senate to defend the right of amateurs to transmit and receive wireless messages. It will be remembered that the Depew Bill, now before that assembly, seeks to give the Government the absolute control of wireless telegraphy. This right is strongly contested by the Junior Wireless Club, which has a membership of nearly 60,000—a circumstance which affords food for reflection. Technical societies of this sort are very popular in the United States and their members are very keen upon getting the best and most authoritative information and the most capable lecturers available. Many of their members become at sixteen or thereabouts practical experts in the particular branch of science they have taken up, and that is one of the reasons why so many young men in the States are to be found occupying positions which elsewhere are not taken up until middle-age. In this atmosphere the strenuous life begins at a very early age.

The New Electric Locomotives.

It is anticipated that by June 1, the bulk of the new giant electric locomotives constructed by the Westinghouse Company for the Pennsylvania Railroad will be ready for use in its New York tunnel-terminal system. There are twenty-four of these locomotives in all and they are now at the works of the Westinghouse Company in East Pittsburg, where they are being equipped electrically, the general mechanical work having all been done at the company's Altoona shops, where the cabs and locomotive bodies also were built. The type has been christened "Pennsylvania" since it is original with this company. The great machines patterned after it are built in two sections, each with two cabs and two sets of running gear, joined at the middle. Each section has eight wheels, four of which are drivers 68 in. in diameter, the other four being truck wheels 36 in. in diameter, constituting in the arrangement and weight distribution what in steam locomotives is known as the "American" type. Differing from steam practice, all rods and moving parts of the "Pennsylvania" type electric locomotives have pure rotation only, being thereby counterbalanced for all speeds and delivering no more shock to track and roadbed than an ordinary passenger car. The operating officials of the Pennsylvania Railroad Company confidently expect that trains will be running direct from Pittsburg into Manhattan by June, when the fruition of the late President Cassatt's stupendous enterprise, which will have cost upward of $100,000,000 by the time it is finished, will be realised.

IPSWICH ELECTRICITY DEPARTMENT.

Mr. F. Ayton, the Chief Engineer and Manager of the Electric Supply and Tramways Department, has issued his sixth annual report. The year's working shows a net profit, after meeting interest on capital and the instalment of repayment of same, of £1,080 6s. 5d. Out of this there has been set aside, by instruction, the sum of £105, as the last payment towards the cost of re-building the boiler settings, which work was rendered necessary soon after the commencement of working; and the further amount of £240 towards the liquidation of preliminary expenses suspense account. These were the expenses incurred in training the staff and getting ready to start the power station, etc. There is only one more similar payment to be made to liquidate this account. The surplus, after making the provision mentioned, is £735 6s. 5d., which has been put to reserve or renewals account.

The total capital invested in the undertaking is £89,041 11s. 2d., and the gross profit from the reserve account represents a return of 7·9% on this sum.

Excluding the installation department, the revenue has increased over that of the previous year by £1,457 10s. 7d., or 11·5%, which shows healthy and satisfactory progress. The expenditure shows an increase of £329 10s. 11d., or 4·7%. The sales in Board of Trade units for all purposes show an increase of 10·2%. The increase in lighting units is 24·9%, and for power (excluding traction supply), 8·9%.

The Admiralty Wireless Telegraph Station in Portmanwalk was connected up, and the supply commenced on August 14, 1909. The Admiralty later expressed in writing their appreciation of the manner in which the work had been carried out by the department.

Several extensions were made to the distributing mains during the year, a list being given.

The Free Wiring (Rental) System has now been in operation for upwards of two years, and during the past year has been the means of obtaining 51 out of the 128 new consumers connected.

The installation department has been kept well employed throughout the year. It will be seen that the value of work done (which does not include the value of free wiring work) has been £3,043 0s. 11d., showing a profit of £166 8s. 11d., which is included in the gross profit of the Electric Supply Department.

THE INSTITUTION OF ELECTRICAL ENGINEERS (Students' Section).—A tour has been arranged to take place from July 25 to July 30, 1910, to visit works in and around Birmingham.

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Business Notes and News.

LIGHTING AND GENERAL—Home.

BIRMINGHAM.—Out of the electricity department's surplus' £10,255 is to be paid in relief of rates, £9,000 to be placed to reserve, and the renewals fund to be increased by £2,000 as compared with last year.

BRIDLINGTON.—A Local Government Board inquiry has been held into the Corporation's application for powers to borrow £3,000 for extensions at the electricity works. The electricity department's last year's profits was £437.

BURY.—Fifteen months ago the Electrical Engineer recommended considerable extensions to the generating plant and mains, and he has now reported that delay is dangerous. The Electricity Committee recommended that no further steps be taken during the current financial year. An amendment, however, was carried instructing the engineer to procure the necessary estimates for carrying out the work.

COVENTRY.—Out of the Corporation's surplus of £10,238 (£6,000 increase on the previous year) in the electricity department, a bonus of a fortnight's pay is being given to the workmen.

DARLINGTON.—During the year just ended the total number of units of electricity sold by the department shows an increase of 20½% over that of last year. The increase in the number of units sold for lighting purposes was 12½%, for power purposes 43½%, and for traction and public lighting the number of units sold was practically the same as last year. The total income showed an increase of 7%, the increase for lighting was 9%, for power 18%, public lighting the same, and there was a decrease for traction of 7½%, owing to the reduction in price from 1½d. to 1d. per unit. Notwithstanding the increase in the charge for rates and taxes, and the reduction in price to the Light Railways Department, the gross profit was £7,402, as against £7,170 last year, and the net profit was £2,190, as against £1,933 last year. The gross profit amounted to 10¼% on the total capital employed.

DUBLIN.—The Irish Cattle Traders and Stockowners' Association are bringing strong pressure to bear on the Corporation Markets Committee to have the Cattle Market lighted by electricity, which is considered absolutely necessary from the business and humanitarian points of view.

DUNDEE.—A recent application by the Corporation Electricity Department of Dundee for increased borrowing powers to the extent of £50,000 has been granted by the Scottish Office.

GLASGOW.—It has been decided to purchase the 53,841 sq. yds. of ground on the west side of Dalmarnock-road from the Merrylee Property Investment Co., Ltd., at 8s. per sq. yd., for the purpose of erecting thereon an additional electricity generating station.

GRIMSBY.—A Local Government Board inquiry has been held into the application of the Corporation to borrow £2,000 for street lighting purposes by electricity. It was explained that it was proposed to substitute metallic filament lamps for gas. About 282 lamps would be charged. The inspector rather demurred to the proposal, as he considered the maintenance charges on the metallic filament lamps would be heavy.

HARROGATE.—With reference to last week's paragraph, it should be pointed out that the saving to be effected by converting 500 street lamps from gas to electricity is estimated at over £145 per annum. Schemes for gas illumination had been submitted by the local gas company, who demanded a 21 years' contract. The chairman of the Lighting Committee stated that the cost of gas lighting for all the streets under Scheme B amounted to £1,362 plus £150 salaries for two inspectors, while electric lighting, with better illumination, would come to £881.

NEWPORT.—The Corporation have decided to instal a 1,500 kw. turbine of the "Disc and Drum" type, running at 1,500 r.p.m.' built by Willans & Robinson, Ltd., of Rugby, and coupled to an alternator built by the General Electric Co., Witton.

ROTHESAY.—The electric light station is to be closed down in June in order to overhaul the engines and dynamos.

WAKEFIELD.—A Local Government Board inquiry has been held into the application to borrow £7,150 to extend the electricity undertaking. The Town Clerk explained that the loan was required in order to extend the plant capacity owing to the steady increase of consumers, especially for power, and it was also proposed to erect a permanent store room in place of a temporary one. The Inspector referred to the fact that there was a deficit on the electric light undertaking, and he questioned whether the Local Government Board would sanction further loans until this had been cleared off. He also stated that he desired further information with regard to the allocation of accounts, etc.; and with the object of getting this information the inquiry was adjourned *sine die*.

LIGHTING AND GENERAL—Overseas.

BUENOS AIRES.—The Compañia Electricidad de la Provincia de Buenos Aires has just purchased for one million dollars paper the electric plant which supplies current to Mar del Plata. The terms are $500,000 cash, and the balance in bonds bearing 6% interest per annum. When the agreement is definitely signed on July 1, the new company will immediately proceed to carry out several necessary improvements in the service, and to facilitate the work a local directorate will be appointed.

MELBOURNE.—Electric cranes are being installed at Spencer Dock by the Colonial Sugar Refining Co., under an arrangement with the Melbourne Harbour Trust. The company has leased a site there, and having discussed the Temperley transporter system, with Mr. Temperley, of Appleby, Ltd., it was decided that electric cranes were on the whole better suited to the particular work in view, and the Colonial Sugar Refining Co., therefore, placed an order with that company for two of these appliances.

NUWERA ELIYA, CEYLON.—Efforts are being made to introduce electric lighting generally. The proposal appears to be to extend the electric lighting station at the Queen's Cottage, which is under the management of Mr. Tom Lallyett.

PHILLIPPOLIS.—The Communal authorities will shortly invite tenders for an electric light installation, and for the construction of electric tramways.

TRACTION—Home.

BIRMINGHAM.—The Corporation Tramway Department's accounts for the year ended March 31 show that the gross profit was £111,990, which, after providing for interest and sinking fund payments, left a net profit of £56,442, which the committee propose to apportion as follows: £23,528 to be placed to the reserve fund, and to carry the balance, £32,914, to the Borough Fund. Last year the gross profit amounted to £105,403 and the net profit to £51,039, and £29,489 was carried forward to the credit of the rates.

DARLINGTON.—The Light Railway Department showed a very serious decrease—£473—in the total revenue as compared with the previous year, and a decrease of £1,236 as compared with the year ending 1907. The working expenses showed an increase of £275, due entirely to the greater cost of permanent way repairs, and the net loss showed an increase of £734. Since March, however, there has been a steady increase of traffic.

LONDON.—Negotiations between the London County Council and the West Ham Corporation, East Ham, Walthamstow, Ilford and Leyton District Councils having been brought to a satisfactory conclusion, a through service of electric tramway-cars from Leytonstone and Ilford to Aldgate has now been opened.

TRACTION—Overseas.

BUDAPEST.—The Budapest Tramways Co. ("Budapester Strassenbahn-Gesellschaft") intend as soon as possible to increase the capacity of their central generating station from 6,500 kw. to 13,000 kw., at a cost of 4,500,000 kronen (£187,500).

LA PLATA.—The plans presented by the National Tramway Co. in La Plata for the exchange from horse to electric traction have been approved.

PRAGUE.—The municipal authorities are about to spend a million and a half kronen (£62,500) on the construction of an electric tramway.

COMPANIES' MEETINGS AND REPORTS.

CHLORIDE ELECTRICAL STORAGE.

The directors of the Chloride Electrical Storage Co., Ltd., have declared a dividend at the rate of 6% upon the Preference shares.

ALDERLEY AND WILMSLOW ELECTRIC SUPPLY.

The report presented to the general meeting showed that further progress had been made with the business. The year's profit amounted to £1,856 18s. 1d. After paying £1,352 10s. 6d. interest on Debentures and loans, £500 was placed to reserve fund, and the balance, £4 8s. 5d., carried forward.

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MUSSELBURGH AND DISTRICT ELECTRIC LIGHT AND TRACTION.

The directors' report states that the accounts for the year to December 31 show an available sum, after providing for Debenture interest, and including £131 brought forward, of £3,811. The directors recommend the transfer of £2,000 to reserve and renewals fund, and to carry forward £1,255, which will permit of a dividend of 2½% on the Preferred shares.

WESTERN TELEGRAPH.

The meeting of the Western Telegraph Co., Ltd., was held at Electra House, E.C., Sir John Wolfe Barry presiding. The Chairman said the receipts from messages showed an increase of £43,408 and from other sources £4,428. The prospects for the current half-year were good, but they were committed to a reduction of traffic to South America on June 1 next which would entail considerable loss of revenue unless traffic increased proportionately. Expenses in London were more by £183, abroad by £5,683; cost of maintaining cables was more by £2,604, and income-tax by £1,897. An analysis of the accounts showed that the increase was due to higher salaries, the employment of a larger staff to deal with growing traffic, contributions to the pension fund, and similar causes. Decreases were shown in the cost of maintenance of land lines, repairs to buildings, and one or two other items. The new cable between Ascension Island and the River Plate had been successfully completed, the expenditure on it being partly met out of reserve fund and partly by the issue of debenture stock.

ANGLO-ARGENTINE TRAMWAYS.

The gross receipts for 1909 amounted to £1,938,887, and working expenses to £1,207,222. The amount brought forward from 1908 was £12,839. Interest on Debentures of amalgamated companies produced £16,728, and sundry items, as per net revenue account, £7,370. After deducting annuity to "City Co." 4% Debenture stock interest, 4% Debenture stock sinking fund, 4½% Debenture stock interest, 5% first Preference dividend, 5% Second Preference dividend, rent of Metropolitano tramways, nine months, and sinking fund for redemption of share capital, amounting in all to £627,631, there is a balance of £140,972. The interim dividend on 300,000 Ordinary shares and on 260,000 Ordinary shares for six and three months, both ended June 30, 1909, being at the rate of 6% per annum, absorbs £60,000, leaving a net balance of £80,972. Out of this the directors recommend that a final dividend be paid on the 500,000 Ordinary shares for the half-year ended December 31, 1909, at the rate of 6% per annum, less income-tax, which will absorb £70,625, leaving £10,347 to be carried forward to 1910. On April 1, 1909, the company took over the working of the Grand National, La Capital, La Capital Extensions, La Nueva, and the Metropolitano Tramways, thus completing "the fusion," and from that date the various undertakings have been worked as one consolidated system, the present total length of the combined tramways being 332 miles of single track. The great development of the company's traffic so increased the congestion in the narrow streets in the heart of the city that the company considered it advisable to apply to the municipality for a concession for the construction of certain subways, and a contract has been concluded with the municipality. In order to provide the necessary funds for the construction of the subways, the purchase of the Metropolitano Tramways, the further extensions which may be necessitated by the growth of the city, and for other capital purposes, the directors ask for power to create and issue £6,000,000 of 5% Debenture stock, to rank after the existing 4½% Debenture stock, and to increase the Second Preference share capital by £500,000 and the Ordinary share capital by £1,500,000. It is also proposed to increase the dividend on the First and Second Preference shares respectively from 5 to 5½%.

WOKING ELECTRIC SUPPLY CO.

The annual meeting of the Woking Electric Supply Co., Ltd., was held at the offices of the company. Mr. John Ashby (chairman) presided, supported by Mr. Henry W. Bowden, M.I.C.E., M.I.E.E. (director), Mr. J. G. McLean, M.I.E.E. (engineer and manager), and Mr. W. Strayton (secretary).

In their report for the year ended December 31, 1909, the directors showed the position of the company to be as follows:—

Revenue.—Total revenue for the year ending December 31, 1909, £13,837 0s. 9d.; expenditure connected with the generation and distribution of electricity and management, £6,948 1s. 3d., showing a balance on the year's working of £6,888 19s. 6d., to which has to be added £706 11s. 1d., the amount brought forward from last year, making a total of £7,595 10s. 7d., which sum the directors propose to appropriate as follows: Payment of interest on the 4½% debentures, £2,101 4s. 2d.; payment of interest on temporary loans, £549 1s. 5d.; payment of dividend on the 6% cumulative preference shares to December 31, 1909 (six months to June 30, 1909, having been paid on October 1, 1909), £2,131 7s. 4d.; payment of a dividend of 5% per annum on the ordinary shares to December 31, 1909 (six months to June 30, 1909, having been paid on October 1, 1909), £1,037 2s. 10d.; to depreciation fund account, £1,000; to reduction of cost of Provisional Order, etc., £28 15s. 2d.; ditto fire appliances, £4 0s. 6d.; ditto debenture issue expenses, £34 2s. 10d.; ditto share prospectus expenses, £66 13s. 4d.; ditto office furniture, £25 7s. 6d.; leaving a balance to be carried forward to the credit of profit and loss account of £617 15s. 6d.

The following table shows the rate at which the company's business has progressed during the last six years: 1903, number of consumers, 660; lamps connected, 25,010; revenue, £7,951 15s. 10d.; 1904, 783, 29,566, £10,340 19s.; 1905, 880, 33,735, £11,476 11s. 3d.; 1906, 1,003, 40,030, £12,296 10s. 9d.; 1907, 1,109, 45,305, £14,130 18s. 3d.; 1908, 1,225, 51,070, £14,452 17s. 10d.; 1909, 1,348, 55,089, £13,740 8s. 4d.

Capital.—It will be seen from the balance sheet that during the year the directors have issued £1,475 4½% debenture stock, £3,965 6% cumulative preference shares, and £525 ordinary shares. Owing to the rapid and continuous growth of the business of the company, the directors are still looking towards issuing further debenture stock, preference and ordinary shares. The expenditure on capital account on December 31, 1909, amounted to £122,174 16s. 3d. During 1909 eight miles of cable have been laid down throughout the company's area.

LEAMINGTON AND WARWICK ELECTRICAL.

The report for the year ended December 31 last states that the capital expenditure during the year amounted to £798 1s. 5d. in respect of cables, mains, etc., for the supply of electricity in the borough of Warwick, and other equipment. The working accounts show a credit balance of £5,504 16s. 9d. from the tramways and electricity supply, and interest and sundry receipts amount to £160 1s. 1d. Deducting therefrom the administration and general expenses amounting to £1,281 2s. 5d. (including £10 2s. 6d. payment to the superannuation fund), and interest on debentures and £350 provision for renewals, there remains a balance of £2,458 15s. 5d. To this has to be added the sum of £282 16s. 5d. brought forward from the last account, making a total amount available for distribution of £2,741 11s. 10d., which the directors recommend should be applied as follows:—Amount to be placed to depreciation and reserve account, raising it to £5,400, £800; amount to be placed to the sinking fund for redemption of debentures (making £1,087), £350; dividend of 5% on the Cumulative Preference shares for the year, £120 10s.; dividend at the rate of 2% on the ordinary shares for the year, £1,351 16s.; balance to be carried forward to next account, £119 5s. 10d. The directors recommend that the discount in respect of the issue of Debenture bonds amounting to £1,750 should be written off out of the depreciation and reserve account, which will then amount to £3,650. Before arriving at the profit, the directors have debited the profit and loss account with a sum of £350, which has been placed to renewals account. This account now stands at £1,050. The unsatisfactory weather that prevailed during a portion of the year had an adverse effect on the traffic receipts, but there is a slight increase compared with last year of £190 16s. 5d., due to increased motor char-a-banc earnings. The supply

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of electricity has progressed during the year, and the number of installations connected at December 31 was 206, exclusive of the tramway load, and is equivalent to 7,870 8-c.p. lamps, compared with 7,402 8-c.p. lamps at December 31, 1908. The gross revenue from the sale of current, etc., was £2,705 4s. 4d., compared with £2,558 0s. 4d. in the preceding year, and the net revenue £884 4s. 9d., compared with £512 18s. 3d. in the preceding year. Every endeavour is being made to improve this part of the company's business, but the depressed state of trade in the district during the past year has made the extension of the business slow. Mr. J. W. Mann, the director retiring by rotation, being eligible, offers himself for re-election. Mr. S. E. Garcke has been appointed a director subject to confirmation.

JOHNSON & PHILLIPS.

The fifth annual general meeting of Johnson & Phillips, Ltd., was held at Winchester House, Old Broad-street, E.C., Mr. Robert W. Blackwell, Chairman of the Company, presiding. He said: Gentlemen, this is our fifth annual report, and you have, of course, seen from the balance-sheet which has been placed before you that the profit for the year on trading accounts, etc., after making provision for bad and doubtful debts, and after charging to revenue upwards of £3,691 for maintenance of buildings, plant, etc., amounts to £15,359 7s. 6d. The balance which was brought forward in 1908 was £681 2s., leaving at the disposal of the company £16,040 9s. 6d. From this there has to be deducted the remuneration of directors, auditors, and trustees, the interest on the Debenture stock and reserve for the Debenture Sinking Fund which is imposed upon the company by the Trust Deed under which the Debentures were made, and the interest on certain Second Debentures to December 31, 1909. These make up a total of £15,098 1s. 4d., leaving us to carry forward to the next account the balance of £942 8s. 2d. During the year we have just passed through, the company's business has improved to a certain extent. It has not, of course, improved to the extent we desire, but we have made a profit for the year over and above that of the preceding year of £5,322. It was the expectation and hope of your directors that the past year would turn out much better. It was, however, the case that for the last four to five months of the year practically all orders seemed to cease, and business was practically at a standstill. I think that has been the case in almost every concern which has anything like a similar business to ourselves. Of course, orders being slow, competition was much greater, and the business that was taken during the year was taken at prices which were distinctly low throughout, while, as you probably know, both copper and rubber, which are portions of our manufacture of all importance, were ruling exceeding high. During the time of the company's existence, which is now five years, we have set aside for depreciation on our machinery and plant the sum of £18,200, and, furthermore, under the conditions of the Trust Deed which governs the Debentures of Johnson & Phillips, we have spent a further sum of £18,652, which has been provided out of profits, and which has redeemed Debentures to the extent of £20,390. Under those circumstances it seemed to the Board that it was unnecessary that a special fund should be written off this year for depreciation, but I may say that during the entire year we have devoted great attention to the keeping up of the plant, and have made such improvements and changes as were necessary, and have attended to maintenance out of the current revenue. For the present year things are looking fairly well. We are busier in the shops than we have been for a long time past, and we sincerely hope that the profit balance for the present year will certainly be greater than it was last year, and will more or less bring us back to the point at which we were a few years ago, before this great commercial depression struck the country. It is, of course, absolutely essential that everyone shall bear in mind the business uncertainty which arises out of the lamented death of the late King. What effect that may have on trade, what may result from the loss which the country has sustained it is, of course, impossible to prophesy at the present moment. I should like to move "That the report of the directors produced together with the annexed statements of the company's accounts at December 31, 1909, duly audited, be received, approved and adopted."

Sir Henry Benbow, K.C.B., D.S.O., R.N., seconded the motion.

The Chairman having invited shareholders' remarks,

Mr. Baldwin said there was one thing which he thought was satisfactory to the shareholders, and that was to see Mr. Johnson on the other side of the table. That should be a good augury, notwithstanding the fact that Mr. Johnson had in the past, he believed, taken a great interest in the affairs of the company. The profit of 1908 was very small, and that for 1909 was certainly more satisfactory; but he must say that it fell far short of the estimates given in the prospectus. Then, with regard to the Second Debentures, was it impossible for the directors to arrange the affairs of the company in any way without making this issue? It seemed rather unsatisfactory to think that the company had started with a cash working capital of £40,000, which he supposed had all been sunk in buildings and improvements, and that the directors had found it necessary to issue Second Debentures to the amount of £37,000, which he believed had been done shortly after the previous general meeting. He thought the shareholders generally would like to see that item disappear, if it were at all possible. He had no doubt that the directors would do all in their power. They had a strong Board, and Mr. Dence, he hoped, would be able to influence business in some way to the benefit of the company. He thought it would be satisfactory to the shareholders to know when the Second Debentures were issued, and whether any further issue of Second Debentures was contemplated. Further, if it would not be prejudicial to the interests of the company, he would like to know to whom the Second Debentures had been issued. He thought it would have been well if they had been offered to the present shareholders, if possible. The 7½% interest which was being paid would have been very acceptable to them.

The Chairman, in reply, said that the Second Debentures had merely been issued as security for a loan of £24,660, and had been entirely taken up by certain of the principal shareholders. The interest that was being paid was 5% per annum, not on the £37,500 of Debentures, but on the amount of £24,660 borrowed only. The company had the right at any time to cancel these Debentures. It was an arrangement which had been made for the convenience of the company, giving them capital at a moment when it was required for certain trade necessities, and was open to cancellation at any moment at the option of the company.

The resolution was unanimously adopted.

The Chairman said that for many years it had been his pleasant duty to refer to the assistance rendered to the company by Mr. W. Claude Johnson. It had always been the desire of the directors, however, that they should be placed in a position in which they could more fully and regularly avail themselves of that gentleman's assistance, and it was, therefore, a very interesting statement to be able to make that some time ago Mr. Johnson had consented to take a seat upon the Board, and to become more or less active in the management of the company. Mr. Dence, who was one of the largest shareholders, had also consented to take a seat on the Board, and the other directors were very glad to welcome him as a business man of known capacity and of influence and standing. It was necessary that the election of these gentlemen should be confirmed by the shareholders, and he, therefore, moved a resolution to that effect.

Mr. John D. Bonner, in seconding the motion, said that, in agreeing to the proposition, the shareholders would really be conferring a favour upon themselves.

The resolution was unanimously adopted.

Mr. W. Claude Johnson expressed his great pleasure and satisfaction at being elected to a seat on the Board. Everyone present probably knew how long he had been associated with the progress of the business and with the formation of the company. Since the concern was converted into a limited company he had never lost interest in its progress, and had done what he could to assist the Board of Directors. He would now feel it his duty to exercise further energies, with the assistance of his old friend, Mr. Dence, to bring about a prosperous state of things in the future. He thanked those who had been instrumental in bringing about his election, and assured them that all his heart would be in the concern.

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Mr. Thomas Dence, in returning thanks for his election, said he had for a long time felt that this company, in not having Mr. Johnson as one of its directors, was without its right hand, as it were. Mr. Johnson had made the business and had carried it on successfully for a number of years. He was a gentleman of great inventive and technical capacity, and it was an element of great strength for the future that the company should have him as one of its directors. He (Mr. Dence) was not at all downhearted about the future of the business. He thought it was destined to have a great and profitable future. Other companies carrying on similar businesses were successful, and he saw no reason why this should not be equally successful. Electrical engineering was not an effete industry, but a thing of the future. It was a thing that would progress more and more, and he did not doubt that this company, along with others of a similar class, would share in that progress.

Mr. Batkin said he supposed the shareholders might take it for granted that no further Second Debentures were contemplated.

The Chairman replied that there was no suggestion of any further Debentures whatever.

Mr. Johnson next moved the re-election of the retiring director, Mr. R. W. Blackwell. In doing so, he said he was sure they could never get a better Chairman.

Mr. Dence seconded the motion, which was unanimously adopted.

The Chairman, in returning thanks, said he hoped that in future he would be able to present better reports than unfortunately had been possible for the last year or two.

Mr. Charles Fox proposed a vote of thanks to the Chairman for presiding, and to him and his colleagues for the way in which they had conducted the company's affairs.

The motion, which was seconded by Mr. Batkin, was unanimously adopted.

The Chairman thanked the shareholders on behalf of his colleagues and himself, and added: We have done the best we could in the interests of Johnson & Phillips throughout our incumbency of the position, and, we trust, with the able assistance of the gentlemen who have lately joined the Board, that we shall be able to do better in the future.

The proceedings then terminated.

FINANCIAL NOTES.

CANADIAN GENERAL ELECTRIC CO.—The directors of the Canadian General Electric Co. have decided to issue 9,400 of the 10,000 $100 Common shares at present held in reserve. This information is contained in a circular recently issued, which states that the existing plant and accommodation are insufficient to meet the growth of the company's business, and that the directors have, therefore, decided to extend their premises and equipment. The new shares are to be offered at par in the proportion of one for every five shares now outstanding, the current price of which is $110. Consequently, the terms on which the new issue is being made represent a bonus of about $2 in respect of each of the Common shares now on the market. All holders of Common shares registered on the 21st inst. will be eligible for participation in the new issue. The announcement now made by the directors of this company may explain the drop which has recently occurred in the price of the Common shares, though in view of the growth of the company's business a recovery is not improbable.

JAPAN-BRITISH EXHIBITION.

In the Marine Section at Stand M 52 the Parsons Marine Steam Turbine Co., Ltd., Wallsend-on-Tyne, and Messrs. C. A. Parsons & Co., Heaton Works, Newcastle-on-Tyne, are making an elaborate display, comprising the following: *Models*—(1) Model showing the interior of engine room of a four-shaft arrangement of turbine machinery, as fitted in large war vessels. The arrangement consists of two complete sets of engines, one set on each side of the vessel, with an astern turbine fitted on each shaft and a cruising turbine on the inner shafts. (2) Model showing the interior of an engine room of a two-shaft arrangement. The arrangement consists of a complete turbine as an independent unit on each side of the vessel.

Photographs.—(1) The *Turbinia*, the first vessel to be fitted with Parsons' marine steam turbines; (2) the *Mauretania*, with the *Turbinia* lying alongside: this photograph gives one an idea of the progress made with Parsons' marine turbines; (3) H.M.S. *Dreadnought* fitted with turbines constructed by the Parsons Marine Steam Turbine Co., Ltd., of Wallsend-on-Tyne; (4) a low-pressure Parsons' marine steam turbine, with cover raised; (5) a portion of the machine shops of the Parsons Marine Steam Turbine Co., Ltd., Wallsend-on-Tyne.

In 1894, the *Turbinia* was the only vessel fitted with Parsons' turbines, whilst at the present time the total horse-power of Parsons' marine turbines, constructed and on order, amounts to about 4,000,000.

From the Heaton Works we find: (1) 120 kw. direct current dynamo, fitted with Parsons' patent compensating winding and carbon brushes; dynamos of this type, aggregating more than 80,000 kw., have been supplied for lighting, power, and tramway work, the largest being tandem plants of 2,000 kw. capacity; this compensating winding is in series with the armature, and prevents all distortion of the magnetic field, and is instantaneous in its action. (2) Exhaust steam turbo blowing engine, output 20,000 cubic ft. of free air per min., at 10 to 20 lbs. pressure per square inch; the air turbine is of the parallel flow type, many of which have been supplied for iron and copper smelting in various parts of the world, including Australia, India, China, and Japan; exhaust steam is practically a waste product in many works, so that a plant of this nature is very cheap to run. (3) Turbo-alternator—Most economical output, 7,500 kw.; maximum output, 14,000 kw. (4) Turbo-alternator—Most economical output, 2,000 kw.; maximum output, 4,000 kw. (5) Turbo-alternator—Most economical output, 3,500 kw.; maximum output, 7,000 kw.

We hope to return to the subject in an early issue.

INSTITUTION OF ELECTRICAL ENGINEERS.
Annual Meeting.

The Annual Meeting of the Institution of Electrical Engineers will be held at 8 p.m. on Thursday, May 26th, at the Royal Society of Arts, John Street, Adelphi, when the Annual Report and Statement of Accounts will be presented, and the election of the Council announced.

PATENTS.

CORRECTION.—In our list of Patents published last week the three "1794—1909, 2608—1909, 4171—1909," should each bear the date 1910.

Distribution of Electrical Energy.

27856.—1908. A. E. TANNER & E. A. CLAREMONT, Old Trafford This is a system for distributing electrical energy by alternating current consisting of cables furnished with pressure distributing conductors. The cross sectional areas of the main conductors and of each of the pressure distributing conductors bear ratio to one another in proportion to the current to be carried. The pressure distributing conductors are composed of two layers of tapes wound spirally and overlapping so that the centre of the tapes in one layer overlap the edges of the tapes in the other layer. These conductors are graded in cross section inversely with the distance from the connection to the device supplying pressure to them, and are connected to these devices at both ends of the system and at intermediate points.

Fixings for Electrical Wires.

5891.—1909. J. J. RAWLINGS, H. W. HANDCOCK & A. H. DYKES, Westminster, S.W. This is a clip provided with a central saddle, which fits over the electric wires, and two side pieces or lugs. The lugs are bent to form a tube. A hole is driven through the outer and inner sides of the lugs. The head of the nail or screw which attaches the clip to the wall or other surface rests on the outer portion of the tube and is thus prevented from being driven too far into the wall.

Producing Indications by Received Electro-magnetic Waves.

6008.—1909. R. E. FESSENDEN, Brant Rock, U.S.A. This is an improved receiver of the type in which the received waves produce an alteration in the traction between two relatively moving bodies. The tractional effect is varied in this apparatus by causing the electro-magnetic waves to excite a small electro-magnet, and is dependent on this magnetisation and not upon a hysteresis effect requiring for its operation the demagnetisation of a constantly remagnetised magnet.

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Quick Make and Break Electric Switches.

8692.—1909. H. Rose, Erdington. The switch blade operates between standards and is controlled by an operating handle which in turn imparts motion to quadrants pivoted on the same bearing as the switch blade. Attached to the switch blades and the quadrants are spiral compression springs and these when operated give a rapid movement to either the on or off position and lock the blade in either of such positions.

Electric Distribution Systems.

8979.—1909. British Thomson-Houston Co., London, E.C. This is an improvement in means for controlling earth connections of electric distribution system and refers chiefly to the earthing of the mid-points of generators. The invention consists primarily in the employment of double throw switches so connected that whilst several machines may be running only one will be earthed. The switches are so arranged that they assume one position on all dead machines and only cause connection of the neutral point of one machine through the resistance to earth.

Filament Lamps.

9318.—1909. S. Horvath, Southfields, S.W. The lamp has an outer globe part of which serves as a reflector. The globe is in the form of a flattened spheroidal shaped glass cover silvered at the back, and is so arranged that the lamp is brought with its longitudinal axis parallel and close to the flattened silvered curvature of the reflector. It is claimed that a much better concentration of light is obtainable with this construction of lamp than hitherto possible.

Control of Electric Motors.

9338.—1909. Felten & Guilleaume Lahmeyerwerke A.G., Frankfort a/Main. This is an improved electric reversing driving gear in which the reversing of the direction of rotation is effected by reversing the driving motor, and the regulation of the speed is effected by a machine adapted to act in opposition to the source of current and working in such a manner that the strength of current of the system cannot exceed an admissible value on the direction of rotation being reversed.

Electric Candle Lamps.

10288.—1909. J. J. Rawlings, South Kensington, W. The lamp is held in the candle fitting by means of springs attached to a plug fixed by means of taper metal screws which operate in the threads of the screws and engage on the inside of the sconce.

Producing Electric Currents.

10793.—1909. Dr. B. Schwerin, Frankfort. This is a process for generating electric currents by forcing liquids through layers of electrically active substance. The conductivity of the layer and the liquid is regulated by the use of electrolytes which are bases for electro-negative bodies and acids for electro-positive bodies, whereby the desired current conditions can be obtained. The liquid is passed through the layer, which is formed of very finely divided substances, at a high pressure. The liquid which gives the desired conditions of current is used repeatedly.

Electric Current Distribution.

11413.—1909. J. Penson, Birmingham. This is an electric current distributor of the type used for controlling the ignition current to the cylinders of internal combustion engines. The object is to provide a distributor which enables the contacts to be readily and individually adjusted in order to obtain synchronism in the ignition of multi-cylinder engines more readily, and to reduce frictional resistance to a minimum, and at the same time permit the distributor to be used with voltage systems generated by any convenient means, or high tension distribution.

Electric Fuse Carriers.

11954.—1909. C. H. Hatrey, Hampstead, N.W. This is an improvement in fuse carriers of the class in which blown fuses are automatically replaced. The carrier has terminals mounted upon it so that it may be used on an ordinary distribution board. A number of fuse wires are arranged in the carrier and are adapted to be arrested and maintained in succession in working position by a member mounted on a carrier adapted to directly engage the fuse.

Electric Motors for Driving Models.

12063.—1909. J. S. Parker, High Holborn, E.C. On the end of the spindle of a wound armature is a wire pinion. On the main spindle of the model is a toothed wheel which receives movement from the pinion. By this means the speed of the main spindle is less than that of the armature.

Trolley Heads.

15147.—1909. E. H. Cockshott, Leeds. The globe spindle is formed hollow and is closed at the top. The spindle socket has a hole through the bottom. An inner spindle is inserted upwards through the hole into the hollow of the globe spindle. Both spindles are secured together by a screw pin. This method of construction simplifies the operation of applying the trolley wheel on to the trolley wire.

Electrically Driven Centrifugal Fans.

16476.—1909. Alldays & Onions Pneumatic Engineering Co., Ltd., Birmingham. The fan casing is formed in two symmetrical halves bolted together by screw bolts which pass through holes in projections in the periphery of the casing. The casing is secured to a ring like supporting plate. This plate is bolted directly on to the bedplate on which the electro-motor is fixed. The central hold of the plate is the same diameter as the inlet openings in the opposite sides of the fan casing.

Telephone Transmitters.

17368.—1909. F. Gottschalk, New York. Between the apertured mouthpiece and diaphragm is a device for concentrating the sound waves produced by the voice at one point on the diaphragm. This prevents dust and germs reaching the diaphragm and ensures a clearer and more sensitive operation of the instrument.

Electric Fuse Indicators.

19209.—1909. British Thomson-Houston Co., Ltd., London. The indicator comprises a fibrous material treated with an oxidising salt and coated with a non-hygroscopic material. An air chamber is formed in the outer wall of the electric fuse, an auxiliary fuse member crosses the chamber, and the indicator is disposed in contact with the auxiliary fuse and extends over the air chamber.

Electric Switches.

19826.—1909. E. Lundsteen, Copenhagen. This is an improved switch of the kind where connection with one of the wires is to be maintained until the connection with the other wire is closed, after which the connection with the first wire is severed at once. The revolution of the switch lever is effected by means of an auxiliary lever in electric connection with one of the wires and in contact with the switch lever until the latter has come into connection with the other wire, after which the auxiliary lever returns to its original position.

Alternating Current Commutating Dynamo Electric Machine.

20005.—1909. Siemens Schuckertwerk, G.m.b.H., Berlin. In single-phase shunt or separately excited alternating current conductor dynamo electric machines, improved arrangements are provided for regulation which consist in a winding on the stator or field magnet system in inductive relation to the armature windings, and are supplied with a voltage of such magnitude and phase that the electro-motive force of self-induction in the armature windings is partly or completely neutralised by transformer action between the winding on the stator system and the armature windings.

Polyphase Commutating Dynamo Electric Machines.

21540.—1909. Siemens Schuckertwerk G.m.b.H., Berlin. This is an improvement in a polyphase series connected commutating dynamo electric machine which has stator and rotor windings connected electrically through series transformers. The exciting ampere turns are produced partly by the stator and partly by the armature windings in a manner which depends on the position of the brushes around the commutator. The stator and armature windings are arranged in such a manner that for one position of the brushes around the commutator the ampere turns per degree of arc in any portion of the circumference of the 'stator winding are exactly equal and opposite the ampere turns per degree of arc in the corresponding portion of the circumference of the rotor or armature winding.

End Connections of Rotor and Stator Bars of Dynamo Electric Machines.

27641.—1909. British Electrical Engineering Co., Ltd., Kingsway, W.C. This is an improved means for securely connecting together the end connections of rotor and stator bars against vibration. A rectangular tube is placed over the two bars and the ends of the bars are saw-cut where they pass through the tube, and a wedge piece is driven between them. The edge of the sawn cut bars are bent over to lock the wedge and connecting tube in position.

Telephone Relays.

65.—1910. C. Stille, Wilmersdorf. Between the poles of the magnet are two opposite wound spools, each equipped with a carbon member having a cavity facing the cavity of the opposite member. The cavities are filled with carbon balls which form microphonic contacts. Any weak current traversing the spools tends to adjust the magnetic axis of the spools coaxially with the direction of the constant magnetic field. Since the spools are oppositely wound they move against one another and influence the contact member located between the spools.

Bearings for Spindles of Electric Measuring Instruments.

2031.—1910. British Thomson-Houston Co., Ltd., London, E.C. The top end of the spindle is bored to accommodate a pintle carried by a spring secured to a bracket through a hole in which the pintle passes. If the spindle vibrates the spring and pintle also move slightly so that the vibrations will be damped.

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TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns per week.			Increase or decrease.		Miles of track open.		Accounts for past year.							Cost per car mile.
	Ending	1909-10.	1908-9.	Week.	Current year.	1909.	1908.	Ending	Total receipts.	Passengers carried.	Car miles run.	Receipts per Passenger.	Receipts per Car mile.	Receipts per Mile of track.	
		£	£	£	£				£						
Aberdeen Corporation	May 11	1,295	1,342	+ 46	— 726	27½	27½	May 31	71,930	17,517,304	1,566,119	·98	11·02	4,940,	5·93
Ayr Corporation	Sept. 18	671	562	+ 108	—	8	8	—	—	—	—	—	—	—	—
Baker Street and Waterloo Ry.	Nov.	8,141	6,070	+2,071	—	4·25	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	May 8	1,137	1,133	+ 4	— 281	24·003	13·52	—	—	—	—	—	—	—	—
Birmingham Corporation	May 7	6,825	6,394	+ 431	—	56·792	58·52	—	—	—	—	—	—	—	—
Blackburn Corporation	Oct. 6	1,100	1,298	— 173	—1,036	24·53	28·3	—	—	—	—	—	—	—	—
Blackpool Corporation	Aug. 26	2,152	2,050	+ 102	+ 732	—	—	—	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams	„ 8	2,304	2,309	— 24	—	—	—	—	—	—	—	—	—	—	—
Bolton Corporation	Oct 10	2,416	2,337	+ 79	— 259	42	42	Mar. 31	117,799	25,492,902	2,492,147	1·1	11·34	2,804	6·50
Bournemouth Corporation	July 21	1,681	1,723	— 42	— 23	29½	29½	„ 31	86,225	13,991,328	1,766,068	1·47	11·71	2,912	7·22
Bradford Corporation	May 7	4,937	4,733	+ 204	—1,504	98	54·81	„ 31	235,258	47,839,569	5,331,007	1·17	10·59	2,378	—
Brighton Corporation	May 8	788	878	— 90	— 785	9·5	—	—	—	—	—	—	—	—	—
Bristol Tramway Company	May 13	5,356	5,331	+ 25	—	57	51½	Dec. 31	265,362	46,652,389	5,756,842	—	—	—	—
Burnley Corporation	May 14	1,227	1,235	— 8	—	19½	19½	Mar. 31	64,261	12,355,958	1,202,330	1·23	12·83	5,971	7·92
Burton Corporation	May 8	251	254	— 3	— 74	6½	6½	„ 31	14,918	3,221,595	430,913	1·04	8·30	1,460	5·85
Cardiff Corporation	April 3	2,000	1,957	+ 43	—	—	—	„ 31	109,979	25,058,146	2,497,169	—	10·57	—	—
Carlisle Tramways Company	June 19	170	175	— 5	— 89	—	—	—	—	—	—	—	—	—	—
Central London Railway	May 7	5,720	5,352	+ 368	+ 740	6·32	6·32	Dec. 31	350,150	41,898,373	1,456,781	2·01	5·769	55,404	30·27a
Charing X, Euston, & Hamp. Ry.	Nov.	6,822	6,092	+ 730	—	7·75	—	—	—	—	—	—	—	—	—
City and South London Railway	May 8	3,175	2,957	+ 218	— 174	7·26	7·26	—	—	—	—	—	—	—	—
Colchester Corporation	July 14	200	219	— 39	—	8	—	Mar. 31	10,983	2,308,721	349,539	1·09	7·74	1,477	6·56
Cork E. T. and L. Company	May 12	450	—	+ 450	+ 1245	9·89	9·89	Dec. 31	24,044	5,737,478	896,945	—	6·43	—	4·43
Croydon Corporation	April 29	1,562	1,424	+ 138	— 169	11½	—	Mar. 31	74,132	16,277,418	1,884,137	1·06	9·56	3,703	7·109
Darwen Corporation	Oct. 1	239	256	— 17	— 201	7·23	7·23	„ 31	13,899	2,557,654	245,584	1·30	13·68	1,922	9·40
Dover Corporation	Sept. 18	230	252	— 22	— 395	7	—	„ 31	11,593	2,697,672	316,754	·98	8·78	—	—
Dublin and Lucan Electric Ry.	May 13	125	145	— 20	+ 17	7	7	—	—	—	—	—	—	—	—
Dublin U.T.	May 6	5,485	5,249	— 236	+ 3,190	54½	54½	—	—	—	—	—	—	—	—
Dundee City Tramways	Oct. 6	1,332	1,305	— 27	— 569	—	26½	May 15	60,573	16,367,911	1,281,552	·875	1·9	2,371	7·46
East Ham Corporation	May 7	996	1,012	— 16	— 152	15	15	Mar. 31	47,430	15,355,703	1,091,586	·73	10·26	—	6·96
Glasgow Corporation	May 7	18,051	17,978	+ 73	+ 3,533	192½	189	May 31	907,494	226,948,290	20,766,722	·96	10·49	5,080	5·86
Gloucester Corporation	Oct. 6	395	425	— 30	+ 535	15	—	—	—	—	—	—	—	—	—
G.N., Piccadilly and Brompton	Nov.	13,429	9,354	+ 4,075	—	9·25	—	—	—	—	—	—	—	—	—
Halifax Corporation	—	—	—	—	—	52·574	37	Mar. 31	81,872	20,378,672	1,786,390	11·40	11·13	1,528	8·40
Huddersfield Corporation	Dec. 4	1,613	1,357	+ 256	+ 2,663	28	28½	„ 31	84,704	16,200,020	1,960,329	1·29	10·37	2,421	5·10
Hull Corporation	May 14	2,608	2,330	+ 277	+ 375	29	26	„ 31	128,722	30,964,254	3,022,844	1·	10·22	—	6·04
Ilford Corporation	Feb. 12	451	391	+ 60	+ 1,969	10	10½	„ 31	25,328	6,385,466	634,446	·87	9·58	2,066	6·42
Ilkeston Corporation	May 11	116	121	— 5	— 89	4	4	„ 31	7,214	1,968,850	198,415	9·1	7·9	1,803	7·04
Kirkcaldy Corporation	Sept. 8	269	266	— 7	—	7½	7½	May 15	14,993	4,874,199	459,066	·711	7·838	1,856	5·26
Lancashire United Tramways	May 11	1,198	1,313	— 115	— 206	39	39	Dec. 31	68,904	12,554,593	2,244,344	—	—	—	—
Leeds Corporation	Sept. 18	6,896	6,624	+ 272	+ 3,662	108	96½	Mar. 31	340,368	75,734,083	7,694,989	1·06	10·62	3,527	5·51
Leicester Corporation	Sept. 11	2,162	2,130	+ 32	—	—	—	—	—	—	—	—	—	—	—
Liverpool Corporation	Nov. 19	10,803	10,687	+ 116	— 1 977	109	104	Dec. 31	572,822	124,043,239	12,231,799	1·108	11·24	5,508	7·94
Liverpool Overhead Railway	May 8	1,407	1,344	+ 63	+ 223	6·65	2·40	June 30	79,004	11,171,515	1,106,386	—	—	—	—
London County Council	April 30	40,744	35,597	+ 5,147	+ 18,429	132½	123½	Mar. 31	1,274,660	279 166,461	25,591,028	1·08	11·74	—	6·79
Lowestoft Corporation	Dec. 11	155	150	+ 5	+ 30	3½	—	Sept. 30	11,399	2,645,206	370,320	1·03	7·36	2,279	6·12
Maidstone Corporation	Mar. 6	157	100	+ 57	—	7·4	—	—	—	—	—	—	—	—	—
Manchester Corporation	Sept. 11	15,631	15,297	+ 334	— 2,871	183	181	—	—	—	—	—	—	—	—
Metropolitan District Railway	May 7	10,911	9,891	+ 1,020	+ 19,336	24	24	—	—	—	—	—	—	—	—
Metropolitan Railway	May 15	16,661	16,210	+ 451	+ 10,578	24½	24½	June 30	680,357	99,846,735	—	1·46	—	—	—
Nelson Corporation	Oct. 16	151	131	+ 20	+ 7	2½	2½	Mar. 31	7,362	2,060,712	204,710	·85	8·63	1,907	—
Newcastle-on-Tyne Corporation	May 7	3,788	3,755	+ 33	— 1,73	60½	59½	„ 31	211,085	46,203,164	4,411,745	1·10	11·48	3,504	6·26
Newport (Mon.) Corporation	Oct. 9	663	638	+ 25	— 311	14½	14½	„ 31	35,531	8,174,003	798,029	1·04	9·89	2,450	7·21
Oldham Corporation	Jan. 24	1,778	1,516	+ 262	— 386	—	—	—	—	—	—	—	—	—	—
Portsmouth Corporation	Oct. 10	2,046	1,809	+ 237	—	28½	28½	Mar. 31	97,741	21,247,048	2,309,439	1·10	10·15	—	—
Reading Corporation	May 12	552	577	— 25	—	13½	13½	„ 31	32,769	7,933,572	915,481	—	8·93	—	4·65
Rochdale Corporation	Dec. 26	1,240	1,126	+ 114	+ 746	20·9	20·93	„ 31	56,558	10,196,148	1,252,925	1·32	10·83	2,693	6·47
Rotherham Corporation	Feb. 4	555	587	— 32	—	—	—	—	—	—	—	—	—	—	—
Salford Corporation	Sept. 27	4,996	4,662	— 66	— 3,326	78	74½	Mar. 31	244,065	45,771,611	5,486,150	1·25	10·67	3,185	—
Scarborough Tramways Co.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Sheffield Corporation	May 8	5,884	5,623	+ 261	+ 1,215	39½	37	Mar. 25	289,745	17,568,686	7,065,380	·896	9·842	4,225	5·04
Southampton Corporation	May 4	1,014	954	+ 59	— 129	18	18	„ 25	52,647	10,121,887	1,157,451	1·25	11·33	—	7·30
Southend-on-Sea Corporation	Aug 21	995	557	+ 438	+ 1,483	—	—	—	—	—	—	—	—	—	—
Stockport Corporation	—	—	—	—	—	25	25	Mar. 31	52,004	9,155,172	1,335,911	1·34	9·342	1,830	4·75
Sunderland Corporation	Jan. 27	1,310	1,336	— 26	—7,984	—	—	—	—	—	—	—	—	—	—
Swindon Corporation	May 4	134	111	+ 23	—	—	—	—	—	—	—	—	—	—	—
Torquay Tramways	Aug. 26	630	647	— 30	—	8·41	—	Dec. 31	15,065	2,880,420	353,297	1·40	1·023	—	—
Wallasey U.D.C.	May 7	883	927	— 43	— 612	12·68	12·45	Mar. 31	43,823	8,331,038	891,540	1·2	11·79	3,453	7·72
Warrington Corporation	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
West Ham Corporation	May 5	2,361	2,248	+ 113	— 401	27	14·7	Mar. 31	122,881	35,502,836	2,556,854	·789	10·95	4,417	6·79
Wolverhampton Corporation	Nov. 3	841	823	+ 18	— 206	21½	—	„ 31	44,432	9,440,o89	975,714	—	10·929	2,190	6·509

a Train Miles. h Half-year's figures.

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THE
Electrical Engineer.
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NOTES.

Standardisation.

The movement towards standardisation on sane lines is very noticeable. At least three recent papers before the Institution of Electrical Engineers have dealt with this phase of practical engineering, and Mr. H. K. Kefford, in his "Standardisation of Fuses," an abstract of which appears elsewhere, is very emphatic on the point. Another aspect of this was touched upon in our last week's leader. Both advantages and disadvantages are fairly obvious, but provided sufficient latitude is allowed for experimentation and adaption to peculiar needs of individual cases or special classes, the benefits certainly far outweigh any arguments that may be brought against a flexibly workable standardisation.

Medical Side of Radio Electricity.

Messrs. Siemens & Halske have brought out an apparatus on the radio-telegraphy principle for use in treating disease. The idea is to send the electric waves through the body, in whatever direction desired. The invention is causing considerable stir in both medical and surgical circles of Berlin. It is thought that the instrument will prove of considerable importance in the treatment of diseases of internal organs. Possibly cures may be effected without the necessity of surgical operations. On the other hand, it is deemed that the instrument may be useful in surgery by arresting bleeding and sterilising wounds. The nature of the electric waves are quite different to those derived from radium, and have a different influence.

Illuminating Engineering.

At the first annual general meeting of the Illuminating Engineering Society, held on Monday, Professor S. P. Thompson, D.Sc., F.R.S., in the chair, some novel photometrical apparatus were shown. The report was justly couched in optimistic phrases, for young as the society is, it has already done some excellent work, notably in arriving at some understanding as to the meaning and effects of glare, and also in formulating the desirable points to be kept in view in standardising measurements of light and illumination. The society is to be officially represented at the International Medical Congress to be held at Brussels this year, when, among other subjects, the question of the hygienic conditions of factories and schools, and the effect of light on the health of employees, will be studied in connection with the engineering aspects of illumination.

Electrolytic Recovery of Tin.

A considerable industry has been established in Italy in the recovery of tin from tin-plate waste by electrolytic action. Usually iron baths of three cubic metres capacity are insulated from the ground, provided with a pump to assure the rapid rotary circulation of the electrolyte, a heating arrangement, a series of about six anodes in the form of iron baskets for containing the waste, and seven iron plates used as cathodes. The electrolyte is a solution of soda in water kept at a high temperature. About 1,000 to 1,400 amperes are used to treat 800 kilos of waste in 24 hours. During the process stannic acid is formed, and this, by reducing the alkalinity of the bath retards the process, so that periodically a small amount of the electrolyte is removed and replaced by an addition of fresh soda solution. Hydrogen is slowly evolved at the anodes, its evolution coinciding with the stripping of the iron plates. The tin gathers on the cathodes in the form of a light powder, easily brushed off. This powder is then compressed into brick form and kept under water to prevent oxidation. Both the tins and the stripped waste find a ready market at good prices.

Transvaal Power Bill.

Active opposition to the Government's Power Bill now before Parliament is arising in many of the industrial centres of the Transvaal. The opposition comes both from the municipalities and the trading community, who regard the provisions of the Bill as far too autocratic. Johannesburg has protested vehemently, in spite of the strong influence of the mining magnates who are nearly all more or less intimately mixed up with the Victoria Falls and Power concern. At Germiston the following resolutions have been passed:

"(*a*) That this Municipal Council, having considered the Power Bill at present before the Legislature, is strongly of opinion that the same should be amended so as to provide that it shall be a condition of every licence to supply that within any municipality the Council of which is by law authorised to acquire, construct, equip or carry on an undertaking for the supply of power the licensee shall not without the consent of the Council supply power except for use in operations and processes directly and necessarily connected with mining, for recovering and treating precious ores or other minerals, and that all powers, duties, privileges, and concessions vested in municipalities be not infringed.

"(*b*) That it be an instruction to representatives of the Council to approach the Government with a view to having the above principles adopted by the Legislature, and that members of the Legislature representing Germiston constituencies be respectfully requested to support amendments to the Bill giving effect to the said principles."

Roodepoort is also up-in-arms, because it cannot secure any pledges from the Victoria Falls & Power people as to when power can be supplied or what will be the charge per unit.

Congresses.

The adjourned Tramways and Light Railways Conference has now been fixed for Thursday and Friday, June 9 and 10, at Dublin. A special saloon will convey a party from London, leaving Euston at 8.45. The programme, already given in these columns, will be adhered to. The Incorporated Municipal Electrical Association's 15th annual Congress is to take place at Glasgow from June 14 to 17, both days inclusive. A definite programme has now been issued and promises a most interesting time.

Protection v. Free Trade.

The field day on the effects of tariffs on the electrical industry, organised by the National Electrical Manufacturers' Association, duly came off at Caxton Hall, Westminster, on Monday, without any broken heads. Mr. J. E. Kingsbury opened the discussion in a studiously moderate statement of the Free Trade point of view, and was followed by a vigorous *riposte* on behalf of Protection by the emphatic and earnest Mr. H. Hirst. Other speakers followed, but the discussion stands adjourned for a fortnight.

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Free Trade or Protection?

British Electrical Manufacturers Discuss the Problem.

The momentous question of the effects of Free Trade or Protection upon the electrical industry provided the theme for an animated discussion by the National Electrical Manufacturers' Association (Incorporated), on Monday, May 23. The meeting took place at the Caxton Hall, Westminster, London, S.W., and brought together a representative gathering of British electrical manufacturers.

Mr. H. W. Butler, Chairman of the Association, presided, and, in the course of a few preliminary remarks, observed that they had met to consider a burning question of the hour. The Association existed for the purpose of dealing with all commercial questions which were of general interest to the trade, and it also formed a common platform where members could discuss various questions of policy of benefit to the trade as a whole. The Association as a body was unable to take sides, so no resolution would be put to the meeting. They were specially indebted to Mr. H. Hirst, M.I.E.E., for coming there that evening. Mr. Hirst had had a severe attack of gout, and it was only that afternoon that he was able to get permission from his doctor to go out.

Mr. J. E. Kingsbury opened the discussion by championing the Free Trade system. He said: One of the effects of Free Trade is that the electrical industry of Great Britain has a higher efficiency than any in the world. I am not indulging in flattery or expressions of vainglorious patriotism; I do not say every department is better or any department bigger than can be found elsewhere, but that the industry as a whole has a higher efficiency. Manufacturers and users alike are striving for higher efficiency—better results with less expenditure of energy or money. If the suitability of the instrumentalities is inferior or the cost excessive the efficiency is low. In no protected country can the engineer extend his horizon beyond the frontier and advise the use of the most suitable instrumentalities regardless of their birthplace. In no protected country can the purchaser exercise his choice except at a cost which is an addition to the value. In the selection of their material our engineers and constructors have been unhampered. The nation has added nothing to the price. Think what that means in the balance-sheet of the electrical industry. Apply the same line of reasoning to other British industries and consider the value as a national asset. Observe its bearing on the advance of an industry and particularly our own—one of the newest. You cannot measure such advance by comparisons—you can be sure that increased cost (*i.e.*, reduced efficiency) would retard progress. And yet we are told that Free Trade is a mistake; that we ought to have built up the industry on Protection. For some years insidious efforts have been made to counteract the operation of Free Trade by the development of an idea that patriotism required the engineer to limit his range of vision and the purchaser to fetter his freedom. Measure the results in efficiency and the consequences in balance-sheets, and which do you think is the truer patriotism—to extend the benefits of an industry and add to the nation's profits, or to retard the development of an industry and add to the nation's loss?

The Electrical Industry.

It is long since we have heard the once familiar phrase that "electricity is in its infancy," and I have no intention of reviving it, but we ought to remember that the electrical industry is still young. Its youth is partly responsible for its international character. No one nation can claim pre-eminence either in discovery or applications as a whole, though some may claim such pre-eminence in certain sections, and the claims can be substantiated. Every cultured nation has contributed its quota in scientific discovery and applied itself with zest to its development, and since it has been the province of electricity to supersede some other agency in most of its applications, it is not surprising that early advances should have been more rapid in communities where the other agenices had not been so long established as to take deep root. Our Free Trade policy permitted us to apply at once any advance made elsewhere and to give the industry a start on the most economical lines. So soon as the demand became large enough to permit economical manufacture we abandoned imports and manufactured for ourselves. Our imports in all probability afforded a profit to the exporters. You Protectionists grudge that profit to the exporters, you think it was a loss to this country. I see in it an enormous gain. By reason of our more settled conditions our development in some departments was necessarily slower than that of some other countries. We were able to make a start at once in any applications not originating with ourselves. We were able to adopt the most suitable instrumentality and obtain the benefit of its successive improvements at small cost. Protection would have delayed us for years and enormously increased the cost. Protected States are behind in the development of enterprises originating in other States. We can adopt and develop without delay and without restriction. That such freedom of action is good for the user there can be no doubt, and it is also good for the electrical industry as a whole, for no article is imported and put into use without leading to the employment directly or indirectly of our own manufacturers sometimes of very much greater value and employing considerably more labour than the imported article itself.

Steady Progress.

Our progress in the past, though not stupendous, has been steady. Our applications in some departments are not what they should be or what we might expect them to be. In pursuance of that unfortunate policy of detraction which is a part of the Protectionist propaganda we have been, and are being, held up to the world as exceptionally backward. Well, the United States is a particularly electrified nation. Their electrical products in 1904 were 6s. 10d. per head of population. Ours in 1907 were 6s. 2d. The years are the nearest available for comparison. The larger rural population of the United States must be taken into account, but on the other hand their values probably represent less material. With all allowances being made, do the figures justify the mournful moanings and the gloomy prognostications of which our Protectionist friends indulge, which go forth to the world in such striking contrast to the proud boastings and confident anticipations of our competitors? Our progress is substantial. Lack of progress in any department can be readily accounted for by our conditions or our own errors. Free Trade has helped us. With Protection our position would have been deplorable. Now the industry is established. We are equipped to do more work for ourselves and the work of so much of the rest of the world as we can get, and we are asked to throw away our most efficient aid to both—to abandon our trusty staff and lean upon a broken reed.

Security of Market and Continuity of Employment.

I think I am stating fairly the Protectionist's argument when I say that it is claimed that Protection makes the foreign manufacturer sure of his own market; that he can thereby organise with confidence for the supply of that market, can arrange for the production of a surplus to dump in our market and can secure for his employees continuity of employment. These are the advantages which Protection is alleged to give the foreign manufacturers; they are the reasons which are presumed to account for his progress, and the inference is drawn that if we had Protection the same advantages and the same progress would accrue to us. The argument is sufficiently plausible to be very generally accepted, but I must question both the statement of the facts and the inferences drawn from them. We talk in a vague way of the competition we experience from another country and then in an equally vague way of the production of that country, when we mean the competition of individual firms in that country and the productions of individual firms of that country. Now, Protection does not make any individual foreign manufacturer sure of his market. He is open to the competition of other manufacturers in his own country, and he therefore has to exercise his judgment of what he will produce and how much of it he may safely produce just as much as the manufacturer in a Free Trade country. Except for the fact that any competition he may have to fear is that arising from within the national boundaries. This reduces the area of competition, but prevents that calm confidence with which he is credited. The argument presupposes that there is only going to be one manufacturer and one output. The tendency of Protection is in that direction, but it has not yet been reached, and the progress of our foreign competitors cannot consequently be attributed to it. The argument for the continuity of employment is negatived by the facts. Neither Free Trade nor Protectionist countries are free from the vicissitudes of trade, and trouble in one country will affect another, but it is a well recognised fact that the trade of a Free Trade country is less disturbed and employment more regular than that of a Protectionist country. Whatever complaints can be made of the volume of electrical trade in Great Britain it cannot be said that the employees of that trade have been subject in recent years to such sudden and such extensive reductions as have taken place in the United States and Germany.

The Educative Influence.

There is another argument for Protection which I sometimes think a very strong one. It is the argument of educative influence, the development of growing industry. Manufacturers say, "If we don't begin to make these things all the experience will be with other countries and a manufucture which might have been ours will be lost to us for ever." Such an appeal as that is likely to strike a responsive chord and meet with a sympathetic reception. It assumes that opportunities have been lost and implies the merit of looking ahead and preventing the loss of similar opportunities. The educative argument is less direct than

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the employment argument, and it is, perhaps, on that account, the more dangerous. To start a factory for the purpose of serving as a school is an expensive form of education, and when it is maintained by a protective tariff the amount paid in fees is likely to be very serious. The large amount of attention given to the profits of manufacture and the small amount of attention given to the purpose of manufacture cannot be very readily explained, but it is worth enquiry. Consider for a moment the difference between the profit on the manufacutre of a spade and the potentiality of profit from that spade in use. A small agricultural community that insists on placing a restriction on the importation of the best and cheapest spade is taking a measure that must react upon its own development. In process of time the requirements of the community become large enough to permit it to manufacture its own spades at a price that will be lower than the imported article. It would pay the community better to develop its resources by imported spades and pay for the education of artificers from its surplus crops rather than to set those artificers to work to produce imperfect or unnecessarily expensive spades which would retard the progress of its agriculture. Early local manufacture can only be undertaken where the soil is so extensive or so productive as to leave a wide margin over necessary sustenance, and as this is generally the case in newly settled countries the settlers are enabled to give rein to their ambitions to extend the scope of their occupations. But in a settled country there is usually no such margin, and no such occasion for such ambitions. The value of the article in use should be the prominent consideration. Its use should be encouraged, and yet the principle of Protection is to discourage its use by delay or excessive cost.

Ethics of Dumping.

The same warped conception of a simple benefit is noticeable in relation to dumping, an expressive word which needs no more explanation than the word "boycott," to which it has some relation. "Dumping" in connection with trade and commerce is reserved exclusively for inter-State transactions. A British purchaser having the alternative of making a bargain with British sellers is not asked to take into account any other consideration than the quality of the material and the price at which the transfer of ownership can be effected. It may suit one of the sellers to dispose of surplus stock or he may have some more economical method of production which enables him to offer a lower price than the other. Whatever the circumstances may be the purchaser is permitted to make his purchase in the cheapest market without any reprehensible reflections being cast upon him, and nobody describes the sale as "dumping." Such a term only becomes operative when a foreigner in competition with British sellers exchanges ownership with a British purchaser. The term is consequently identified only with international commerce, and is intended, by arousing international prejudice, to limit transactions within the nation. Nothing can be said against the principle of leaving to the buyer the exercise of his individual will. There is, and always will be, I hope, a preference for the interchange of commodities within the nation or the Empire, but I venture to submit that it is unbecoming a great commercial nation with a world-wide trade for any section of its traders to endeavour to limit the freedom of the individual by the creation of a public sentiment based on international prejudice. If such principles had governed British commerce in the past Great Britain would not be a great commercial nation. If they are allowed to operate in the future Great Britain will inevitably cease to be a great commercial nation. When the prejudice is utilised to further the claims of Protection it becomes a double evil. I shall have occasion later to examine more closely the measure of "dumping" in the electrical industry. I would simply ask you now to approach the consideration of international purchases and sales as far as you possibly can free from the prejudice which has been so industriously fostered.

Not Enough to go Round.

At a time when we have not work enough to go round amongst ourselves, the introduction of a policy which should secure the margin of that work at present lost, and which should have also the not improbable effect of improving the profits on the remainder, sounds tempting—so tempting, that it is not surprising numerous adherents should be found. But you must remember that what we are talking about to-night is for practical purposes, not what will be the effect of Protection applied to the electrical industry alone, but rather what is going to be the position of the electrical industry if Great Britain gives up her Free Trade and adopts Protection generally? The responsibility which lies upon the promoters of the protective policy is a large one. Their belief in its necessity must be profound, or their careless trifling with the destinies of a nation deplorable. But profound belief does not relieve them of the responsibility of demonstration. Happily I think it can be shown that there is no conflict between the interest of the electrical industry and the interest of the nation. As a fact, there never was any conflict between the interests of any industry and that of the nation, but I am not so sure that it can always be so easily seen. Observe the danger, then, of approaching the consideration of the greater question *via* the smaller, as is so frequently done. You are asked to adopt Protection so as to limit the freedom of action of those to whom you sell. Other industries are asked to do the same. Do you and the other industries realise that by your adhesion you are preparing fetters for yourselves and for the trade and commerce of the nation as well? "Where fetters are to be worn, it is a wretched ambition to contend for the distinction of fastening our own shackles," said Sheridan on one occasion in the House of Commons. Do you want to contend for the distinction of fastening your own shackles? If you believe it is for the general welfare, you can do nothing else; but have you taken all the precautions necessary to assure yourselves that it is for the general welfare? It is not our province to-night to examine in detail the proposition before the country, but a consideration of its probable effects are essential to reach a conclusion on the point that is before us.

The Home Market.

The trade and commerce of Great Britain, and the consequent position of London as the centre for international financial transactions, are the envy of the whole world. The manufacturers of Great Britain must not assume that they can consider the introduction of Protection apart from its effects on trade and commerce. A study of the growth of that commerce under Free Trade conditions, a careful weighing of the arguments of financial authorities can only lead to the conclusion that with the introduction of Protection our supremacy must wane and our trade decline. What will it profit you to secure your home market if thereby you reduce it to insignificant proportions? Let us see what the position of the home market is. In 1907 we imported, roughly, about 17½% of our consumption. We will call it 20%, and that may perhaps be divided by two to indicate the imports which are new or advantageous, and those which compete with our standard manufactures. The novelties are wanted to maintain our efficiency and promote the use of accompanying manufa tures of our own. Our grievance, then, is that 10% of our electrical consumption is imported, and could have been made by ourselves. It amounts to a little over three-quarters of a million pounds. Does the case seem quite a strong one to put before the electorate? Is there not danger that some of them at least might remind us that the retention of our home market might possibly result in the ruin of our export market?

Greatest Advantage of All.

Our exports must grow, but we have keen and alert competitors. Every advantage at our disposal must be used. Free Trade is the greatest advantage of all. I do not know that I have seen this more clearly stated than in the following quotation from an article in the *Daily Telegraph* some time before Protection was exhumed: "The logic of Protection involves the rejection of foreign trade to preserve an internal monopoly. When supremacy in international commerce has become an object, the maintenance of exclusive tariffs becomes injurious and absurd. It is like nothing so much as the process by which the case armour in the Middle Ages was increased in weight until it disqualified the combatant, so that churls and peasants came up with unknightly weapons when splendid signiors were once unhorsed, and hewed them to pieces like logs as they lay prone under their harness." There is reason to believe that that case armour has already told upon one of our competitors. Upon another the weight is not so great, and the frame is yet too strong for it to overbear some other advantages, but the weight will tell with the period of wear; the cost of production will increase as the cumulative effects of Protection permeate the fabric of the State and the bills for stimulated progress and enterprise come due for payment. To our electrical exports we must look for developments, and we are asked to discard the weapon which we know gives us our advantage in cheap production and promotes that oversea trade which facilitates the exchange of our manufactures for others' products. And in place of the weapon which has proved its utility, we are invited to adopt this protective armour of the Middle Ages, whose deadly weight would crush us with more celerity and greater certainty than any other nation. The dependence of the electrical industry upon the general trade and commerce of the nation cannot be questioned, and it is to be regretted that more attention is not given to such points and less attention bestowed on minor questions which, whilst making appeals to individual interest or sympathy, have much less effect on the real settlement.

Growing Out of Ruins.

Our feelings are harrowed by appeals for Protection to prevent the ruin of industries or to assist in the building up of those we have hitherto been able to do without. As if it were not established that an industry ruined in a Free Trade country has another industry growing out of its ruins, and an industry protected in a protected country needs more and more protection. I will give you an example of each. The policy of stimulated exports of sugar from the Continent crippled our sugar refining and had serious effects on our sugar growing, but it gave us cheaper sugar, upon which other and larger industries have been built. Our Free Trade policy of buying in the cheapest market was justified by results, and if we had tried to save a threatened industry, we should have lost an important outside contribution to our finances—how important you can judge from the statement of a writer in a Berlin *Review*, who estimated that the

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annual contribution of the Continental taxpayers to the English Treasury by means of the sugar bounties was equal to the interest on 150 million pounds, the amount expended on the South African War at the time of his writing. My other example is of increase in duties. In 1853 Mr. William Chambers, a member of the celebrated publishing firm, paid a visit to America and recorded his impressions. He remarks that the prosperity of Lowell rested on the precarious foundation of a tariff which excluded the more cheaply produced goods of England. I understand that the tariff at that time was 25% *ad valorem*, and is now 50% *ad valorem* plus 40 to 50 cents. per lb. When anyone suggests the placing of a protective duty on our electrical industry in consequence of its infantile character, and considers it likely that the duty might be subsequently dropped, he might bear this example in mind. Amongst the many other arguments for Protection which are put forward, I must select only one more for comment. It is often urged by moderate men, who do not recommend Protection as a good in itself, but think a tariff might be useful as a basis of negotiation and permit

Retaliatory Measures.

Confining myself on this point to the electrical industry, let us face the facts. Can we say that any of our active competitors are so poorly equipped electrically, that the operation of a retaliatory tariff is likely to lead to a reduction in their duties of any item which will facilitate our exports to them? You will, I believe, agree with me and answer "No!" In that event, Protection as a retaliatory measure is useless to the electrical industry as it is equally useless in other respects. Time does not permit my commenting on any more of the numerous claims which have been advanced on behalf of the electrical industry for the abandonment of Free Trade and the adoption of Protection. I have been obliged to limit myself to a few bearing directly upon the subject which has been given me. At a time when so much has been heard of Protection, I suppose it must not be considered surprising that a section of those engaged in the electrical industry should have turned to such a policy in the hope of finding therein some remedy for "the present discontent." But I regret that it has been so, and I believe that the industry has suffered by the agitation. We must recognise that a difficulty exists in reaching a conclusion within the industry itself. It is not easy to acquire that complete capacity for detachment which could recognise that it can be good that our business should be spoilt by imports from a country to which it is impossible for our manufactures to be exported. A conclusion is, I think, more easily reached if we consider the interests of the nation. There can be no question, then, what is the interest of the industry. In considering the interests of the nation, it is much easier if we abandon our return circuit ideas. It is no use thinking of trade and commerce in terms of out and home conductors that run in the same trough. We may do better by reverting to earth circuits. The return may be an unconscionably long way round, but whichever route it traverses, we know it is the one of least resistance, and we know that it is complete by the work done. In spite of the important spots of rocky ground, the rest is "good earth," and the whole is available.

Sympathise with the Trader.

I should like, if possible, to see developed a more reasonable attitude on these foreign trade questions. We adopt for ourselves a policy which we think best, and we don't intend to let any other nation interfere with us. Other nations do the same, and are in no way influenced by our arguments. In such a progressive industry as ours, in the developments of which, as I have previously said, all cultured nations take an active interest, it is not reasonable to suppose that any one can produce the best of everything. We know that it does not. We have much that others could take with advantage to themselves. They shut their doors. Shall we also shut ours? In the case of anything which benefits us it would be a mistake, and our Free Trade policy prevents our making such a mistake. But we know that there are compensations, though not always directly traceable to a particular industry. Yet I do not see why we should not imagine a part of the Continental contribution in the sugar bounties as having been expended in the electrical equipment of a chocolate or a biscuit factory. We must sympathise with the trader who finds his sales affected or the profits reduced by imports from a country from which his own products are rigidly excluded, but if we legislate for hard cases, we start on the road to ruin. The operation of Free Trade is eminently fair. It may deal out hardship with one hand, but it promotes prosperity with the other. The Trade Returns of Great Britain, the condition of the population of Great Britain (in spite of all deputations and detractions) clearly demonstrate the wisdom of our fiscal policy.

Mistake to Agitate.

Whether it be regarded from that larger standpoint or from the more definite interests to which, mainly, I have been compelled to devote my remarks, I hope it will be seen, I think it will be seen, that the electrical industry only requires to use its right arm and make the most of its opportunities under the policy of freedom of trade. I have finished the task that was set me in the presentation of the case for Free Trade. The other side has yet to be put before you. I am not going to prejudice the conclusion. You who have your doubts whether the fiscal system our fathers strove for, and we have for half a century striven under, is good enough to go on with; you who are not quite so satisfied as I am that Free Trade is essential to the progress of our industry, can at least have no doubt that the effect on the electrical industry of the continual decrying of our powers which accompanies the agitation for Protection is extremely detrimental. If you have so little confidence of your powers in open competition, can you be surprised that others should have even less? Whilst you are pursuing what I believe to be a will o' the wisp, are you possibly neglecting opportunities of taking practical measures for ameliorating any of your conditions which may need amendment? The best and strongest firm cannot afford to lose goodwill. Now, Great Britain's loss in goodwill in the last few years has been serious, entirely from the deprecatory arguments of the protective agitation. It would have been more serious but for the fact that our customers, our friends, and our competitors have not taken us quite so seriously as we take ourselves. Unless you are satisfied that Protection is a real necessity, unless even you believe that the electorate can be convinced of that necessity, it is a mistake to continue the agitation.

Mr. H. Hirst, M.I.E.E. (Managing Director, General Electric Co., Ltd.), who followed, strongly favoured the adoption of Tariff Reform. He said: By the ruling of your Chairman and your Committee, I am not permitted at this juncture to deal, as I am eager to do, with the way in which my friend, Mr. Kingsbury, has stated the case of "Free Trade and the Electrical Industry," but I may be allowed to express my heartfelt appreciation of the interesting, informing, and able manner in which he has handled a very difficult subject. I look forward to another occasion to discuss in detail the arguments which Mr. Kingsbury has urged with so much personal conviction, and I hope we shall then have the benefit of the knowledge and experience of some distinguished men in our profession or calling who are present to-night, or who will be present at the second meeting which, I trust, it may be necessary to call. I feel that I must take this opportunity to congratulate the Chairman and Committee of the National Electrical Manufacturers' Association on having organised this meeting, and thus afforded the leading members of the electrical industry an opportunity of exchanging their views on a question fraught with immense potentiality not only to the industry itself, but also to the country as a whole. Nothing but good can come of a frank exchange of views amongst the various units of the industry here represented. I only regret that for so important and complex a subject as "Protection and the Electrical Industry" your Committee has not chosen a more able and deserving exponent champion than myself. I possess neither gift of rhetoric nor genius for statistics, but I may make up for these shortcomings by my somewhat unique experience as a manufacturer, for as such I have not only produced almost every class of electrical commodity in this country, and this has naturally brought me into contact with our own economic conditions, but I am also associated with concerns manufacturing and selling in protected countries, while again I am still further fortified by my actual experience as a free importer of foreign made goods. It is the privilege of an Englishman to grumble at any and everything. Now, it appears to me to be a very peculiar thing that, although we grumble at our present position as manufacturers individually around our firesides and on political platforms, electrical manufacturers as a body have been reluctant to express their views. Yet if our own and other industries were to collectively make known their opinions, and if the demands of the majority were heard, what a tremendous help it would be to statesmen of both political parties in their endeavour to do the greatest good for the greatest number. On the other hand, the most direful and misleading results can follow indecision and halting counsels on the part of industries like our own. When one industry shouts loudly for a continuance of Free Trade, and other industries, which need protection, remain silent, the result is bound to be harmful to the country. It may safely be stated that the indecisive results of the last election on the subject of Tariff Reform were largely due to the loud and insistent voice with which the cotton industry clamoured for Free Trade. Yet other industries of this country have a perfectly good and fair reply to give to the cotton spinners; and as that subject has now become one of general interest to the country, and as before I deal with purely the electrical industry, I must necessarily refer to some general considerations, I take this opportunity of suggesting a reply to what we have been told from Lancashire and Yorkshire.

Firstly: It is not generally understood that the cotton industry already enjoys a kind of Protection through the ideal climatic conditions for its particular work, the artificial reproduction of which in other countries has so far met with partial failure.

Secondly: That every argument brought forward in favour of Free Trade for their manufactures by the cotton spinners is in reality an argument in favour of Protection for every other industry. What do they say? This, in short. In case of Tariff Reform, the workshops in this country would get busier, the demand for labour would increase, the standard of wages would

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go up, and, in consequence, the cost of production might increase and interfere with their own competing power in foreign countries. In the absence of a published census of the production of the cotton industry, it is difficult to say what is the exact proportion of manufactured cotton goods in relation to other productions of this country. By circumstantial evidence, however, I conclude, and I am erring on the generous side when I suggest the relation is 20% for cotton and 80% for productions of other industries. Now, is it fair that the interests of the latter should be altogether subordinated to the interests of the former ? You must not forget, firstly, that a large proportion of our cotton exports can only come from Lancashire, for the simple reason that they can only be produced in Lancashire. Secondly, the proportion of wages relatively to the total output of cotton goods is again at a generous estimate only 30% of the total value of such goods, and a rise in wages of 20% would, therefore, only mean 6% increase in cost price. Now, that little difference against the cotton industry could easily, I should say, be equalised by two or three features partly resultant upon the introduction of Tariff Reform. A certain amount of goods now imported would be excluded, and it would bring additional work to the cotton spinners of this country. Reciprocal and preferential treaties with other countries would come into existence and be a potent factor in building up markets which the cotton industry can now only enter under severe competition.

Finally : Before dismissing the subject of the cotton industry have we not a right to ask ourselves whether all is well with it ? Is it not an admitted fact that, in spite of an increase in the population of nearly three and a half millions during the last census decade, the number of cotton operatives has actually decreased by 23,000, whilst in other countries it has increased? Do you, gentlemen, here realise that there are only 580,000 operatives engaged in the cotton industry in this country, and is it not a fact that we electrical engineers more than anybody else have noticed a spirit of *laisser aller* instead of *savoir faire*? Are we not mindful of the report recently published by an important section of the cotton industry that they considered electric driving unsuitable, when we know from personal experience and the experience of other countries that the cost of production can be considerably reduced by the introduction of electricity and modern plant in cotton mills ?

Definition of Terms.

Another general point that I should clear away before proceeding with the discussion of the actual subject of this evening relates to a definition of terms. We are discussing " Protection and the Electrical Industry," not the electrical " trade." Speakers on this subject are not always careful to distinguish between trade and industry. I find that loose ways of speaking are almost always an index to loose ways of thinking. Too many people in this country have got into the way of coupling " trade " and " industry " as if they were convertible propositions. But they are nothing of the kind. As a matter of fact, good " trade " may very conceivably be the absolute enemy of " industry," and in that case it would necessarily prove detrimental to the aims and ideals of Tariff Reformers. If trade is to be profitable in proportion to its volume, it is essential that it should busy itself only with the import of such commodities as the land is incapable of growing or producing, and with the largest export of such commodities as the land can and does produce.

In what does the wealth of a country really consist ? It does not consist merely in cheap buying or cheap selling. Free Traders freely admit in all their text books that the wealth of a country consists in its ability to produce cheaply relatively to its competitors in the world's markets. Is not this, therefore, the vital question—*Under what conditions can we produce cheaply ?* I maintain that if you can establish such conditions as will enable the country to produce cheaply, you can turn 80 to 90% or more of the inhabitants of this Empire into producers. If you look after the producer, the consumer is automatically looked after, because consumers will then practically be also producers. But if the legislator—and you must not forget that in framing tariffs and in devising any fiscal system the lawmaker is shaping for good or for ill the economic destinies of his countries—keeps only in view the consumer, and neglects to force his country to produce up to the limits of its physical capacity ; if, in short, he neglects to protect the producer and allows outside forces to limit the field within which he can profitably work, that legislator is limiting the benefits of legislation to the smallest number of citizens, instead of extending them to the greatest number. The Free Trader argues frequently as if the country were divided into two numerically equal sections, the producer and the consumer. But in an industrial country like ours, if it is to maintain a high state of efficiency, each consumer should also be a producer, though the nature of the production may vary: it may be industrial, agricultural, transport, exchange, or last, but not least, brain production. In this calculation I, of course, include merchants as producers. So long as merchants do what is ideal for the country, viz., distributing as far as possible home-made goods and importing as far as possible the raw material which we require, I consider them producers. The same remark applies to the inland transportation service for the whole of the country.

Our Former Successes.

I maintain that Great Britain, compared with its competitors, had drawn nearest to this ideal state of efficiency at the close of that period of Protection which culminated in 1846. She was the chief producer amongst civilised nations. For a time the repeal of the Corn Laws appeared to have the effect which its champions alleged as their guiding motive, to wit, the expansion of our power of production by the reduction of its cost. But the student of history who examines the facts with an impartial mind can only conclude that the results we obtained were snatched in spite of Free Trade. They certainly received a check as soon as other nations had the opportunity of so organising their economic forces as to place themselves in a position to challenge our industrial supremacy. It seems to me that three factors which are rarely mentioned, but which must be quite familiar to such an assembly as this, worked together to ensure our brilliant success as a producing country, in spite of Free Trade ; and these causes were operative until about the early 'eighties.

Firstly : From 1848 to 1878 nearly all Continental nations were strenuously fighting for national existence, while those who were not actually engaged in war, lived in almost daily fear of it. The concentration of their energies on this one absorbing and, to them, vital issue, meant a large and profitable trade for this country in all kinds of war supplies. Large orders were constantly being placed in this country by belligerents in the same quarrel. In the Western Hemisphere much the same state of unrest, when not broken by actual war, existed throughout this period. The immediate effect of this condition of things was to stimulate industry in Great Britain and to arrest the progress of the arts in other lands.

Secondly : It so happened that the introduction of Free Trade in this country tallied with the development of steam as a power to reduce the cost of production. Under the favourable conditions in which this country was placed, it reaped the utmost benefit, almost exclusive benefit, for a series of years from this new force.

Thirdly : Steam, by providing better means of transport, became a potent force in the opening up of new countries as markets for surplus goods. England was for a long time the only country to utilise to any extent, during a long period of peace and remarkable progress in invention, the steam engine, all kinds of textile machinery and agricultural machinery and machine tools, and she, consequently, was the only country in a position to supply those distant markets. Such lands became most valuable outlets for British goods, not only for consumption in those lands, but—what was of very great importance—this trade enabled us to collect the primary products of tropical and other countries, giving us at once cheap raw material for our industries and profitable return freight for our vessels, and incidentally made us the distributing nation for these goods for all neighbouring countries. Thus was created a very profitable exchange business, by which the wealth of this country was greatly increased during 1846 to 1880 period. This phase of the economic position was so patent, that a school of thought arose which maintained that the prosperity and economic future of this country was essentially based on the business of exchange and such factors as transport, freight, foreign investments, and so forth, and not on our country's power of production. In my view, the factor of cheap production is the only one of vital importance, all the others, exchange transport, etc., following in its train.

Supremacy Gone.

But those who have watched the progress of economic development during the past 30 years have been obliged to disagree with the conclusions of this school, and to no one has their philosophy been more completely disproved by facts than to the electrical engineer. In 1880 or 1881 Great Britain was at the zenith of her industrial power. Steam, gas, hydraulics, railways, steamships, electric telegraphs, celluloid, spinning, weaving, and knitting machines ; rubber, vulcanisation, dynamos, and I do not know how many more mechanical inventions, all of English origin, kept busy the factories and workshops of this country in supplying the markets of the world. Scarcely any engineering enterprise of any sort, whether in the way of railroad or bridge building, no tramway, gas, or water scheme was set on foot in any country unless there was English brains, industry, and capital at the back of it. Now, I would ask, How is it that in the short span of one generation our supremacy as a distributing nation is seriously challenged ? How comes it that in so many industries where we were leading we have either been caught up or overtaken ? Why is it that we no longer hold the market for raw materials, that we even have to purchase a good deal on the Continent, where, by the way, it is not produced ? Why is it that in this country land is depreciating in value, whereas in the countries which have challenged us so strongly, it is appreciating ? Why is it that the standard of comfort among all classes, while developing very rapidly in the leading industrial countries of the world, can be satisfied more easily in almost any land than in this country ? Why is it that unemployment, though to some extent incidental to all industrial lands, has become simply chronic with us ? Above all, why is it that the proportion of skilled to unskilled labour is, in this country,

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diminishing instead of increasing? If we would obtain a striking view of this process of falling back in the world's industrial race, it is only necessary to compare the relative position of the electrical industry as it is in England to-day with the position it occupied a generation back.

I am sorry to say that I am old enough to have a clear recollection of that time. The electrical cable, and telegraph industry was exclusively in British hands. The manufacture of dynamos and of incandescent lamps was a flourishing industry in England, while that branch of technics was, on the Continent, still considered only suitable for laboratory research. It was in the early 'eighties that the firm of Crompton & Co. was summoned to Vienna to fit up the Opera House and the Emperor's Palace. There are many engineers in this room who in those days were busy with installations in Germany and other foreign lands. I myself was connected with the largest accumulator works in this country, a company of which your Chairman this evening is so prominent a member, and I can well remember one of the directors of the A.E.G. visiting this country and raising his hands in astonishment at the great things we were doing here. The arc lamp industry, transformers, etc., were all developed in this country. Instead of a foreign country sending cables to the United Kingdom, they had to buy the machinery from us before they could make them. If in those days an electrical firm had establishments in England and elsewhere, it was always the English branch which was industrially the leader; but to-day, alas! that position is reversed.

What Protection Would Do.

In the course of the 40 minutes allowed me for my speech, it is not possible for me to give detailed reasons for every step in this downward path. I propose, therefore, to omit, in favour of Tariff Reform, all those arguments which we know well from the political platform. I only wish to confine myself to the one argument that under Tariff Reform or Protection we shall be able to produce in very much larger quantities, and by doing so we shall be able to produce much more cheaply. These two vital effects of Protection seem to me all-important. We engineers know that in arriving at the cost price, the quantity you produce is a much more important factor in keeping the price of production lower than any advantage which a Free Trade country may have by somewhat cheaper raw material or cheaper labour. Why can a manufacturer in a protected country produce in larger quantities? Well, it stands to reason that a manufacturer who has a market of 60 million of inhabitants secured to him, who has the advantage of preferential treaties with other countries, and who can, whenever he chooses, use for any surplus the markets of the Free Trade country, I say such a manufacturer must have a bigger market, a secured market, and a continuous market—invaluable points for producing cheaper than a manufacturer of a Free Trade country. The reasons why producing in larger quantities leads to cheaper production is apparent to us here, but for the purpose of this discussion, I venture to enumerate a few of the most salient arguments.

Firstly: In a secure market the outlay of works can generally, from the beginning, be a most efficient one. A manufacturer opening works in a protected country is sure that, given equal conditions of technical skill and sufficient capital, he could rely upon securing a certain minimum of orders per annum. It is a simple sum to him. He has only got to divide the total absorbing capacity of the country by the number of firms competing in that market, making due allowance for the technical perfection of their respective plants and for the capital invested in each enterprise. It is on the solid basis of this minimum of business and limitation of competition that he erects his works, and develops his engineering and commercial staffs. He capitalises his business, and has a limit to expenditure in tools, patterns, and so forth; but if he should make a mistake, if he should over-estimate the absorbing capacity of his market, he can always fall back on England as a dumping ground for his surplus production, within, of course, certain limits, and then he will soon enter the ranks of profit earning firms.

Secondly: He can standardise or confine his work to specialities. In a country which produces for itself such as Germany, thought is apt to be moulded in certain forms, and the effect of this is seen in a scientific industry such as electrical engineering to this extent, that there is usually a minimum of divergent theories, with the natural effect that fewer clashing systems are developed. This makes it easier to standardise, and this in itself is a great gain to any manufacturer with a corresponding effect on the price of production.

Thirdly: Except in a period of depression which may happen once in a decade, perhaps through influences from without, the manufacturer in a protected country is sure of a continuity of orders. It stands to reason that a country that must cover its wants from the home producer must keep its workshops filled more regularly. The effect of such regular occupation shows itself in quicker turnover in the requirement of smaller capital for carrying on the work in proportion to the turnover in the opportunity of using specialised tools and machinery, in cheaper buying and breeding greater skill amongst the workpeople and staff; and last, not least, the expenditure of less men and power per £ output, as well as the offering of greater inducements to workpeople to work harder. We know how workpeople slacken down in their daily output when orders are getting scarce.

All these factors again tend to cheapen production, all tend to the making of quick and big profits which attract capital with its purifying and cementing influence of the industries of the country, and these profits seem to be fairly divided between the State, the manufacturer, the workpeople, and the investing public. On the other hand, a man who starts electrical works in England to-day realises that to a great extent he is entering on a gamble. It is very easy for him to build his works too large from a dividend point of view, or again he may make them too small for the work which may come to him, but it would be a very clever man who could exactly apportion his outlay to the work he could obtain. In this country the science of industrial economics is to a great extent in an anarchical condition. We have no school of thought. Free Trade has produced a condition of intellectual drought. We are too apt to take for our pattern all that is done in other countries, whether suitable for our conditions or not. Every manufacturer, small or large, is expected not only to copy the work of every manufacturer in every other country, but even if he sets himself out to attempt this hopeless task it will not help him much unless he can show the man who has the order to give that he has in his works or elsewhere the exact machines which his customer may imagine are indispensable for the fulfilment of the order. I can hardly suppose that the most dogmatic Free Trader would deny that our power to produce as cheaply as Germany under such conditions is possible. We must, therefore, realise this fundamental and principal fact—that by producing regularly and large quantities, we can produce cheaper, and we are better able to supply our own Colonial and foreign markets. To this I pin my faith. If it were not so the so-called advantages of our geographical position, most favoured nation clause, the best transport organisation for shipment to and from abroad would have enabled us to have still kept the lead, but all these advantages failed us one by one as soon as our industrial position was being challenged by our competitors, simply and solely because we cannot, under our present conditions, produce as cheaply. Every other reason put forward seems mistaking cause and effect.

Arguments for Free Trade Opposed.

Let us consider what have been the reasons which have been hurled at us during the last five years or so for our relative decline.

I will endeavour to treat them seriatim:—

Water Power.

There was a time when some of us were afraid that the existence of high water-falls might favour some other countries in the race for industrial supremacy, but we have lived long enough to have become convinced that coal at 5s. per ton supplied the whole year through to a power station at the top of a coal mine is not more expensive than any water power with its irregular supply, its great capital expenditure, due in many cases either to difficulties in harnessing the falls or to the necessity for spare plant during some months of the year.

Technical Education.

We heard a great deal that technical education is the cause of our backwardness. How is it that in the early 'eighties, for instance, our education was quite good enough to enable us to take the leading place in the world's industrial race? We could not have deteriorated all at once. Some of the electrical engineers who were then leading are still working and struggling along, but we cannot make much headway. My reply is that so long as our education is confined to learning what others are doing for the purpose of making the same things and selling them below their selling price (not necessarily below their producing price), and as long as we neglect the means which would enable us to produce cheaper to get below the cost of production of our competitors, our technical education has no incentive to improve, and any amount of Technical Colleges will not improve our education when the incentive is missing. Let us close the circle and keep out the foreign manufacturer, making all we require at home ourselves, and we shall be on the high road to economic perfection. Our manufacturer will then be able to deal effectually with industrial problems as they arise; there will then be the best incentives for the use in any given industry of the best brains. Under such conditions technical education is bound to advance at a rate which was never known before, for the good reason that there will be a better market than ever for intelligence trained to cope with the technics of what will then be a profitable industry. But as things are to-day why should the foreman of our works, for example, send his boy to Birmingham University? He could afford to do it, but why should he when he sees that a draughtsman, a scientifically trained engineer, gets less than the wage of a shop foreman. The latest development in electric railways has reached us partly from Germany, partly from America. Well, it is a fact that in these countries several manufacturers combined some five or six years ago to experiment in electric railway traction. They formed an experimental company with a capital of £100,000. That was a bold, but doubtless a sound enterprise. Why was no such enterprise forthcoming in this country? Is it because we are unenterprising? No, I do not think that can be laid to our charge. Was it for lack of capital? Certainly not.

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The simple reason was that under similar conditions an English syndicate would have had no guarantee that any railway company in this country would have given them an order. It is such opportunities as these which are missing in this country, which do more to foster education, to attract brain, to start new industries, than any amount of preaching. I will give you another proof for the soundness of my argument. There are electrical companies which have been most successful in Germany and America and who have established large works in this country. These companies had practically unlimited capital, they had at their disposal the best brains and experience available for this industry. From time to time such companies have sent us some of their best men, who have done as good work in this land as they ever did in their now land, but what has been the result? It is no secret that without exception the financial results of these enterprises have been anything but satisfactory to the parent companies abroad. Now if lack of technical education is the cause of our decline, why is it that these branch factories, equipped as they have been with the best technical and commercial men which our competitors can produce—why can they not make adequate profits? I think it is fair argument that no amount of mere technical education will improve our present condition.

Inventiveness.

Some people are fond of casting in our teeth that we have not been fruitful in new inventions. It is a fact that nearly every electrical invention originated in this country until 1884 or 1885, but since that time, with the one exception of the steam turbine, almost everything new in electrical engineering has come from abroad. It is perfectly plain that the manufacturer who works in a protected country under such conditions as I have described has much more chance of meeting with his due financial reward than any manufacturer who has to get along under present conditions in Free Trade England. As a fact, most manufacturers are so proud of their calling that they are as a rule only too ready to use all or the greater part of their profits for further developments. Now in America and in Germany the profits secured to manufacturers have rendered funds available for research and experiment which have proved stepping-stones to great industrial expansion in both those lands. But while German and American manufacturers have been able to thus step into new and loftier positions, we in England have had to remain below consoling ourselves with recollections of our past industrial supremacy. Thirty years—perhaps 25 years—ago, hardly any mechanical invention was thought to be worth consideration unless it came from England. But to-day, after a period of 25 years defence of Free Trade, hardly any electrical invention is considered worth looking at unless it is first appreciated abroad. After all, people are apt to forget that inventions spring from laboratories attached to busy but not to empty workshops. Inventions, apart form discoveries, which are very rare, are nearly always evolutions.

Capital.

A great deal has been said of late about the influence of capital being always held ready to further industry abroad, while the apathy of the British capitalist is severely blamed for the backwardness of industry in this land. My experience is that you can always get capital if you can show good dividends. But for the reasons I think I have made plain, we cannot in this country show equally attractive dividends, and for this reason we are deprived not only of the immediate but also of the potential help of capital. In Germany capital helped to directly create industries, as, for example, in electrical engineering, because it was sure of its reward, and over and above this inestimable service capital has helped to regulate output, a very important and delicate matter; but this great service would not have been possible but for what I may term the federating influence of the tariff. It made it worth the while of the capitalist to join hands with the manufacturer, and it also gave capital the right of organising, so to speak, the course of the industry it was befriending. A further valuable result of this nationalisation of industry, for it is nothing less, has been the incentive it has afforded to costly experiments for the application of electricity to any number of allied industries which have enabled electrical engineers of other countries to extend their operations to mining electro chemical, iron and marine work, and in many other directions. But, of course, capital would never have run such risks except with some certainty that in case of success repeat orders would be there to recoup them for all their outlay. Yes, gentlemen, these conditions which I have explained this evening account for the fact that our mining industry, the oldest in this country and in the world, seems unwilling to electrify a mine without a visit to Dusseldorf. The installation of a gas plant or of an electric railway or telephone sends the buyer abroad simply because our manufacturers have no security that if they create anything new their markets will be secured to them. This is why British capital finds greater profit in financing foreign industrial concerns. This is why the Victoria Falls and other great electrical prizes have gone abroad.

Labour.

We are told that if we have Tariff Reform we shall have more trouble with labour. I cannot agree with that view. As long as there are employers and employees there must be differences of opinion between the two as to the value of labour, whether the employers be private, municipal, or the State. These differences have found expression in slack and in prosperous times. I prefer them to happen in prosperous times for the sake of both parties. The worker, when trained to higher skill of efficiency, has a right to demand more and the employer has a greater margin to give, and is more eager to give as he cannot afford, during a time of busy workshops, the emigration to protected countries of the skilled labour such as is going on in such a deplorable manner at present. With regard to labour, it is unhappily true that under a Free Trade system the proportion of skilled labour tends to decrease, while the proportion of unskilled labour increases. But it has been my experience, and I have had unusual opportunities of comparing the relative efficiency of British and foreign labour in the electrical industry, connected as I have been and am with foreign companies which make the same kind of goods as I produce, and I gladly state that British workmen, properly lead, are second to none in the world. British labour may be dearer per head, but it is not dearer per pound of output, neither is it dearer per manufactured article. Given proper industrial conditions, there is, I am convinced, no country in the globe which could steal a march on us. It is a favourite argument with Free Traders that unprotected countries commodities are dearer, but we electrical engineers and manufacturers know that the prime factor in determining cost price is the quantity that can be produced. I am quite satisfied that it does not require a large percentage of duty to secure our market. For instance, if we only had a duty of 10%, foreign competing firms would well understand that that figure could be varied, and in that case they would be placed in the same position of insecurity in our market in which we are to-day. Under such conditions they would probably, in organising their works, be more careful to avoid over production. They would not organise for working our market as they do now. Hence, instead of sending us an unknown quantity of foreign products and for ever depressing our prices, some of these competitors would doubtless start works here, which, of course, would be to the benefit of the working man and the State in general. The manufacturer, on the other hand, would not have any reason to grumble, because he would no longer be liable to be taken at an unfair advantage. The net result would be that we could turn out from our existing works continuously larger quantities securing regular profits, giving regular employment, and at the same time be able to reduce our cost of production. Assuming that last year we imported eight to ten million incandescent lamps, I am bold enough to say that, under a tariff of only 10%, the bulk of those lamps would never have been imported, but would have been manufactured in the existing English workshops, many of which last year were running short time. The cost of production would have been reduced by at least the amount of the duty. Nobody would have been a penny the worse, but the factories would have made some profit and employment would have been larger and more regular, to say nothing of the attendant advantage of a bigger wage fund for distributing among British operatives, which, of course, means an increased power of expenditure in the home market for the benefit of every other industry.

Last, but not least, I will put one question to you. Could our country be equally prosperous and equally secure if it ceased manufacturing altogether? If, in short, we were to buy all we wanted. This may be called an *argumentum ad absurdum*. No doubt it is pushing the Free Traders' argument to its extreme limit, but that is, and nothing less, what the Free Trader maintains. It is possible, nay, likely, that under such a system some people provided with capital and well found in experience might grow yet richer. But imagine for a moment the disastrous effect of such conditions on, firstly, employment; second, on the national wealth. This latter point needs little elucidation. Our rich stores of coal, iron, etc., are natural wealth, but of what value would they be to us if we made up our minds to let them lie in the ground. The nation which elected to follow out a Free Trade policy to its logical conclusion would be equally annihilating its powers of exchange. Grave as such a condition would be, the evil would not stop there. A nation which deliberately stopped manufacturing, that is using its material resources to the best effect, would be taking the shortest and directest route to national suicide. For such a policy would in the highest degree tend to stunt all those qualities which lie at the basis of national efficiency, self-reliance, perseverance, the perceptive and reflective faculties would each and all be weakened. How would a great Empire like ours exist without Dockyards and Arsenals, but the building of Dreadnoughts and the making of 100-ton guns is only one expression of the manufacturing genius which is the basis of civilisation. Having said so much in favour of Protection for the electrical industry, I would like to add that it would sound peculiar that I am at heart a believer in Free Trade, but what I mean by Free Trade is not the spurious type that obtains in England to-day, but Free Trade amongst all nations, and this might even now be brought about by the erection of a tariff barrier as impregnable as those which protect the preserves of our rivals. We have grown so strong through the inherent advantages which exist in our Empire, that the absurdity of running tariff walls against us would become apparent with the results that trade would become free in the

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best sense. Given equal conditions, neither British brain nor British muscle would need artificial bolstering up by tariff. One word more. Those who come, as I do, into personal daily contact with many of the manufacturers of Germany, France and America, and discussed with them international commercial relations, know full well that our competitors fully recognise it as a natural and necessary step that we should protect our industries. Now, as so great a portion of the world is still undeveloped and so many industries are in a state of germination and growth, there is still time to put our houses in order and march side by side with our German, French and American friends in the cause of civilisation. If we hesitate, if we delay, we encourage them to increase their factories as well as their reliance upon the British market. So the day may come when any attempt to do what we can do now will be regarded as a direct disturbance of their national and vested interests, which will be correspondingly resented. Thus it is my view that in the best interests of the country, as well as the electrical industry, manufacturers and workers should be protected now while it can be done with the goodwill of the nations.

Mr. Raworth observed that he was born a Free Trader, bred a Free Trader, and he was afraid he was going to die by Free Trade. Not a single penny was being invested at the present time in England, simply because we were still labouring under the old Tramway Act of 1870, which was made for the purpose of dealing with the horse traffic. That Act was the very beginning of all the persecution of the industry, and the effect of it was that when a Corporation came to buy up tramways made under that Act, they had nothing to buy but old rubbish at prices which nobody imagined at the time they would ever have to pay. Restricted trade meant less profits, and gave the foreigner the opportunity of coming in. The whole point was that Mr. Kingsbury had pointed out the great advantage of Free Trade; but we had not had it.

Mr. Edward Cowan feared that the division was too deep-rooted between those who were assembled in that hall for there to be any reasonable hope that the discussion would modify their existing views or that it would have any useful effect. But they were all agreed, he thought, that the electrical industry was sick, and, therefore, whatever disadvantages there might be in talking of it outside, there could not be any difficulty in facing the problem among themselves. It was foolish to stand idle and do nothing. We might, he added, count up the achievements of the past, as Mr. Mordey did in some very interesting and useful figures, showing that we are ahead, or well ahead, in respect to the consumption of electricity per inhabitant and the cheapness of that supply, but the contemplation of that does not alter the fact that, notwithstanding the amount of fruit the tree has borne in the past, it has at the present moment a disease at its root. The production of electrical apparatus requires the combination of certain necessary factors of production—labour, capital, enterprise, and the ability of the *entrepreneur*, that is, the man whose business it is to put all these different factors of production into combination for the best effect. These elements are all vital in the interests of production, and each factor must receive a sufficient remuneration for its services if that service is to be maintained. Now, is capital receiving to-day in the electrical industry a living wage? Is enterprise receiving a living wage? The answer to both these questions is an emphatic negative. That is the disease the industry is suffering from at the present moment. Every contract given by the London County Council or by any of the municipalities or any corporation in this country upon terms which does not sufficiently remunerate all the necessary factors of production, was destructive in its effect, and was sapping the life-blood of the industry. Without referring to the cause, they might diagnose the disease as a case of destructive competition. They had met together, conscious of this fact, to confer upon the efficacy of Protection or the maintenance of the *status quo* in respect to free imports. Now which of the two systems or methods of conducting our business was likely to cure this disease that they were all agreed upon existed? In his opinion neither of them would cure it. The disease originated in the environment of free imports, and it would continue its destructive course in that environment. A tariff on electrical imports only would afford relief, of course, but there was not the remotest chance of the Government giving them a tariff upon electrical imports alone. The essential difference between the free importer's conception of the effect of a duty and the Protectionist's was this—the Protectionists believed that the gain to some industries would be an absolute gain. The free importer believed that the gain was only a differential gain; that the gain to some was accompanied by an equivalent corresponding loss to others; that while they are filling up one hole they were making another. It was surely worth while to try and see whether they could not agree upon some compromise which was consistent with each side maintaining its own conception of the resultant effects of duties. Could we find a "centre" party solution? Compromises and conferences were in the air at the present time. I venture to make a suggestion, he said, and it is that we should unite in banishing from our industry the rigid—and here I know Mr. Hirst will agree with me—the rigid application of the doctrine of *laisser faire*. We can never have united action without sacrifice of some of our own particular notions, and without union we can do very little. Therefore, I say, leave the State alone for the present, and let us voluntarily co-operate for two main objects—first, to eliminate destructive competion; and, secondly, to attain higher economy by the regulation and organization of production in the same way that the railways did in the very early days of their development, and the steamship companies have followed on the same lines. To abolish destructive competition we do not need the assistance of the State, but we do need the co-operation of electricity supply works engineers and their committees, and councils and of consulting engineers, as representing the consumers' interests. The support and co-operation of the consumers is, in my opinion, essential to success. It must be realised that we are not combining to secure monopolistic profits—if it is once thought that we are doing that then all hopes of doing anything will be gone; but that we are merely seeking to put our house in order for the benefit of those who use electricity and electrical apparatus, as well as for our own benefit.

Mr. G. Harland Bowden ranged himself on the side of Mr. Hirst—the side of the practical as against that of mere assumption. Mr. Hirst proved quite conclusively that this country had prospered during the last 60 years, in spite of Free Trade, from engineering enterprise. Speaking as a contractor, he said that if there was anything in the Free Trade cheap market he would like to consider it, but he firmly believed that by adopting a carefully thought-out system of scientific tariffs this country would bring back into existence several decading industries, giving employment to our people. The electrical industries would benefit and share in the demand thus created, and join in the national prosperity which would certainly result. It could not be said that the electrical industries in this country were in a flourishing condition. On the other hand, electrical industries in protected countries were in a flourishing condition, employing a greater number of men, who were earning a rate of wages higher than that paid in England. By imposing a reasonable duty on foreign iron and steel, a duty which would prevent our large railway companies spending big sums of money abroad on purchases of rails, we would encourage the British iron and steel industries to employ more men and re-open works which had had to be closed down, and we would at once create a demand for more electrical apparatus. He would have welcomed a vote on the question. In Tariff Reform rested our hope for the future.

Mr. Bennett Fitch said he believed Tariff Reform was the most important question of the day. The cause of our national prosperity in the early 'sixties, and for some years later, was entirely due to development of engineering and mechanical knowledge.

At the suggestion of Mr. Garcke, the discussion was adjourned for a fortnight.

CATALOGUES AND PRICE LISTS.

Messrs. Julius Sax & Co., Ltd., in leaflet No. 51 give particulars of their electric trembling bells, which embody Sax's original rubbing contact system. The bells are made in a number of sizes and special gongs, known as the "Dome," "Sheep," "Church," and "Wire" gongs. These bells can be fitted with continuous ringing attachment, wound for special resistance, or arranged for high voltage circuits.

The Maschinenfabrik Oerlikon's latest leaflet deals with variable speed induction three-phase motors for driving ram pumps, centrifugal and turbine pumps, main fans, rolling mills, haulage gears and tools of all kinds.

Messrs. W. N. Brunton & Son's new catalogue of Wire Ropes and Fittings for Mining is reduced to the smallest possible compass compatible with usefulness. This has been accomplished by omitting all extraneous subjects, but all practical information is given, often in the form of tables.

The Cromil Engineering Co. are issuing a hang-up illustrated card giving directions for lubricating engine cylinders with graphite.

From Messrs. Henry Wallwork & Co., Ltd., come two pamphlets, one dealing with Worm Reducing Gear applied to winches, haulage machines and pumps, and the second to High Efficiency Gearing, its application, design and testing. The firm's system of testing worm gearing is most elaborate and should certainly tend to safety and economy.

Telegraphic and Telephonic Materials, including iron poles, insulators and other fittings form the subject of an elaborate publication (pamphlet No. 11) issued by Messrs. Siemens Bros. Co., Ltd. Each article is illustrated, while diagrams, tables and all necessary information are given. Another fine production is pamphlet No. 500, a bound volume containing a most instructive illustrated description of the firm's works at Woolwich. The extent and splendid equipment of this establishment with its numerous branches are well brought out.

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TESTS OF AN ILGNER ELECTRIC HOIST.*

By R. R. Seeber.

In the copper mining district of northern Michigan a fair-sized mine usually operates two or more shafts along the strike of the lode, these shafts being usually at least a thousand feet apart. The tonnage to be hoisted from each shaft is large—from 13,000 to 25,000 tons per month. The hoisting engines used are generally steam-driven, non-condensing, duplex engines with Corliss valves, supplied by steam from separate boiler plants where the distance between shafts is great.

In an attempt to centralise power plants and secure central station economies, the Winona Copper Company installed an electric hoist of the Ilgner type, with Ward Leonard control. The only point of variation from the simple Ilgner set lies in the connection of two generators to a single induction motor by flexible couplings. These generators serve motors which operate hoisting drums at separate shafts, viz., No. 4 shaft Winona, and No. 1 shaft, King Philip. The hoist for No. 4 shaft is about 1,700 ft. from the power plant and in this building the motor-generator set is placed. No. 1 King Philip hoist is 1,500 ft. from the motor-generator set. The equipment of the motor-generator set is as follows:

In the middle of the set is a 12-pole, 450 h.p., 600 r.p.m., 2,080 volt, three-phase, 60-cycle, variable-speed, induction motor, connected on each side to a 20-ton flywheel which is 10 ft. in diameter, and to a 6-pole, 170 kw., 575 volt, interpole, direct-current generator. On each side of the shaft is placed a separate exciter which delivers current at 125 volts. The lubrication of the four main bearings that support the flywheels and direct-current generators is supplied by two sets of oil pumps, belt-driven from the shaft.

The hoist motors are 6-pole, 200 h.p., 430 r.p.m., 550 volt motors, and are shunt wound. The fields, both of this motor and the direct-current generators are excited by current from the exciter on the motor-generator set, which is kept at a constant voltage of 125 by voltage regulators. The current in the hoist motors is varied and reversed through controllers of the usual railway type, placed in the field circuit of the generators. The first point on the controller operates a contactor which closes the main circuit from the generator to the motor.

The alternating current for operating the motor-generator passes through a regulator which automatically varies the resistance in the rotor of the motor-generator set in proportion to the demand of the motor for current.

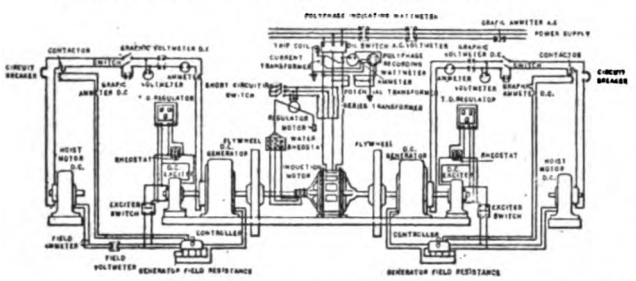

FIG. 1.—DIAGRAM OF CONNECTIONS OF MOTOR-GENERATOR SET.

During February, 1910, detailed tests of this set were made to determine the performance under varying conditions, and to procure coal-to-rock ratios to compare with ratios for steam hoists under similar conditions.

On the switchboard controlling the set, the following instruments were already installed:

Alternating current indicating ammeter.
Recording wattmeter.
Direct-current ammeter and voltmeter for each direct-current generator.

In addition for the purposes of this test, the following instruments were installed, as shown on the diagram, Fig. 1:

Two 600-0-600 direct-current graphic voltmeters, one in each generator circuit.
Two 800-0-80 direct-current graphic ammeters, one in each generator circuit.
One 125-ampere alternating current graphic ammeter.
One 125-volt direct-current indicating voltmeter.
One 100-ampere direct-current indicating ammeter.
One indicating wattmeter with necessary current transformers.
One 600 r.p.m. tachometer.

No. 4 shaft Winona is served by the hoist drum in the same building as the motor-generator set. This is an old duplex steam hoist, with the cranks disconnected. The motor drives the old crank shaft through gearing. The drum is 7 ft. in diameter and holds 1,500 ft. of rope. The rope is $1\frac{1}{8}$ in. in diameter and weighs 2 lb. per ft. No. 4 shaft is double-compartment and the skips work in balance. Because at present very little hoisting is being done in this shaft, only the south skip is used for loads and the north skip carries 2,100 lb. of rock to lessen the starting moment. At the time of the test the north skip had filled with ice, so that the total counter-balancing weight was 3,300 lb. This caused more power to be used for the lowering of the south skip than for hoisting it. The loaded skip weighed 5,400 lb. Of this amount, 3,300 lb. is counter-balanced leaving only 2,100 lb. of rock and the hoisting rope as the net load.

No. 1 shaft King Philip is operated by an old geared steam hoist, with the cranks disconnected and the crank-shaft geared to the motor in the same manner as at No. 4 Winona. The drum is 5 ft. in diameter and holds 1,200 ft. of 1 in. rope, weighing 1·58 lb. per ft. The shaft is built with two compartments but only one skip is running, leaving the hoist unbalanced.

The skips in both shafts are the same and weigh 2,900 lb. each. Each holds 2·7 tons of rock when full. The test was conducted under normal working conditions and the loads varied. During the time of test, a man was stationed at the brace of each shaft to observe the fulness of the skips. The average distance of the rock from the top of the skip was estimated for each load and a correction was applied.

The work at present being done at these shafts is comparatively small, because only development work is under way. Since all reliable information that I had concerning the operation of steam hoists was at a hoisting rate of 12,000 to 15,000 tons per month, we arranged to hoist from each shaft for an hour at near this rate. During all this time the curve-drawing instruments were in operation and gave accurate records of each operation. Readings of the alternating-current wattmeter, voltmeter, and ammeter were taken every five seconds. The starting and stopping time of each of the hoist movements was taken, and the nature of the load recorded. The speed of the motor-generator set was taken at regular intervals.

Adding the total tons hoisted at Winona to the total tons hoisted at King Philip during the same period gives an equivalent of 131 tons hoisted from a depth of 600 ft. in a 70° incline. The total kw.-hours taken by the motor-generator set during this hour was 211. This output was determined by reading an indicating wattmeter every five seconds and taking the average. The power necessary to hoist one net ton of rock from a depth of 600 ft. on the incline was 1·61 kw.-hour.

Tests of our power plant, under present light-load conditions, have shown that it requires about four pounds of coal to produce one kw.-hour delivered on the switchboard of the motor-generator set. The amount of coal required to hoist a ton from this distance is therefore 6·44 lb., giving a coal-to-rock ratio of 1 to 310.

Winona	..	70·15 tons
King Philip		60·88 ,,
		131·03 ,, hoisted at 600 ft. depth on 70°

211 kw.-hour taken by set.
1·61 kw.-hour per ton.
6·44 lb. coal per ton at 4 lb. coal per kw.-hour.
Coal-to-rock ratio = 1 to 310.

For purposes of comparison with the steam hoist conditions, I have tabulated the results in rock hoisted and kw.-hours taken by the motor-generator set for an average day.

* Abstract of Paper presented to the American Institute of Electrical Engineers, New York, March 11, 1910.

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16 hours 211 kw. = 3,376 kw.-hour
4 „ 80 kw. = 320 „
1 hour 55 kw. = 55 „

Total of 3,751 kw.-hours.

3 hours shut down.

Total of 24 hours.

Rock is hoisted during but 16 hours of the time, making the total rock hoisted for both shifts 2,096 tons; or 1·79 kw.-hour are required to hoist one net ton of rock from a depth of 600 ft. on a 70° incline. This makes the coal-to-rock ratio for the above conditions 1 to 279.

The theoretical value of kw.-hours per ton hoisted taken from Fig. 21 of the paper presented by Messrs. Rushmore and Pauly is 1·7 kw.-hour. Taken from the curves in Fig. 22 for the 8,000 ft. hoist, this value is 1·55 kw.-hour.

At the D shaft of the Champion Copper Co., a 24 in. by 60 in. duplex Corliss engine operates a double conical hoist drum. The shaft inclination is about 70° the skips working in balance. The boiler plant supplies the rock-house engine and dry in addition to supplying the hoist. For the first four days of November, 1905, the boiler plant supplied the hoist alone. The coal-to-rock ratio for these four days, at 600 ft. average depth, was 1 to 154. Using a percentage of fuel burned for the rock hoisted, obtained from results of this four days' test (68·4% to

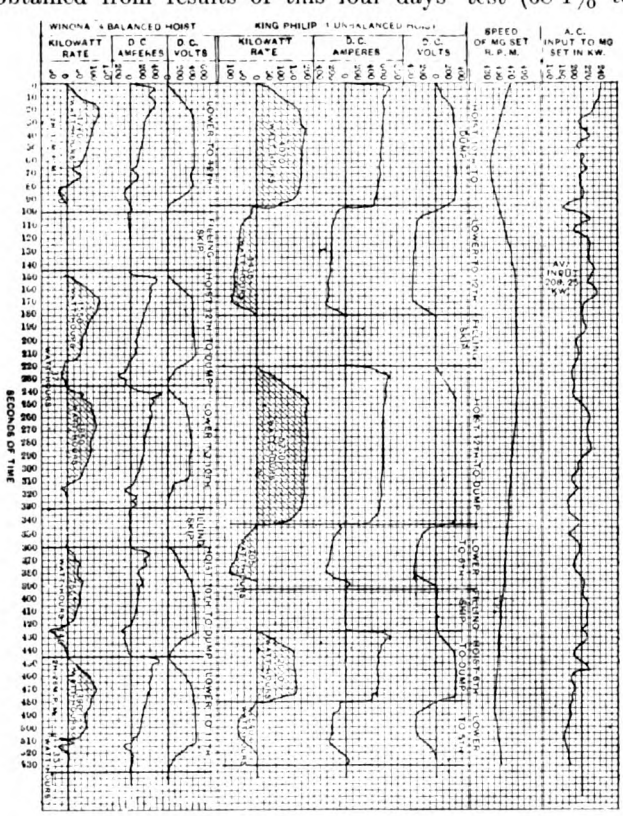

Fig. 2.—Operation of Motor-Generator Set.

hoist), the ratio for the remainder of November was 1 to 185, showing gain by better boiler load. For December of the same year on the same basis, the ratio was 1 to 166. The average load of rock was 2·1 tons, the total amount hoisted in a month being about 15,000 tons.

At the Winona mine, No. 3 shaft was operated in June, 1907, by a separately-fired boiler plant. The hoist is a duplex geared hoist with a rolling valve. The shaft is inclined 70° from the horizontal and the skips work in balance. The average load of rock was about 2·1 tons. In June, the coal-to-rock ratio at 600 ft. depth, figured as before, was 1 to 124. In August and September, 1907, this hoist was supplied from a larger plant, the hoist being 15 to 20% of the whole load. The distribution of coal which we made gives a ratio of 175 to 200.

The following tabulation compares these ratios:

Electric hoist, two shafts, Winona; coal-to-rock ratio 1 to 279.

Champion *D* hoist; steam (alone); coal-to-rock ratio 1 to 154.

Champion *D* hoist, with rockhouse; coal-to-rock ratio 1 to 185.

Winona No. 3 hoist, steam (alone); coal-to-rock ratio 1 to 124.

Winona No. 3 hoist, steam (central plant)—coal-to-rock ratio 1 to 175, to 1 to 200.

I feel satisfied from these figures that, even with steam generated in a central plant, a coal-to-rock ratio of 1 to 200 is about all that can be expected from steam hoists of this type, under the given conditions. This shows a coal saving by the electric method of 25% over the steam method.

Fig. 2 shows the operation of the motor-generator set and both hoist motors for a typical section of about nine minutes length, taken from the one-hour test. The curves here shown will serve to describe most of the operation. The top curve shows the alternating-current input plotted from five second readings of the indicating wattmeter. The average for the nine minutes is 208·25 kw. or slightly below the average input for the hour.

The second curve shows the speed of the motor generator set, the extreme variation being from 440 to 480 r.p.m. during this period.

The next three curves show the volts, amperes, and kilowatts output of the direct-current generator driving the No. 1 King Philip motor.

The last three curves show the volts, amperes, and kilowatts output of the direct-current generator driving the Winona No. 4 hoist for the same period.

Where electricity is used for hoisting, the main reason for using an Ilgner flywheel set is to take the peak loads off the power station. How well this is accomplished is shown by comparing the input curve of the diagram with

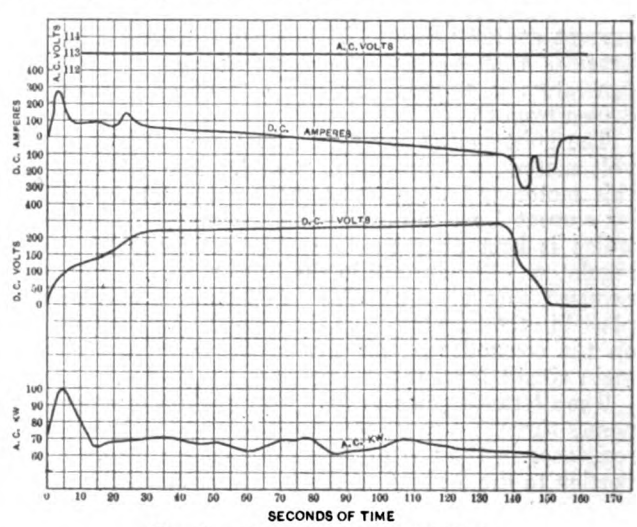

Fig. 3.—Restoration of Energy.

the two curves of direct-current output. Incidentally, this method utilises the energy of a descending unbalanced skip, the motor acting as a generator and restoring energy in the fly-wheel. For the King Philip hoist, unbalanced, the amount thus restored is comparatively large, varying from 20% to 35% of the energy required to hoist the loaded skip from the corresponding level. This variation is due to variation in the loading of the skips. On the Winona hoist, balanced, the amount of energy thus restored is very small and occurs only when the motor is used as a brake at the close of the hoisting period.

The restored energy for both cases is shown on the shaded areas below the line. An interesting example of this restoring action is shown (Fig. 3) on Winona No. 4 hoist, where men are being hoisted on the south skip. Energy is required at starting but the demand gradually decreases and at about the eighth level the weight of the descending north skip counterbalances the ascending skip. During the remainder of the hoisting period energy is being stored in the fly-wheel.

Where a double compartment shaft can be used and the skip and rope can be counterbalanced by duplicates in the other compartment, the counterbalancing skip being ready for a paying load on reaching the bottom, it is obviously not economy of power to use any other system of restoring the energy of the descending skip. The efficiency of any other system will be very low compared to the efficiency of the counterbalancing skip where the only losses are friction and air resistance.

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Fig. 4 shows the current output of the King Philip generator when hoisting a full skip from the twelfth level, and the energy restored to the set when lowering the same skip still full. This was done twice, as shown.

The watts used in hoisting the first time were 4,250; watts returned lowering were 2,243, showing an efficiency

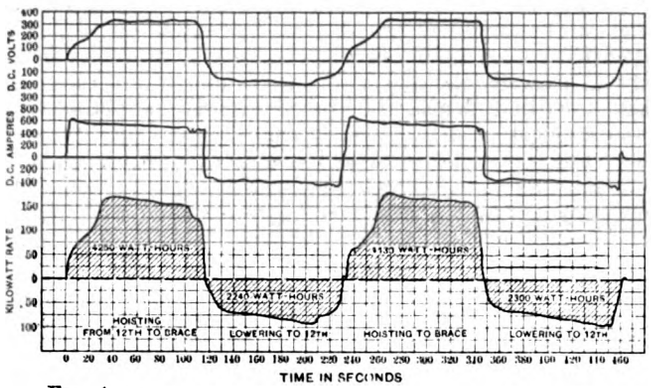

FIG. 4.—ENERGY EXPENDED IN HOISTING AND LOWERING UNBALANCED HOIST.

of restoration of 52·8%. The watts used hoisting the second time were 4,430; the number of watts returned lowering the second time was 2,300, showing an efficiency of restoration of 51·9%.

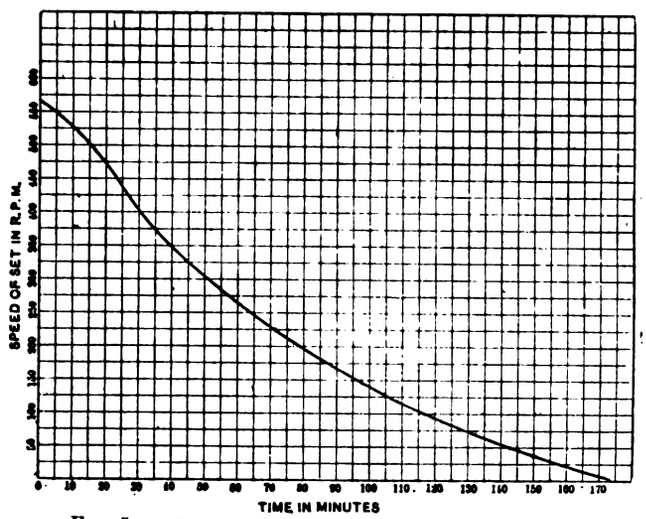

FIG. 5.—RETARDATION OF MOTOR-GENERATOR SET.

Fig. 5 shows the decreasing speed of the motor-generator set, after the power is shut off on Saturday nights. About three hours are required for the set to come to rest.

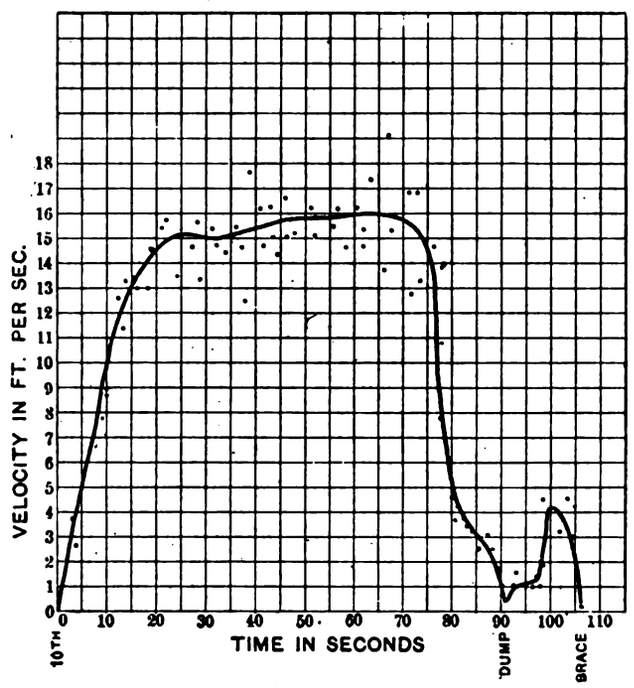

FIG. 6.—VELOCITIES OF HOISTING.

Fig. 6 shows the acceleration of the skip and the rope speed for the hoisting period.

The greatest disadvantage of the Ilgner system is a constant loss in windage and bearing friction of the motor-generator set itself. Observations have shown this loss for the set at this plant to be very nearly 55 kw. This loss can be reduced materially by casing the fly-wheels. When the work done by the hoist is large enough to make the proportion of this constant loss small, an Ilgner fly-wheel set adds fuel saving to the saving of labour, etc., due to the centralisation of the power plant.

The use of this system enables us to dispense with two boiler plants and their firemen. It would have been necessary, also to build larger boiler plants, with railroads and coal trestles to serve them. The hoists themselves handle the skips much better than the steam hoists, starting from rest very smoothly. The large amount of repair work necessary on a reciprocating engine is also done away with.

MERCURY VAPOUR AND ITS PROPHET.

Mr. Peter Cooper Hewitt might well be called the prophet of mercury vapour in the field of electricity. His mercury vapour lamp has been recognised as a practical invention capable of being commercially utilised not only in illumination proper, but as a splendid medium for photo-printing, and latterly as a handy and efficient aid to sterilisation of liquids and possibly also of solids. Then came the mercury-vapour rectifier and the mercury-vapour interrupter, which many look upon as one of the most promising departures in securing effectiveness in syntonic and wireless telegraphy. The United States, in confirming the patents relating to this last invention, declare him to be the discoverer of a fundamental principle in electrical science for the rectifying

of an alternating current to a unidirectional current. The Court defined the invention as "the combination of an hermetically sealed enclosing chamber, a gas or vapour path therein, a plurality of positive electrodes and a common negative electrode, each of the positive electrodes being connected with a separate source of current." Mr. Cooper Hewitt, who is a wealthy man, coming from a wealthy family, is a hard worker, not only in the electrical science, but in automobolism and aviation, as well as a keen man on the commercial side. He is a member of the American Institute of Electrical Engineers, the American Physical Society, New York Electrical Society, and several other scientific and business associations. As our portrait shows, he is still a young man (born in 1861), so much may be still expected from him.

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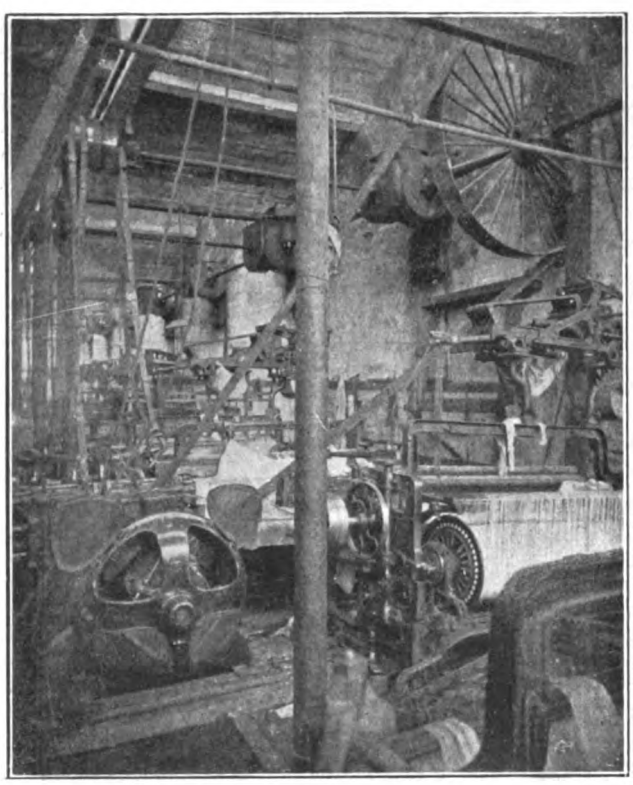
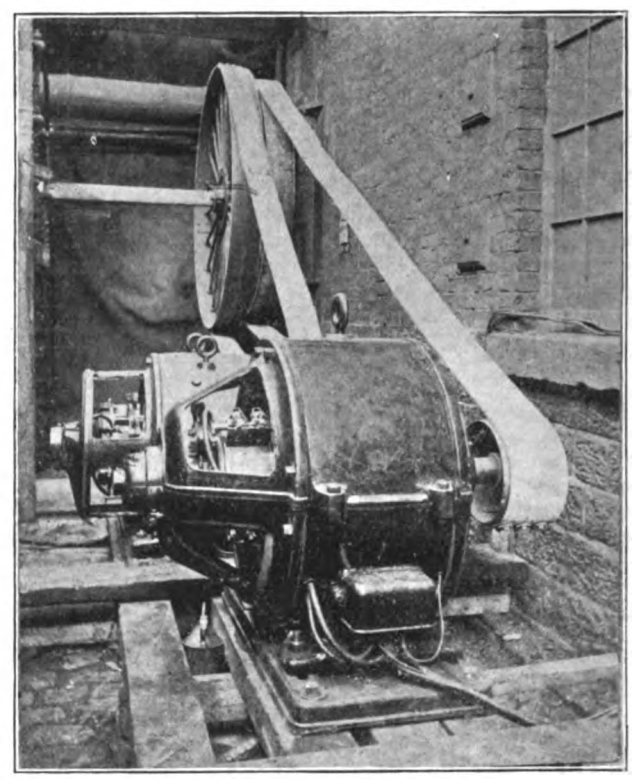
FACTORY BREAKDOWNS AND ELECTRICITY.

It will be remembered that early in March, Mr. Roles, the City Electrical Engineer of Bradford, was happy enough to come to the rescue of a steam-driven packing case factory which broke down. On that occasion it was agreed to put down a 45 h.p. electric motor, as being the quickest way of getting the premises running once more. To obtain the necessary supply a cable trench 86 yards long had to be excavated across the road under the tram lines, at which point the digging reached a depth of 5 ft. The motor was got ready and taken to the side of the breakdown, where it was fixed. Within 36 hours of the mishap the premises were running as if nothing had happened, the whole of the work being done by men in the electricity department.

More recently a rather similar accident, only on a larger scale, was equally successfully tackled at Blackburn. In this instance Mr. P. P. Wheelwright had to deal with the 820 loom steam-driven Struan Cotton Mill, owned by Messrs. John Yates (Blackburn) Ltd: One day, when the mill was in full working order, the second motion pinion wheel on the main shaft had one of its teeth broken, with



the result that there was a jamming with the fly spur wheel, three of its teeth giving way under the shock. Naturally enough all the bearings and gearings were smashed, the shaft strained, and the whole of the 820 looms in the mill brought to a standstill. Engineers found that the repairs would take at least a fortnight, and under the circumstances a director of the company appealed to the Corporation Electricity Department to see whether they could supply motive power in place of the disabled engine. Mr. Wheelwright and the staff turned to at once. They received information of the affair at noon on the Saturday, and by the Monday morning an electric motor was installed in the top shed of the mill, which was driving 100 looms out of the 820, connection being made between the motor and the looms by means of a large temporary pulley affixed to the driving shaft. By Tuesday morning another motor was put down, which drove another 100 looms, and the following morning a third motor added another hundred to the total of looms restarted. Some of the many practical difficulties to be overcome were thus described by an eye-witness. The motors themselves having to be brought into the shed piecemeal and built up there, while there were all the necessary electrical connections and a switchboard to erect. Then on the Thursday morning 250 looms out of 400 in the bottom shed were re-started by connecting up two other motors with the driving shaft. The electrical staff had not a single motor which was at the same time large enough, powerful enough, or of the right speed to drive the whole of the 400 looms. They, therefore, brought in two smaller motors, but here again there was a difficulty, because these motors ran at different speeds and were of different sizes and powers, and, therefore, if both were connected with the single driving shaft, there might have been a tendency to pull against each other. This difficulty was got over by carefully adjusting different sized pulleys on to the shaft, and more exact adjustment was possible by slightly speeding up one motor and slightly slowing down the other. By this means the 250 looms were quickly set running smoothly, and thenceforth worked admirably. The power was supplied to the motors by cables which were carried over the roof of the shed and connected with the underground cables in Eanam. In addition to running the ordinary hours, the firm made arrangements with their



men weavers for 350 looms to be worked overtime from a quarter to six to eight o'clock each evening, and in this manner, along with the invaluable assistance of the electrical staff of the Corporation, the mill has been enabled to run at practically its full working capacity, in spite of the breakdown, and the firm will not suffer loss upon the pressing orders mentioned, while the workpeople have gained the benefit in wages. While, of course, the matter has been a purely business arrangement between the firm and the Corporation Electricity Department, the chairman of directors (Mr. Kay) and his son, Mr. Arthur Kay, also a director, pay the highest possible tribute to the energy and enterprise of Mr. Wheelwright and his staff in carrying out the work with such celerity and effectiveness in the face of many practical difficulties.

It is anticipated that one result of this prompt and satisfactory piece of work is likely to give a real impetus to textile mill electrification in the district. It has certainly afforded a most useful object lesson to all concerned.

ELECTRICAL ENGINEERS TERRITORIALS (London Division).—Orders for the week ending, June 4. Monday, May 30, "A" Company, Recruits' Infantry Drill, 6 to 6.45 p.m.; Company Drill, 7 to 9.30 p.m. Tuesday, May 31, "B" Company, Company Drill, 7 to 9.30 p.m. Wednesday, June 1, Gymnasium, 6 to 9.30 p.m. Thursday, June 2, "C" Company, Recruits' Infantry Drill, 6 to 6.45 p.m.; Company Drill, 7 to 8.30 p.m.; Technical Drill, 8.45 to 9.45 p.m. Friday, June 3, "D" Company, Recruits' Infantry Drill, 6 to 6.45 p.m.; Company Drill, 7.15 to 8.30 p.m.; Technical Drill, 8.45 to 9.45 p.m. Saturday, June 4, "Drill Competition." Drill Parade at Headquarters, 3.30 p.m. Dress, Service dress with putties. Arms will be issued at 3.30 p.m.; equipment to be worn, belt, frog, haversack and water-bottle.—C. H. Campbell, Captain R. E., Adjutant, for O.C.E.E., L.D.

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THE

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Displayed Advertisements intended for insertion in the current week's issue, and alterations for standing advertisements must reach the offices by 9 a.m. on Monday if proofs are required.

Contracts, Patents and Small Advertisements by 9 a.m. on Wednesday.

Terms for displayed advertisements may be had on application.

Second-hand Plant and Machinery Advertisements, 24 words 1s. per insertion, three insertions for 2s. 6d., each additional line of eight words 4d.

Situations Vacant, 24 words 1s., three insertions 2s. 6d.

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Municipal Central-Station Engineers and Tramway Managers are invited to send advance notes of new work being undertaken by them, and of successful results obtained from the undertakings under their charge.

Secretaries and Managers of Companies are asked to furnish Notices of Meetings, Issues of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers.

Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

Contractors can make use of our columns to obtain the names of the makers of any specialities they require in their business.

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ELECTRIC DRIVE FOR MACHINE TOOLS.

There is an evident quickening in the recognition of the advantages gained by the electric drive. We see this in the busy manufacturing centres, where more and more shops are being equipped with electrically driven shafting, or with machines with individual motors. Again, evidence is forthcoming in the rapidly increasing number and variety of machine tools placed on the market with electric drive fittings. Up and down the country there are, in the aggregate, an enormous number of machines in small factories and home workshops driven by electricity. These include, for the most part, lathes, drills, grinding machines and to a lesser extent planers. On the Continent what we may call the domestic use of electrically driven machine tools is adopted on a very extended scale; for instance, among the working jewellers and makers of *articles de Paris* in Paris, and, as we recently pointed out, even in such industrially backward centres as Moscow, where, indeed, the adoption of the electric drive by home workers is actually bearing hardly upon the larger manufacturers. We have not come to this general adoption over here, though satisfactory advance is being made. Perhaps a more interesting phase is that of factory electrification. We have several good examples of machine shop electrification in England, and many more of partial electrification. But probably the largest and more elaborate equipments are to be found in the United States. Some points of American practice are dealt with by Mr. Charles Fair in another part of this issue, and he brings out not only particulars as to detail equipment, but the advantages of the system itself. Briefly, these are simplification of shafting, doing away with counter-shafting, reduction or total abolition of belts with all their attendant troubles and expense, and consequent gain of light and head room for hoists, etc. Moreover, it is easier to make the utmost use of floor space where the electric drive is used either for groups of machine tools, or for running tools with individual motors. The greater flexibility, too, is soon appreciated. In the early days of the application of electricity

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to driving machine tools much was made of the necessity to adapt motors and so on to the special tools. No doubt attention must be paid to this matter and wise adaptation to the ends in view are to be commended. At the same time it is easy to exaggerate the need of such modifications. In actual practice it is found that there is no great difficulty even in driving old machine tools by electricity, considerable advantages being gained in spite of short lengths of belting often having to be used in such cases. But most machine tools are now made ready to be coupled with standard types of motors, and really the complication is not by any means great. Where special study is of very real benefit is in the matter of control appliances, and here our British manufacturers hold a deservedly high place in the esteem of mechanical engineers and the users of machine tools. The whole subject is one which is daily assuming more importance in the eyes of those anxious for the scientific organisation of our industries. Everything should be done to foster this movement, which should turn out to be one of considerable moment to the electrical industry.

FULHAM ELECTRICITY UNDERTAKING.

The Electricity Undertaking of the Metropolitan Borough of Fulham has had a most prosperous year, and efforts to extend service are to be made. With this view it has been decided :—

(*a*) That the wiring and fitting of 500 consumers' premises complete for electric light, for approximately six lights, on deferred payment be carried out at a total estimated expenditure of £2,000, made up as follows: Wiring and fitting, 500 at £2 8s., £1,200 ; 500 transformers at 15s., £375 ; 3,000 lamps at 2s., £300 ; provision for extra points where required, £125 ; total, £2,000 ; (*b*) That as a general policy, the wiring of premises under this scheme be carried out by local contractors, who have carried out a fair amount of work in the Borough, at schedule prices according to specification to be prepared by the Borough Electrical Engineer, and approved by this committee ; (*c*) That the system of wiring to be adopted, be determined by the Borough Electrical Engineer according to circumstances in each case ; (*d*) That the charge for current consumed as recorded by the prepayment meters under this system be fixed at the following rates, viz. : (i.) Where the Council provides the requisite lamps upon the landlord's undertaking to defray the cost of all renewals, other than as may become necessary through ordinary wear and tear, the charge per unit be 5½d. ; (ii.) Where, failing an undertaking from the landlord, the tenant provides the requisite lamps, the charge be at the rate of 5d. per unit.

The Electricity and Lighting Committee also reported: "With regard to the proposed introduction of a less powerful outside shop lamp at a fixed annual charge, according to candle-power, for all practical purposes this would be an extension of the present arc lamp rental scheme and would supply the demand which is said to exist for a less powerful illuminant at a lower fixed charge. The suggestion is that the Council should arrange to supply, fix, maintain, clean and renew a suitable outside lantern with 13 in. reflector globe and bracket for fixing to shop facia (the customer providing his own wiring up to the bracket), the lighting being by metallic filament lamps of either 100, 200, 300 or 400 c.p. at the following fixed charges, viz. : (*a*) A fixed charge of £1 3s. per lamp installed irrespective of candle-power, to be paid on lamp being fixed. (*b*) A quarterly payment in advance according to power of lamp installed, as follows : 100 c.p. size : Two winter quarters at 15s., £1 10s. ; two summer quarters at 5s. 6d., 11s. ; annual inclusive charge, £2 1s. 200 c.p. size : Two winter quarters at 20s., £2, two summer quarters at 16s., £1 12s. ; annual inclusive charge, £3 12s. 300 c.p. size : Two winter quarters at 30s., £3, two summer quarters at 21s., £2 2s. ; annual inclusive charge, £5 2s. 400 c.p. size : Two winter quarters at 40s., £4, two summer quarters at 26s., £2 12s. ; annual inclusive charge, £6 12s. The present form of arc lamp rental agreement may be adapted to apply to these lamps, as the conditions are practically identical.

The Committee further recommended : (*a*) That the introduction of metallic filament lamps for outside shop lighting at fixed charges according to candle-power and payable by instalments as above indicated be approved and adopted. (*b*) That all current supplied in excess of 870 hours per annum be charged for at the following rates, viz. : For 100 c.p. lamps, ½d. per hour ; for 200 c.p. lamps, 1d. per hour ; for 300 c.p. lamps, 1¼d. per hour ; for 400 c.p. lamps, 1½d. per hour.

This was approved.

HULL CORPORATION TELEPHONE RECEIPTS.

At a meeting of the Hull Corporation Telephones Committee, the manager (Mr. T. Holme) submitted his annual report, which showed the gross receipts amounted to £11,670, an increase of £1,076 on the previous financial year, and there had been a gross profit of £4,823, as against £4,443 for the previous year, an increase of £380. They had transferred to loan repayment account £1,994, an increase of £208. The total amount carried to loan repayment account is now £5,668, to temporary sinking fund £1,948, and to reserve fund, £3,380, being a total (including this year's surplus of £1,170) of £12,166, after deducting the cost of diverting the post office junction circuits. The Government royalty amounts for the year to £1,188, and the total of this account to March 31, 1910, is £4,966. The capital account totals £60,315, compared with £57,858, being an increase of £2,456, which has been expended on extending the plant under the main headings of underground, overhead, and instrument construction. On underground construction the amount expended during the year has been incurred in laying 1,620 yards of conduits and extending the cable system by cables containing 154 miles of metallic circuit. The total conduits now laid measure 37 miles, and the underground mileage equals 4,050 miles metallic circuit, or 8,100 miles of single wire. On overhead construction the amount expended during the year has been incurred in joining up additional subscribers and extending the overhead routes in the area by the erection of 27 poles. The total overhead mileage is now 581 miles of metallic circuit, or 1,162 miles of single wire, and the number of poles erected 1,370. The expenditure on instrument construction during the year has been incurred in joining up additional telephones, also private branch exchanges, extension bells and sundry apparatus. The cost per station now stands at £20·58 compared with £21·42 last year, and it is now a certainty that the actual cost of the scheme will be below the estimates. The cost per station of the National Telephone Co. is £31·5, and the Post Office £52.

DIARY.

FRIDAY, MAY 27.

PHYSICAL SOCIETY OF LONDON.—Imperial College of Science, South Kensington, at 5 p.m. Dr. W. H. Eccles on "An Oscillation Detector actuated solely by Temperature of Resistance"; Mr. A. Eagle on "Exhibition of a Resonance Transformer"; Mr. S. W. J. Smith on "The Limitations of the Wetson Cell as a Standard of Electromotive Force."

TUESDAY, MAY 31.

FARADAY SOCIETY.—8 p.m., in the Rooms of the Chemical Society, Burlington House, Piccadilly, W. The following papers will be read : "Some Practical Experience of the Sherardising Process," by J. W. Hinchley, M.Sc. ; "Note on the Composition of Eutectic Mixtures," by Cecil H. Desch, D.Sc., Ph.D. ; "Relations between Critical Temperature, Boiling-Point, and Expansion Coefficient of Phosphorous Pentachloride," by E. B. R. Prideaux, M.A., B.Sc ; "Thermic Reactions in Vacuo," Parts I., II., and III., by Frank E. Weston, B.Sc., and H. Russell Ellis, B.Sc. ; Messrs. C. V. Biggs and W. Pollard Digby will exhibit and give a short demonstration of, (1) Apparatus for the Rapid Determination of the Resistance of Liquids ; (2) Apparatus for the Determination of Specific Resistance of Oil.

SATURDAY, JUNE 4.

ROYAL INSTITUTION (Albemarle-street, W.).—At 3 p.m. Professor J. A. Fleming, D.Sc., F.R.S., on "Electric Heating and Pyrometry" (The Tyndall Lectures, Lecture I.).

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PUBLICITY.

In this Section of "The Electrical Engineer" we give Publicity to New Inventions and Specialities.

Helsby Wireless Telegraphy and Telephone.

A strikingly convincing demonstration of the telegraphic and telephonic systems worked under patents controlled by the Helsby Wireless Telegraph Co., was made at the Crystal Palace, Sydenham, on Monday before representatives of the technical press.

The Helsby radio-telegraphy system embodies many novel and valuable features. One's first impression is the silence, compactness and simplicity of the apparatus used, for all the instruments are assembled in separate cases, which when assembled and bolted together form a small cabinet, connections being made automatically by plug contacts, the operating table being close handy or at a distance. This arrangement is shown in Fig. 1, and it will be seen that the question of installation is thereby made very easy. When we study details, it is evident that problems of simplifying everything, and making the system easy to be used and controlled by anyone having a knowledge of ordinary telegraphy has been kept well in view right through. The basis of the whole system is to utilise a rectified high tension alternating current to charge a storage condenser, whence a small charge is withdrawn continuously to energise the oscillatory circuit. A high tension transformer of novel construction has its primary fed from a suitable supply, while its secondary terminals are connected respectively to the junction of two valves, and to the conductor joining the storage condensers in series. The terminal plates of the condenser battery are connected through conductors whose resistance is so adjusted to give the required high group frequency while avoiding the production of an arc. The group frequency is governed by the relation between the capacity of the condenser in the oscillatory circuit, the break down voltage of the spark gap, and the resistance of the supply leads. As each storage condenser is alternately charged to the full potential available at the secondary terminals of the transformer, while both are in series in relation to the leads supplying the oscillatory circuit, twice the secondary voltage is impressed on the latter.

The modifications introduced in the company's transformers are of the greatest importance as regards securing efficiency. By an ingenious arrangement, the peripheral distribution and method of insulating the iron tails, or wires, provides for efficient cooling, while placing the whole of the magnetic medium in proximity to the winding, where it acts most effectively. Another advantage is that the mass of iron can be reduced, with the result that the total hysteresis loss is less. It follows also that the demagnetisation is more rapid, so the transformer can be worked continuously without heat being generated to any extent, and the formation of eddy currents is prevented.

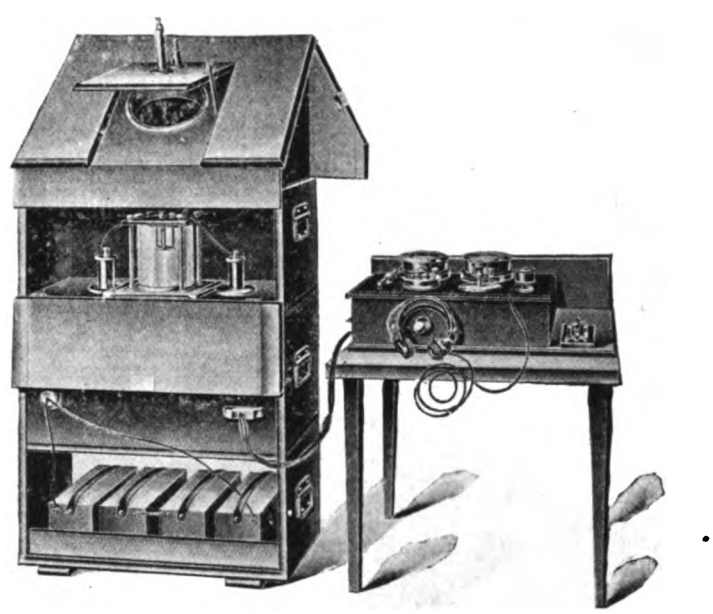

FIG. 1.—WIRELESS TELEGRAPH APPARATUS FOR SHIPS, YACHTS, TRAWLERS, ETC.

We have alluded to the silent working of the system. This is due to the use of a patent multiple gap. By utilising more than one discharge element the spark discharge is broken up, with a remarkable lessening of noise. By a single highly insulated lever the distance between the several discharge elements can be regulated. Another point of the patent is that a highly hygroscopic re-agent is used to keep the containing vessel free from moisture, which is of material importance in maintaining the efficiency of the gap. The improvements here introduced will be clear enough to those accustomed to the noisy spark, the difficulties arising from gases generated by the electric spark between discharging elements and the rapid formation of nitric acid within the discharge gap chamber, which latter drawback leads to oxidisation of the discharge rod, resulting in imperfect contact. While touching upon the question of gap, it is well to mention that a special patent covers a new way of imparting musical qualities to the discharge, and necessarily to the receiving signals. This is secured by forming a resonance circuit tuned to the

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musical note it is desired to produce, this circuit being coupled to the discharge circuit. This, of course, adds to secrecy in operation. Then, again, another patent provides a controlling or master switch, by which the change in connections between the sending and receiving devices and the aerial, as well as the changes in connection to ensure protection of the receiving devices and control of local battery circuits, are conveniently effected by a single movement. The receiving and controlling devices are contained in a single piece of apparatus which is arranged in a compact form. The ammeter and voltmeter and fuses are mounted on the same case within which the resonant circuits for tuning the apparatus to the incoming signals are placed. There are two circuits, the aerial consisting of variable inductance and variable condenser, placed in series or parallel at will, and adapted for reception on either common wave length. The coarse setting is effected by varying the inductance and the fine tuning by the variable condenser. Switches are provided for instantly changing from one to the other common waves when listening for a call. The detector circuit is also variable by a similar method, and can be coupled to a variable degree with the aerial circuit and also with the detector proper. A potentiometer is provided for obtaining a suitable potential difference across the detector terminals. The detectors of which two types are used are respectively: 1, Rectifying; 2, new type electrolytic (distilled water protected by vaseline). These detectors are mounted in similar ebonite cases, are interchangeable, and provided with plug contacts. Double-head gear telephones are used for reception. As we have said, the whole is contained in separate cases readily formed into a single small cabinet, and on the operating table.

Another novelty is that the patent signal recorder used is at the transmitting end. We give an illustration of the instrument, which records on a paper tape all messages despatched by the operator and furnishes an independent means of detecting any inaccuracies or breach of the rules laid down by the International Convention for the conduct of traffic. The apparatus is mechanically operated and entirely free from atmospheric disturbances, and it is absolutely impossible for the operator to transmit any signals without actuating the recording device. The standard speed of 20 words per minute is easily recorded by the instrument, while any variation in that speed is indicated.

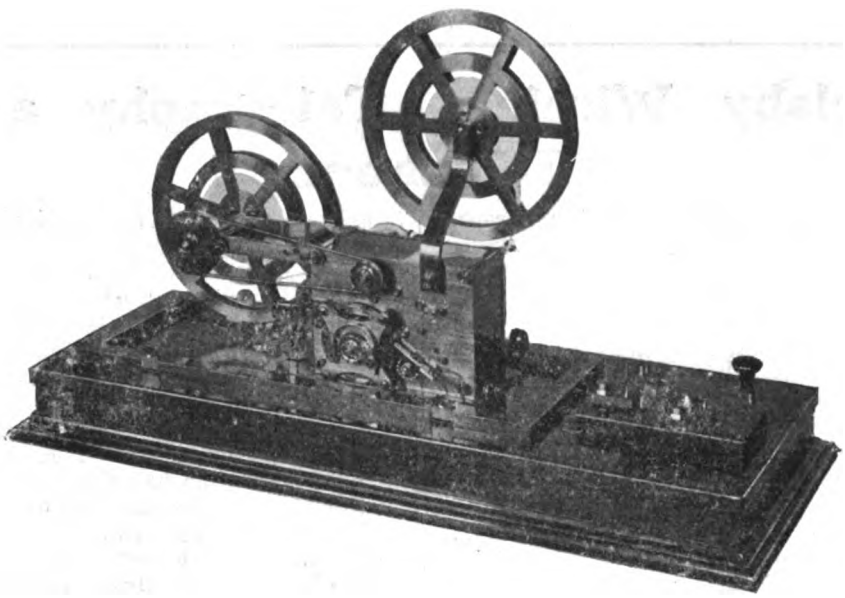

FIG. 2.—OUT-GOING SIGNAL RECORDER.

This all applies to apparatus for a fixed station, but an interesting demonstration was made of a portable telegraphic set (of which we give an illustration), which answered well, but details of which must be withheld for the present, pending completion of patents.

So far we have dealt with the air-wave system, but a totally different set of demonstrations were next made of a patent system of telegraphy and telephony where the earth is used as the sole transmitting medium. The apparatus is by no means complicated, and imparts impulses of suitable character to separate ground plates, and certainly seems a vast improvement upon the former attempts to utilise earth induction by means of interrupted battery currents or sinusoidal currents, or even a combination of the two. So far only small battery power has been used, but there is every reason to believe from what has already been accomplished, that apparatus requiring considerable energy will be equally successful. The use of such a system would be enormous, both for temporary installations in the field, and for permanent installations, perhaps even in mines. All the apparatus used consisted of rods, ordinary bell wire connected with the rods, and small battery, and the transmitter and receiver.

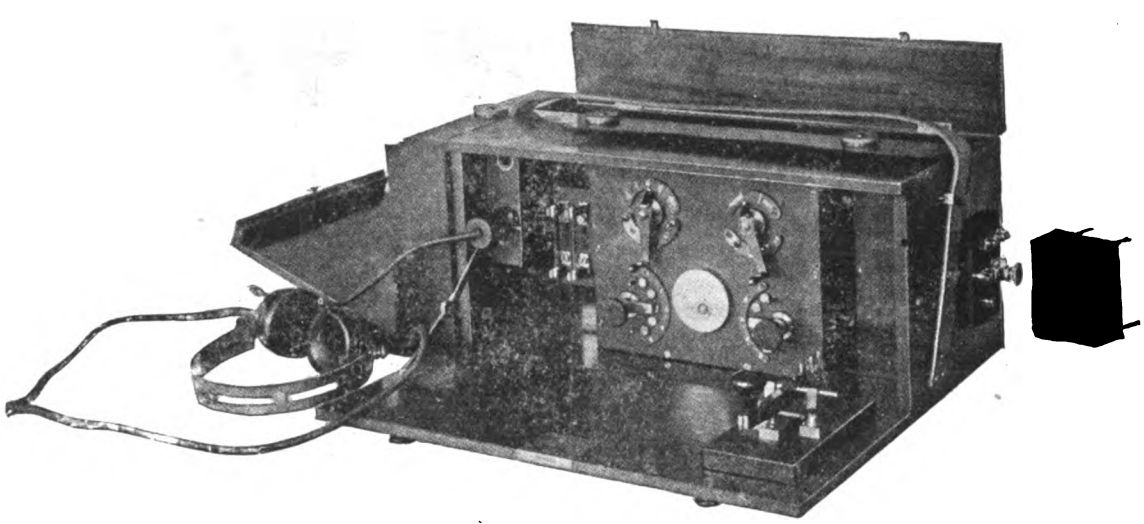

FIG. 3.—"CYMOPHONE" PORTABLE WIRELESS TELEGRAPH AND WIRELESS TELEPHONE APPARATUS

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Electrical Contractors' Section.

A Survey of New Things and Business Prospects.

NOTICE.

Contract and Miscellaneous Advertisements should reach this Office by Mid-day on Wednesday. For rates apply to the Manager, 149, Fleet Street, London, E.C.

CONTRACTS.

LIVERPOOL OVERHEAD RAILWAY.

CONTRACT FOR STORES.

The Directors are prepared to receive TENDERS for the SUPPLY of the Company's Ordinary Requirements of the FOLLOWING ARTICLES during the Twelve Months ending June 30, 1911:—

1. Bolts and Nuts.
2. Electrical Fittings, etc.
3. Files.
4. Fluid (Boiler).
5. General Stores.
6. Indiarubber Material.
7. Iron and Steel.
8. Ironmongery.
9. Oil and Grease.
10. Packing (Engine).
11. Screws.
12. Soap (Liquid, etc.).
13. Tapes (Insulating).
14. Timber.
15. Waste and Sponge Cloths.

Further particulars and Forms of Tender may be obtained on application to 31, James-street, Liverpool, where parties are requested to call and examine the samples before tendering. The sample-room will be open for this purpose on May 24, 25, 26, and 27, between 10 a.m. and 1 p.m. and 2 p.m. and 4 p.m. The Company's patterns cannot be sent away for inspection, all being exhibited at the before-mentioned address. Tenders, properly endorsed and addressed to the General Manager, must be sealed and posted so as to be received not later than 10 a.m. on Tuesday, June 7, 1910. Any sent otherwise or not in special envelope provided for each contract) will not be considered. The Directors do not bind themselves to accept the lowest or any Tender.

E. J. NEACHELL,
General Manager.

31, James-street, Liverpool.

URBAN DISTRICT OF HANDSWORTH.

ELECTRIC SUPPLY DEPARTMENT.

TENDERS FOR COAL.

The Urban District Council of Handsworth invite TENDERS for the SUPPLY of STEAM COAL for use at the ELECTRIC GENERATING STATION, SOHO-ROAD, HANDSWORTH.

Conditions of Contract, Specification, and Forms of Tender can be obtained from Mr. F. A. Nixon, the Electrical Engineer to the Council Generating Station, Soho-road.

The Tender of any person or firm paying less than the standard rate of wages will not be accepted.

Tenders, under seal, endorsed, "Tenders for Coal, Electric Supply Department," must be delivered to me not later than Twelve noon, on Tuesday, May 31, 1910.

The Council does not bind itself to accept the lowest or any Tender.

ERNEST WARD,
Clerk to the Council.

Council House, Handsworth.
May 12, 1910.

HAMMERSMITH BOROUGH COUNCIL.

ELECTRICITY DEPARTMENT.

The Council invites applications for the supply of High Tension Substation Switchgear.

Specification, form of tender, and full details may be obtained upon application to the Borough Electrical Engineer, 85, Fulham Palace-road, Hammersmith, W.

Tenders endorsed "Tender for Switchgear" must be delivered to the undersigned not later than 4 p.m. on Wednesday, June 1, 1910.

The Council does not bind itself to accept the lowest or any Tender.

H. THOMPSON,
Town Clerk.

Town Hall, Hammersmith, W.
May 23, 1910.

CONTRACTS OPEN.

HOME.

BARNSLEY.—Tenders are invited for electric lift at Beckett Hospital. Particulars from G. Moxon & Son, architects, 26, Church-street, Barnsley. May 31.

BATLEY.—Corporation Electricity Works.—One lighting and traction switchboard. (Specification, £1 1s., Borough Electrical Engineer). June 1.

CORK.—Cork Electric Tramways and Lighting Co.—(1) Steam boiler, evaporative capacity of 18,000 lb. p.h. from and at 212° F., and fitted with a superheater capable of delivering steam with a superheat of 110° to 120°; (2) electrically-driven feed pump, having a *minimum* capacity of 6,000 gallons p.h. (Particulars, Engineer and Manager).

EGREMONT.—Wallasey Urban District Council.—Two years' supply of alternating current transformers. (Particulars, Electrical Engineer, Seaview-road, Liscard). May 30.

FINCHLEY.—Urban Council invite tenders for sinking and equipment of deep tube well at electricity works. Particulars from Electrical Engineer, Squire's-lane, Finchley, N. May 28.

HANDSWORTH.—Urban District invite tenders for supply of steam coal at electricity generating station. Particulars from Mr. F. A. Nixon, Electrical Engineer. May 31.

LEICESTER.—Corporation Tramways Committee.—Contract (a) one mixed pressure steam turbine, direct coupled to a 750 kw. direct current generator, together with condensing plant, switchboard, etc. Contract (b), two Lancashire boilers, fuel economiser, steam feed, blow off, and drain pipes, etc. (Specification, £2, Tramways Engineer, Belgrave-road Station). May 28.

LIVERPOOL.—Liverpool Overhead Railway Co. invite tenders for following stores for year ending June 30, 1911: (1) bolts and nuts, (2) electric fittings, etc., (6) India-rubber material, (9) iron and grease, (10) engine packing, (13) insulating tapes, (15) waste and sponge cloths. Particulars on application to General Manager, 31, James-street, Liverpool. June 7.

LONDON.—L.C.C. Tramways.—Tenders invited for the road-work and platelaying required for the reconstruction, on the underground conduit system of electric traction, of the Council's existing horse tramways in Tooley-street, Bermondsey; Dock-head, Parker's-row, Jamaica-road, Union-road and Evelyn-street, Deptford; and the construction on the same system, of the authorised tramway in Creek-road, Bridge-street and Church-street, from the terminus of the existing horse tramway in Evelyn-street to a junction with the existing conduit tramway in Nelson-street, Greenwich; also for the paving works of the street widenings on the above route. About 8·16 miles of single track. Specifications from the Chief Engineer of the Council, County Hall, Spring-gardens, S.W. May 31.

MANCHESTER.—Corporation.—23 tons of 30 lb. steel rails, fishplates, etc., and 2,100 creosoted sleepers. (Particulars, Superintendent, Cleansing Department). June 1.

MORTLAKE.—Barnes Urban District Council.—Triple concentric, paper insulated, lead sheathed and jute scroll cable, 660 v., B.E.S., (4,000 yds., 25 ft. by 25 ft. 125 sq. in.). (Particulars, Engineer and Manager.) June 14.

NEWPORT.—Corporation invite tenders for the supply, delivery and erection of the following plant: Two 400 kw. motor generators, three-phase to direct current; one 600 kw. motor generator, three-phase to single-phase; one bus-bar three-wire booster. Specifications (£3) from Town Clerk. May 31.

PLYMOUTH.—Electricity Department invite tenders for supply of 7,500 tons of clean high-grade steam coal. Specification (20s. deposit) from the Borough Electrical Engineer. May 31.

OVERSEAS.

ADELAIDE.—Tenders will be received at the office of the Deputy Postmaster-General, Adelaide, up to noon on July 6, for the supply of cordless switchboards, in accordance with specification No. 338. A deposit will be required with each tender. Local representation is necessary. Copies of the specifications, etc., may be obtained, and preliminary deposits paid, at the offices of the High Commissioner in London for the Commonwealth of Australia, 72, Victoria-street, S.W. A copy of the specification may be seen by British firms at the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, London, E.C.

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CONTRACTS—continued.

BOROUGH OF BATLEY.

LIGHTING AND TRACTION SWITCHBOARD.

The Town Council are prepared to receive TENDERS for the Supply and Erection at their Electricity Works, George-street, Batley, of

ONE LIGHTING AND TRACTION SWITCHBOARD.

Specifications, with General Conditions and Form of Contract, may be obtained on application to Mr. S. Derwen Jones, Borough Electrical Engineer, Batley, on payment of one guinea for each Specification, which will be returned on receipt of *bona fide* Tender.

Extra copies may be obtained at 5s. each specification, which is not returnable.

Sealed Tenders, endorsed "Tender for Electric Lighting and Traction Switchboard," to be delivered to the undersigned not later than Wednesday noon, June 1, 1910.

The Council do not bind themselves to accept the lowest or any Tender.

J. H. CRAIK,
Town Clerk.

Town Hall, Batley.
May 10, 1910.

ILFORD URBAN DISTRICT COUNCIL.

ELECTRICITY DEPARTMENT.

CONDUITS.

The above Council invites Tenders for the supply of about 1,600 yards of Conduit.

Form of Tender, Conditions and full particulars may be had on application to Mr. Arthur H. Shaw, M.I.E.E., A.M.I.Mech.E., Electricity Works, Ley-street, Ilford.

Sealed Tenders endorsed "Tender for Conduits, Electricity Works," must be delivered to the undersigned on or before 12 noon on Tuesday, the 14th day of June, 1910.

The Council does not bind itself to accept the lowest or any Tender.

By Order,
ADAM PARTINGTON,
Clerk and Solicitor.

Town Hall, Ilford.
May, 1910.

PATENTS.

S. SOKAL, Chartered Patent Agent,
AND
Certified Austrian Patent Attorney (Patentanwalt), Specialist for German Patents and Patent Litigation.

55, CHANCERY LANE, LONDON, W.C.

THE PROPRIETORS of the PATENT, No. 17601 of 1901, for "Improvements in Apparatus and Devices for Controlling Electric Currents," are desirous of entering into arrangements by way of license and otherwise on reasonable terms, for the purpose of exploiting the same and ensuring its full development and practical working in this country. All communications should be addressed in the first instance to: HASELTINE, LAKE & Co., Chartered Patent Agents and Consulting Engineers, 7 and 8, Southampton-buildings, Chancery-lane, London, W.C.

THE PROPRIETORS of the PATENT, No. 28159 of 1897 for "Means for Use in Lighting Railway Cars or Carriages by Electricity and for Regulating the Current for the Same," are desirous of entering into arrangements by way of license and otherwise on reasonable terms, for the purpose of exploiting the same and ensuring its full development and practical working in this country. All communications should be addressed in the first instance to: HASELTINE, LAKE & Co., Chartered Patent Agents and Consulting Engineers, 7 and 8, Southampton-buildings, Chancery-lane, London, W.C.

THE PROPRIETOR of the PATENT No. 16962 of 1902, for "Improvements in Electrical Switches or Cut Offs," is desirous of entering into arrangements by way of license and otherwise on reasonable terms for the purpose of exploiting the same and ensuring its full development and practical working in this country. All communications should be addressed in the first instance to HASELTINE, LAKE & Co., Chartered Patent Agents and Consulting Engineers, 7 and 8, Southampton-buildings, Chancery-lane, London, W.C.

THE PROPRIETORS of the PATENT No. 17314 of 1905, for "Improvements in Automatic Regulators or Rheostats for Electric Currents," are desirous of entering into arrangements by way of license and otherwise on reasonable terms for the purpose of exploiting the same and ensuring its full development and practical working in this country. All communications should be addressed in the first instance to HASELTINE, LAKE & Co., Chartered Patent Agents and Consulting Engineers, 7 and 8, Southampton-buildings, Chancery-lane, London, W.C.

ADELAIDE, S.A.—Postmaster-General.—Cordless switchboards (Specification No. 3,381). July 6.

ADELAIDE, S.A.—Deputy-Postmaster-General.—120 common battery switch boards, cordless, for private branch exchanges, four (4) line, equipped for two (2) extension and one (1) main line only; 70 common battery switchboards, cordless, for private branch exchanges, six (6) lines, fully equipped; 30 common battery switchboards, cordless, for private branch exchanges, ten (10) lines, fully equipped. (Specification No. 338.) July 6.

ANTWERP.—Lower Scheldt Works.—Electric lift for vehicles on floating pier. Dep., £320. Specification No. 19, 2d., plans 1s. 5d., Direction du Service Spécial de l'Escaut Maritime. June 16.

BELGRADE.—Monopolies Administration.—One five-ton electric crane. (Dep. 20%.) (Particulars, Administration Autonome des Monopoles.) June 25.

BUDAPEST.—H.M. Consul-General at Budapest (Mr. Esme Howard, C.V.O., C.M.G.) reports that tenders are invited by the Municipality of Pécs for the building and working of an electric railway in that town. Tenders will be received up to noon on June 6, by the "Pécs varos gazdasagi tanacsnokanak, Varosi Székhaz," Pécs, Hungary, from whom also detailed conditions and forms of tender may be obtained at a cost of 2 kronen (1s. 8d.). The plans and other documents can be examined on personal application at the Engineering Office of the town of Pécs.

CAIRO.—Department of the Interior.—For electric lighting plant for Assiut. July 30.

MELBOURNE.—Postmaster-General.—4,000 telephones, wall sets, magneto, complete (specification No. 220 and pattern C. No. 11); and 200 telephones, bridging table (specification No. 221, and pattern N.S.W. 339, schedule 321.) July 9.

ROME.—Municipality.—Central electricity station.—No. 1. Building in ferro-concrete; No. 2. Turbo-alternators and accessories, boilers, piping, coal conveyers, etc., for an output of 6,000 kw. (Particulars, via SS. Apostoli 49.)

RUSSIA.—Central Electric station construction and equipment at Novgorod, Koupiansk (Kharkoff), Rowno (Volhynia), Karassubazar (Crimea), Alexandrowsk-Gruschersk, Rostoff on the Don, Piatigorsk (Caucasus), Abachukino (Caucasus), Kharbin, Vladivostock; also electric lighting at Tambow, Hennitchesk, Orgieff, Novo-Nicolaiefsk; extensions at Kieff; and dynamo and steam engine for Poltava.

SYDNEY, N.S.W.—Municipality.—House service fuse boxes. (Specification, £1 1s., City Electrical Engineer, Queen Victoria Markets-building.) July 17.

NOTES.

Ebonite and its Manifold Uses.

All the excitement of the "Rubber Boom" on the Stock Exchange has tended to stiffen prices of rubber and its derivatives to an unpleasant degree. Some makers of insulating materials, however, are in a strong position, partly owing to their carrying a fair stock, but largely owing to the excellence of their specialities. Among these firms are Messrs. Carson & Evans, manufacturers of "Vulcanite" and "Ebonite," which well tested insulating materials are placed on the market in so many forms—rods, sheets, tubes, turned and moulded goods. Prices have had to be advanced to some degree, but this has not interfered with demand, either from the Admiralty, War Office and other Government departments, or from leading electrical manufacturers and contractors. Whatever other insulating materials are economised upon, "Ebonite" is still bought largely, indeed, in increasing quantities. The fact is, it has such a wide application and such a high efficiency. It should be known that Messrs. Carson & Evans prepare moulded or turned goods promptly for any purpose on receipt of designs, and are always ready to give expert advice to makers, dealers and others when in doubt about some detail of fittings requiring high insulation with hard wear. This is a point that should be borne in mind by readers of this column. Both "Vulcanite" and "Ebonite" are also largely in demand for export accumulator, telephone and other contracts.

Transformer for Metallic Filament Lamps.

The fact that metallic filament lamps so far have not been produced to run on high pressure voltage except in high candle powers, thus debarring many consumers reaping the full benefit of the new invention, has suggested an excellent idea to Messrs. Birch Bros., of Leeds. They

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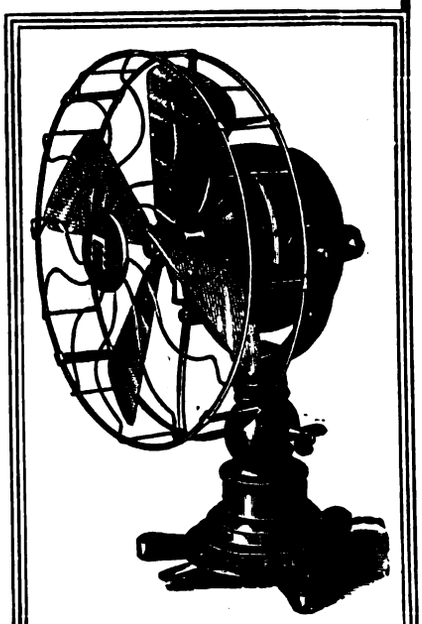

E.A. 2701/7.

THE GENERAL ELECTRIC Co. Ltd.,
Head Office:
67, Queen Victoria St., LONDON, E.C.
Works:
Birmingham, Witton, Manchester, London.

THE PROPRIETORS of the PATENT No. 15243 of 1903 for "Improvements in Means for Automatically Regulating Electric Currents Generated by Dynamos," are desirous of entering into arrangements by way of license and otherwise on reasonable terms for the purpose of exploiting the same and ensuring its full development and practical working in this country. All communications should be addressed in the first instance to HASELTINE, LAKE & Co., Chartered Patent Agents and Consulting Engineers, 7 and 8, Southampton-buildings, Chancery-lane, London, W.C.

THE PROPRIETOR of the PATENT, No. 10187 of 1905, for "Improvements in Electric Couplings," is desirous of disposing of the patent rights, or of negotiating for the granting of licences to work thereunder. For particulars apply to G. F. REDFERN & Co., Chartered Patent Agents, 15, South Street, Finsbury, London, E.C.

PLANT FOR SALE.

Advertisements under this heading: Twenty-four words, 1s. per insertion; three insertions for 2s. 6d.; or each additional line of eight words, 4d.

EIGHTY MOTORS AND DYNAMOS for sale or hire.—MARTIN, 320, Witton-road, Birmingham.

FOR SALE, 20 h.p. Suction Gas Plant and 14 b.h.p. Engine; also 10 h.p. Vertical Boiler and 6 h.p. Vertical Steam Engine.—Box C.E., c/o THE ELECTRICAL ENGINEER, 149, Fleet-street, London, E.C.

PLANT WANTED.

PLATINUM UTENSILS, SCRAP, LAMP TOPS.—Best prices given by DERBY AND Co., LTD., 44, Clerkenwell-road, London, E.C. N.B.—Platinum Sold.

MISCELLANEOUS.

ENGLISH Metal and Carbon Lamp Manufacturers, at present able to produce 300,000 lamps per annum, and capable of extension, desire to arrange with a Wholesale Factor House to take practically exclusive output.—Address "LAMPS," c/o CLARKE, SON & PLATT, LTD., 317, High Holborn, W.C.

FOR SALE.

COMPLETE VOLUMES of THE ELECTRICAL ENGINEER for years 1906-7-8, bound in neat red covers; also for 1909 (half-year), unbound, with loose cover. All in very good condition. What offers?—Box M, 45, c/o THE ELECTRICAL ENGINEER, 149, Fleet-street, London, E.C.

SITUATIONS WANTED.

FOREMAN WANTS SITUATION with Arc Lamp firm; well up in Theory and Practice of Mechanics and Electricity; 32 years of age, and 17 years' practical experience.—Box W. E., c/o THE ELECTRICAL ENGINEER, 149, Fleet-street, E.C.

ELECTRICAL ENGINEER desires berth in Central Station, or charge of private installation.—Box C., c/o THE ELECTRICAL ENGINEER, 149, Fleet-street, London, E.C.

WANTED, SITUATION as DEPOT SUPERINTENDENT, or take charge of Private Installation.—Box 43, c/o, THE ELECTRICAL ENGINEER, 149, Fleet-street, London, E.C.

WIREMAN WANTS WORK, 12 years' experience; screwed conduit.—G. H., 14, Sterndale-road, West Kensington.

OBITUARY.

We regret to record the sudden death from heart failure of Mr. Geogre Bremer, who for 21 years was the trusted representative of Mr. G. Braulik.

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are now putting on the market a special design of their "Optimus" high efficiency transformer for installing on consumers' lighting circuits. They are simple in construction, perfectly insulated, silent in action, of moderate size and most reasonable price. Messrs. Birch, who also manufacture a special electric bell transformer, issue useful tables of data as a guide to dealers and customers.

Lectures to Wiremen.

We note that at the Borough Polytechnic Institution, Borough-road, S.E., a series of six lectures and practical demonstrations on the "O.S." Wiring System with "Stannos" wire is being given by Mr. Charles Rawlings. The course commenced on Monday, 23rd inst., the lectures taking place on Mondays from 7.30 to 10 p.m. The fee for course, which is open to journeymen wiremen only, is a modest half-crown and opportunity is given to students to wire various circuits on the two-wire and concentric system. It is a good idea which should receive further extension up and down the country. Everything possible should be done to encourage efficiency in wiring work. We congratulate the Borough Polytechnic and hope success will induce the authorities to repeat the course.

A Tubular Osram.

The General Electric Co., Ltd., are placing on the market tubular shaped "Osram" lamps, which are made from 100 to 135 volts of 16 c.p., and catalogued at 3s. 6d. each, of course subject to the usual trade discounts. This shade is likely to prove exceedingly popular for business and decorative purposes, and is certainly one of the patterns that should be stocked. It lends itself well for the distribution of light, for instance, in shop windows, and is also suitable for brackets with some of the new styles of shades and reflectors.

Julius Sax in Scotland.

Messrs. Julius Sax & Co., Ltd., will in future be represented in Scotland by Messrs. Watson & Whyte, of 19, Waterloo-street, Glasgow.

NATIONAL ELECTRICAL MANUFACTURERS' ASSOCIATION (INCORPORATED).

We understand that a meeting was recently held in Manchester for the purpose of forming a Northern Section of this Association. The meeting was well attended, and it was resolved that this Section should be formed. Mr. B. Longbottom was elected honorary secretary, and as the outcome of the meeting the following firms have since joined the Association :—

E. Brook, Ltd.
H. T. Boothroyd, Ltd.
Clarke, Chapman & Co., Ltd.
Evered & Co., Ltd.
Liverpool Electric Cable Co., Ltd.
Bertram Thomas.
Wright & Wood.

Several other firms agreed to join, and have since sent in their applications. The result, therefore, of this meeting is that a strong Section of this Association is now formed, consisting of firms in the North of England which will deal with local matters directly.

As a result of strong feeling shown at this meeting that the Association should be more national in its character, a revision in its bye-laws has been made, so as to put the British manufacturers in their right positions.

VULCANITE
GUARANTEED QUALITY
PROMPT DELIVERY
F. CARSON & EVANS.
3A FENCHURCH BUILDGS. LONDON.E.C
EBONITE

CONTRACTS WORTH WATCHING :—

Barnsley.—Messrs. G. Moxon & Son, 26, Church-street, Barnsley. New block and other additions to Beckett Hospital.

Deal.—Mr. E. W. May, architect, Walmer. Alterations and additions to Schools.

Elland.—West Riding County Council. Secondary school.

Grays.—Colonel F. F. Johnson, C.B., Bank Chambers, Chelmsford. New headquarters for Essex Territorial Battery.

Glasgow.—Rev. H. Wallace, Parkhead Church. New hall.

Halifax.—Messrs. C. Williams & Sons, architects. Commercial-street, Halifax. Business premises on Wards End Estate.

Liverpool.—Mr. H. P. Cleaver, Union Clerk, Borough-terrace, West Derby-road, Liverpool. Hospital.

Saltney Ferry.—Minshall & Mospratt, architects, Old Bank Buildings. Church.

Walton.—West Riding Treasurer, County Hall, Wakefield New schools.

PERSONAL.

Mr. F. H. Chamberlain, who was responsible for the construction of the Christchurch (New Zealand) tramways, and who has been connected with hydro-electric undertakings in Canada and the United States, has been appointed managing engineer of the Westport-Stockton Coal Co., New Zealand.

The Ipswich Corporation have raised the salary of Mr. Frank Ayrton, the engineer and manager of their electric supply and tramways undertakings, from £500 to £600 a year.

As the result of the appointment of Sir George Gibb as chairman of the Road Board, Mr. Albert H. Stanley has been elected a director and appointed Managing Director of the Metropolitan District Railway. Mr. J. Carter resigns his office of Secretary to take up the post of Assistant Managing Director, while Mr. W. E. Maudelick, secretary of the Underground Electric Railways Co., of London, and of the Allied Tube Railways, has been appointed to succeed Mr. Carter, still retaining his other posts.

Councillor Dudley Stuart, M.I.E.E., has been appointed Chairman of the Electric Lighting Committee of the Wimbledon Corporation in place of Alderman A. Holland, J.P., who has resigned.

STANDARD ELECTRICAL WORKS.

TELEPHONY. The Practical Telephone Handbook and Guide to Telephone Exchanges. By JOSEPH POOLE, A.I.E.E. (Wh.Sc.). With 480 Illustrations. Third Edition, entirely re-written, Revised and Enlarged. 6s. net. Recommended by the Engineering Staff of the National Telephone Company and by the Examiners for the City and Guilds Institute Examinations in Telephony. [1282]

WELDING AND CUTTING METALS BY AID OF GASES OR ELECTRICITY. By DR. L. A. GROTH, Consulting Engineer. 10s.6d. net. [2698]

WIRELESS TELEPHONY IN THEORY AND PRACTICE. By ERNEST RUHMER, translated from the German by J. ERSKINE-MURRAY, D.Sc., F.R.S.E., M.I.E.E. With an Appendix by the translator. 358 pages, 145 illustrations. Demy 8vo. 10s. 6d. net [3106]

The ELECTRICAL ENGINEER, 149, Fleet Street, LONDON, E.C.

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MOTOR APPLICATION TO MACHINE TOOLS.*

By Charles Fair.

Much has been written on the advantages of motor-driven tools; it will suffice here to mention briefly only a few; such as sanitation, unobstructed light, absence of belts and belt troubles, head room for cranes, hoists, etc., elasticity of arrangement, ease of adding new tools and of moving and rearranging tools, close speed regulation, greater power and overload capacity, maximum output of tools, power transmission, facility for running only such tools as are required for overtime work, and finally, under modern structural conditions, avoidance of the well-understood difficulties of line shaft installations in cement buildings.

Up to comparatively few years ago in the majority of the shops where motors were used, they were simply belted to the lineshaft or countershaft of the tool. Adjustable-speed motors were not so commonly used then as now, nor were they made in the great variety of sizes and speeds now obtainable. To-day, especially in the case of new tools with their requirements of higher power and closer speed regulation, due to the use of high-speed steel, it becomes not only more convenient, but in many cases almost a necessity, to apply the motor directly to the tool.

When the work of actually equipping a factory with motor drives is undertaken, it will be necessary to study the conditions of operation, which vary greatly with the product manufactured, and while in some cases these conditions are comparatively simple in others they are more complex. The arrangement of tools will to a large extent depend upon the nature of the work, and as to whether alternating or direct current is available; it will also depend upon whether the convenience of operation and handling of material are of sufficient importance to call for a considerable number of individual drives, or as to whether it is to be generally a group-driven shop.

In driving tools with individual motors it will be remembered that the motor not only supplies the power and speeds best adapted to the tool, but that the speed of the motor alone in many cases covers the entire speed range of the tool, and that the motor can be applied directly to the tool, making a compact unit.

When equipping tools with individual drives, the controlling apparatus as well as the motor should be attached directly to the tool when possible. This arrangement allows moving the tool by simply disconnecting the leads and connecting them in the new position. In the case of portable tools this, of course, is an absolute necessity.

A graphic recording wattmeter in circuit with a tool not only tells the actual power consumed by the machine, but also shows whether the tool is operating at its maximum rate, by registering the time of unproductive cycles or the length of time the tool is idle; and by analysis, the cause of the lost time may be discovered and result in a change of conditions with a corresponding increase in production. Poor lineshaft alignments have been detected by watching the integrating wattmeter. Many shops are paying dearly for lack of attention to alignment of shafts, etc.

Difficulties concerning the choice of the type of motors for tools have been considerably exaggerated.

It must be kept in mind, however, that various circumstances, such as size or roughness of work, flywheel capacity, etc., may call for radical departures in choice of motors, this list being compiled to meet average conditions. Shunt motors, for instance, are used in the following cases: when the work is of a fairly steady nature; when considerable range of adjustment of speed is required, as on lathes and boring mills; and on group and lineshaft drives, etc.

Compound-wound motors are used where there are sudden calls for excessive power of short duration, as on planers, punch presses, etc.

Series motors should be used where speed regulation is not essential and where excessive starting torque and slow starting speeds are required; as, for instance, in moving carriages of large lathes, in raising and lowering the cross rails of planers and boring mills, and for operating cranes.

When in doubt as to the choice of compound or series motors of small horse-power, the choice might be determined by the simplicity of control in favour of the series motor. Series motors, however, should never be used when the motor can run without load, as the speed would accelerate beyond the point of safety.

The alternating current motor of the squirrel cage rotor type corresponds to the constant-speed, shunt, direct-current motor, but with a high-resistance rotor it approaches more closely the characteristics of a compound direct-current motor. It is understood that the variable-speed machines, checked in this list under the alternating-current squirrel cage rotor column, have the necessary mechanical speed changes.

The slip-ring induction motor with external rotor resistance would be used for variable speed, but this must not be construed to mean that it corresponds to a direct-current, adjustable-speed motor, as it has the characteristics of a direct-current shunt motor with armature control.

The self-contained, rotor resistance type would be used for lineshaft drives, and for groups when of sufficient size.

Multi-speed, alternating-current motors should be used where alternating current only was available, or direct current limited; and the speed range of the motor, together with one or two change gears, would give the required speeds.

One of the most important features in the selection of motors and one that is persistently overlooked, is the strict adherence to the use of standard motors, and by standard motors is meant standard armature shafts as well. The importance of maintaining standard armature shafts will be readily recognised by the factory management when it is pointed out that by such an arrangement spare armatures are reduced to a minimum, and that in an emergency it is possible, where these are not carried, to replace an armature or even a whole motor, from an idle tool, or from a tool of relatively less importance at the time. Also, of course, stock motors can be supplied promptly by the manufacturer and shipments materially improved if special shaft extensions are not called for. That special features in a motor are sometimes desirable, is not to be denied; it may so happen that the advantages from some special feature in the motor may more than offset the disadvantages above referred to, but in cases where these features are thought necessary they should be carefully considered before final decision.

The method which is selected for connecting standard shafts will depend upon the conditions surrounding the drive under consideration. Tools which only a few years ago were equipped with special motors are to-day driven by standard motors, and as a result are easily and quickly repaired. In the early days of the motor drive many special features were thought necessary in the motor to make it adaptable to the tool; special frames, shafts and speeds were required by the tool builder, and little thought was given to the interchangeability of parts. It is therefore easy to recognise in these early equipments responsibility for the existing idea that special features in the motor are still necessary for tool equipments. Many of these features are now recognised as unnecessary, and to-day the tool builder in many instances builds his tools ready for attaching standard motors.

At the present time, as far as tools are concerned, we think of the motor largely as a means of driving the tool and not of the possibilities of the motor becoming the mian element of the tool construction. Here, again, high-speed steels, together with the improvements made in the motor, will produce many new designs in tools with corresponding higher efficiencies.

The old prejudice existing against the electric motor, which was mostly a mistrust due to a lack of familiarity with its operation, is rapidly dying out, and to-day motors are found driving machines in shops of every description.

Equally important with the choice of motors is that of control. In selecting the control it is necessary to consider the nature of the work, its accessibility to the operator, the method of attaching it to the tool and in some cases its relative position to other tools, for instance; an open type starting rheostat should not be exposed to danger of short-circuit from flying chips. In the majority of cases, a shunt motor of ¾ h.p. and less would be started by a switch. Exceptions to this would be motors on tools that must be gotten under way slowly, and grinders driven by direct-current motors for reasons of safety. With adjustable-speed motors, care should be taken to throw the switch on full field. Series motors up to 8 h.p. or even larger can be

* Abstract of paper presented to the American Society of Mechanical Engineers, New York, April 12, 1910.

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started by switch. Exceptions to this would be cranes and tools requiring a certain amount of armature speed regulation. Larger motors, for tools where starting service is infrequent or not severe, and for lineshafts and for group drives, would be satisfactorily operated with a dial type controller, which is cheaper than the drum controller, provided, however, that the controller is placed in a protected position.

When making the installation, accessibility to the controller in case of accident should be kept in mind, even though of little importance so far as starting up is concerned. The starting apparatus should be placed where the motor or some of the moving parts can be seen by the operator. On individual motor-driven tools, where the motor is started and stopped many times a day or where the starting conditions are of a severe nature, or where tools are edged along, drum type controllers with extra heavy starting resistance should be used. For adjustable-speed motors, using the drum type control, the field control should be through fingers making contact on segments of the controller drum and not by sliding contacts on a dial, as with the latter, trouble will develop sooner or later. Motors above 40 or 50 h.p., under these severe conditions, are best operated by a master controller which operates contactors for cutting out steps of starting resistance, and if adjustable-speed, the field control should be taken care of, as stated above, by fingers making contact on segments of the drum. This class of starting apparatus will stand any quantity of abuse and, by the addition of a simple current limit relay device, becomes practically a fool-proof protection for the motor. There are cases where it might be advantageous to use master controllers and contactors even with smaller motors.

Alternating-current squirrel cage rotor type motors, two-phase and three-phase, up to 5 or 8 h.p., generally speaking, can be thrown on the line, depending largely upon power conditions. Above 5 or 8 h.p. they should be operated by compensators. The self-contained rotor-resistance type would be started by a sliding resistance in the rotor, and the slip-ring type by a controller with external resistance.

Upon the convenient arrangement of the control depends, to a considerable degree, the output of the tool, and the importance of the arrangement from the standpoint of the operator cannot be ignored, since the output of a tool will be materially increased when an operator can start and stop the tool and obtain at all times maximum cutting speeds by simply turning a handle. The controller must be placed in a safe position and should be accessible for repairs, which very often means that some arrangement is necessary to bring the operating handle within easy access of the operator. A familiar illustration of the convenience of control is the arrangement so commonly seen on lathes, whereby the operating handle travels with the tool carriage and allows the operator at all times a complete control of his tool.

The horse-power required for driving tools calls for the exercise of considerable judgment, especially in the case of alternating current motors where power factor enters into consideration. Exhaustive tests have been made to determine the amount of power required to drive tools, but it is to be regretted that many of these tests are lacking in essential features that would make them valuable. Conclusions drawn from incomplete data are apt to be misleading; as in the case of tests made with motors which are considerably underloaded or overloaded, and where efficiencies are not taken into consideration; or where the material used and duration of test are not stated; or where there has been failure to state whether the test was a practical one or merely a breakdown test. The conclusions drawn from breakdown tests are often deceptive and should not be used for determining power to drive tools; also it does not follow that a tool which stands up longer than another under breakdown conditions, will do the same under practical conditions. The majority of the formulas now in existence for computing horse-power required for tools are generally misleading and useless, and no general formula that would be of practical value has been developed, as the power required varies with the metal worked, the cutting speed and many other conditions.

The construction of the tool is seldom taken into consideration when estimating horse-power, yet some of the worm-driven tools are notoriously inefficient. Other tools are so constructed that the greatest part of the power delivered to the tool is consumed in friction losses and not in useful work; again, the tool may be constructed upon approved lines but may not be still enough to stand the strains to which it is subjected, thereby causing considerable loss of power, all of which, as well as the difference in power due simply to the shape of a cutting tool, has been repeatedly proved by tests. In one instance, it required 72% more power to drive a plain spiral milling cutter than the same cutter nicked.

The advent of the high-speed steel and the high-power tools, together with the increased speed of old tools, makes much of the data bearing on horse-power collected up to a comparatively short time ago, of somewhat doubtful value. From the above, and from the fact that the duty required of a tool in one shop may be more severe than that in another, it will be seen that it cannot be accurately stated that a definite size of motor is required for a given tool. In the majority of cases, however, the horse-power for small tools has been pretty well fixed. With the larger tools the variation in horse-power required is much more pronounced, and at the same time, is more important on account of the size of the motors involved. This variation in horse-power is often as much as 4 to 1 and sometimes even 6 to 1.

Considerable difference of opinion has developed as to the advantages of individual *versus* group drives, and while it is generally agreed that it is advantageous to have the larger tools individually driven, the agreement by no means extends to the smaller ones. Under certain conditions there is no question as to the advantages of the individual drive for small tools, as, for instance, where small tools are necessarily placed among larger ones, or to allow convenient placing of tools in the assembling departments. The cases where it would be advantageous to have small individually-driven tools are numerous.

Little trouble is experienced in obtaining new tools already arranged for attaching motors, since many of the tool manufacturers are alive to the superiority of the motor drive and have for years built tools especially adapted for motor drives. Unfortunately, others have seen fit merely to arrange them for attaching motors, while still others leave the purchaser to attach the motor as best he can, consequently the best results are not always obtained.

When the driving of old tools by individual motors is under consideration, it is important to take into account the nature of the work, the speed range, the number of similar tools to be equipped and the condition of the tool. It sometimes happens that when a tool in itself would not call for an individual drive, certain circumstances might make such a drive advisable.

As an illustration, when the majority of tools in a shop have become individually driven, there might still remain a number of scattered tools, which, unless they were driven by individual motors, would necessitate the running of a long line of shafting; or, in the event of moving into new quarters—a cement building perhaps—it is decided not to use line shafting. It is understood, of course, that when old tools are scrapped the motors can be transferred to other tools.

The application of motors to tools, whether old or new, is not a difficult matter, and we trust that the advantages claimed for such applications have been made fairly evident.

WIRELESS TELEGRAPHY IN FRANCE.

New regulations have come into force with regard to the organisation of wireless telegraphy. Wireless stations are open to the public at Ajaccio, Boulogne-sur-Mer, Brest, Cherbourg, Dunkirk, Fortdeleau (Algeria), Lorient, Ouessant, Porquerolles, Rochfort, and Sainte Marie de la Mer. The tariff from coastal stations to vessels at sea is fixed at 40 centimes a word, with a reduction to 15 centimes a word for messages sent from Mediterranean stations to vessels regularly plying between France and Corsica, Algeria, or Tunis. Vessels fitted with wireless apparatus are authorised to demand a tariff of 40 centimes a word from the receivers, which is reduced to 10 centimes per word for vessels plying between the French Mediterranean possessions.

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STANDARDISATION OF FUSES.*

By H. W. Kefford, Assoc. I.E.E.

The standardisation of electric fuses and the enforcement of more stringent regulations with regard to their design and use would contribute greatly to the increased safety of electrical installations and would put the manufacture of this class of apparatus on a more uniform and scientific basis. The difficulties to be overcome before a standard system of fuses can be brought into general use are certainly numerous, but delay renders the problem more and more complex. The necessity for and advantages of standardisation do not require very much demonstration, and the only point in this connection which the author desires to emphasise is the importance of simplicity, efficiency, and reliability in every detail of the electric circuit. If we would foster the popularity of electrical applications and the prosperity of the industry we must create and maintain confidence in the safety, reliability, and convenience of electrical power by every possible means. In addition to contributing largely to the attainment of this end the standardisation of fuse design would undoubtedly conduce to economy in manufacture and result finally in a reduction of cost.

Makers of fuses now display in their catalogues so many types and so many designs of each type that it is difficult to escape the conclusion that the fuses are ornamental adjuncts to a switchboard and may be chosen in a style most suitable to, say, the scrollwork which supports the clock. Up to a certain point it is a very simple matter to determine the behaviour of a fuse when blown under working conditions, and this fact renders still more inexplicable the retention of many types which are wholly inadequate and of others which are needlessly elaborate.

In the present paper the subject is dealt with from a practical rather than academic point of view, the object being, if possible, to suggest a few lines along which certain essential questions may be tackled. The results of tests on commercial fuses will be considered in conjunction with corresponding theoretical indications, and definite deductions will be drawn as to the most suitable quantitative and structural properties for a standard line of fuses. Up to the present time the tests referred to have been confined to low-tension fuses up to a normal carrying capacity of about 60 amperes, but it is hoped to continue the experiments on fuses of much larger capacity.

The complete specification of a line of fuses will embrace :

(*a*) A definition of the " marked " or " rated " current in terms of the "limiting" current (also called the " normal fusing " current).

(*b*) A standard range of rated-current values and voltages.

(*c*) A definition of one or more points on the " time-overload " curve of each fuse.

(*d*) Regulations as to non-interchangeability, temperature rise, freedom from deterioration, and perfect operation under all conditions.

(*e*) Specifications for the standard method of carrying out short circuit, temperature rise, and overload tests.

In framing suggestions with regard to the above points due consideration is demanded for the user, the workman, the retailer, and the manufacturer; for example, the quantitative properties of the fuses should lend themselves to simple control in the factory, the number of types should be reduced to a minimum, the price should be moderate, etc.

(*a*) The Rated Current.

As is well known, the chief characteristic of a fuse for quantitative purposes is its " time-overload " curve and the asymptotic current value of this curve to which the name " normal fusing current " has been given, but which will be referred to in this paper as the " limiting current." The strict definition of the limiting current is the minimum steady current which will produce fusion after an infinite time interval, but for practical purposes we might substitute with advantage a definition referring to a definite time-interval—say 4 hours—instead of the unlimited period. The limiting current or limiting overload is the one fundamental quantity to which any definition of rated current should refer. An appropriate way of defining the rated or marked current of the fuse is as follows: A fuse which is rated at R amperes must fuse within 4 hours when carrying a times its rated current, but must be capable of carrying $a - \alpha$ times its rated current for at least 4 hours without fusing. If L amperes is the limiting current, the rated current R amperes must lie between

$$\frac{L}{a} \text{ and } \frac{L}{a-\alpha}.$$

The values chosen for a and $a - \alpha$ depend on a large number of practical considerations, and should also be selected with a view to facilitating the application of the above definition in factory and test-house. Thus the difference α between the two values may be looked upon as a measure of the accuracy with which the specified conditions can be attained in manufacture.

The latter point recalls the fact that the Wiring Rules of this Institution require that no fuse shall carry more than 200% overload without fusing (*i.e.*, $a = 3{\cdot}0$), whereas the rules of another recognised authority in this country restrict the permissible overload to 50% ($a = 1{\cdot}5$). The writer has recently heard of suggested modifications to the overload regulation from two independent sources, one of which was a proposal to permit an overload of 300% ($a = 4$), while the second authority was of the opinion that the permissible overload should be even less than 50% if manufacturers could work to a narrower limit. If, as may be assumed, the smaller overload is the one dictated by considerations of safety, irrespective of manufacturing limitations, whereas the higher figure is based on a compromise between what is desirable and what is present practice, these figures furnish one of the most striking arguments for the need of a system of non-interchangeability for fuses of small capacity. This point will be dealt with more fully later in the paper. The regulations for enclosed fuses by the Underwriters Association in the United States, which have been framed with the co-operation of manufacturers, fix the values of a and $a - \alpha$ at 1·25 and 1·10 respectively, but these figures were only decided upon after manufacturers had endeavoured to work to a smaller value of α than 0·15, as specified above. These close limits are in marked contrast with the figures quoted above.

The results of an experimental investigation of the properties of current commercial types of fuse should give a reliable and useful indication of the possible values of a and $a - \alpha$, the limits between which the ratio $\frac{\text{limiting current}}{\text{rated current}}$ must lie, and it becomes a relatively simple matter to determine whether this ratio should have the order 4 or 1·5. In drawing inferences from such tests due weight must be given to the many other properties which are closely connected with the ratio a, and observations must be made of running temperature, voltage drop, behaviour when blowing on overload and short circuit, and general reliability and safety.

Tests were carried out on a representative variety of fuses in common use; and deductions drawn from the results obtained.

Before proceeding to discuss these deductions let us consider one or two points which may serve for general guidance. Taking first the case of a bare fuse wire stretched between two terminals, let us assume that a line of fuses, all of equal length, is to be designed. It will be found that the voltage drop is proportional inversely to about the square root of the limiting current: thus, for example, fuses for 5 amperes and 50 amperes limiting current, which are to be rated at 50% or at 2·5 and 25 amperes respectively, will, if of tinned copper, have diameters :—

5 amperes limiting current .. .. 0·0145 cms.
50 „ „ „ .. .. 0·079 „

At the same percentage of their limiting currents, corresponding in this example to the same percentage overload, the two fuses will have voltage drops proportional respectively to—

$$\frac{5}{(0{\cdot}0145)^2}, \text{ or } 23{,}800 \text{ for the } 2{\cdot}5 \text{ ampere fuse,}$$

and—

$$\frac{50}{(0{\cdot}079^2)}, \text{ or } 8{,}010 \text{ for the } 25 \text{ ampere fuse,}$$

* Abstract of paper read before the Institution of Electrical Engineers, May.

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so that the volts drop of the smaller fuse will be roughly three times that of the larger one. With a length of 3½ in. the actual voltage drop when the fuses are run at 50% of the limiting current will be—

0·34 volt at (5 × 0·5) amperes,

and—

0·11 volt at (50 × 0·5) ,,

The corresponding figures for a current 90% of the limiting current are—

1·40 volt at (5 × 0·90) amperes,

and—

0·47 volt at (50 × 0·90) ,,

The drop of 1·40 volts is excessively high and would in most cases form a large proportion of the total fall of pressure in the circuit; the figure can be reduced either by decreasing the length of 3½ in. between tne terminals or by increasing the ratio of $\frac{\text{limiting current}}{\text{rated curent}}$ *i.e.*, by using a larger wire and permitting a greater overload. Hence the same value of a is not advisable for large and small fuses; it may be desirable to increase the value of a as the normal working current diminishes.

In the case of fuses of the totally enclosed type, whilst the above remarks still apply, we have also to consider the effects of the increased cooling facilities and capacity for heat of the fuse enclosure. Owing to the large radiating surface, the size of wire for a given limiting current is reduced, and the drop of volts may therefore become large if the length of the fuse is not reduced or a metal adopted which has a low melting-point. If the fuse is very short, on the other hand, conduction and dissipation of heat from the terminals will play an important part and exercise a similar influence in increasing the voltage drop and power loss. In order to reduce these two quantities to economical and safe limits, it becomes necessary to rate the smaller fuses at a lower percentage of the limiting current. Since well-designed fuses of the enclosed type may be made very much shorter than a corresponding open-type fuse for the same voltage, advantage should be taken of this possibility in order still further to reduce the losses; the alternative course of using a low melting-point metal is far inferior, and the larger volume of metal required may prove a source of danger. It may be noticed that it is open to the designer to rate the higher capacity fuses at the same low percentage of the limiting current as the smaller sizes, but this again involves the use of an unnecessarily large volume of metal, a proceeding to be avoided as much as possible, particularly for fuses carrying heavy currents and liable to severe chort circuits.

From a purely utilitarian standpoint it is probably correct that small fuses should carry higher overloads than fuses of large capacity, and all that might be said from this point of view may be best summed up by considering a 5 ampere fuse capable of carrying 10 amperes, and a 100 ampere fuse permitting a continuous load of 200 amperes.

The most important factor in determining a standard value or values for the ratio $a = \frac{\text{limiting current}}{\text{rated current}}$ is the maximum safe overload to which an electric circuit may, on the average, be subjected; the results arrived at from this consideration can, if necessary, be modified to meet the limitations of manufacture. The possibility of more economical utilisation of the apparatus protected is a natural consequence of adopting fuses which restrict within narrow limits the overload which may be imposed on a circuit. For fuses up to 50 amperes a maximum permissible continuous overload of 25%—as in the United States—is not wholly desirable, since most circuits and apparatus should be designed to withstand this amount of overload without injury, and further, even the best system of non-interchangeability would fail and the circuits be overfused if users and wiremen found that they could not overload circuits to more than 25% even for short periods. Fuses run normally at only 20% under the limiting current must of necessity have fusible metal of low melting-point if the running temperature is not to be unduly high; for reasons of equal importance the use of such metals is bad.

Nearly all the metals used for fuses suffer oxidation if run at temperatures much above that corresponding to 50% of their limiting current, although if silver be employed the rated current may certainly be as much as 65 to 70% of the limiting current without the occurrence of any deterioration. The permissible overloads corresponding to a rating 50% and 70% of the limiting current are 100% and 43% respectively, and the large difference in these overload capacities is of interest as showing the superiority of a non-oxidising metal like silver if it is desired to reduce to a minimum the possible overload. Assuming, as will be afterwards shown, that copper and silver are the only metals suitable for standardised fuses, we can take as a rational basis—

Copper.—Minimum value of $\frac{\text{limiting current}}{\text{rated current}} = 2{\cdot}00.$

Silver.—Minimum value of $\frac{\text{limiting current}}{\text{rated current}} = 1{\cdot}43.$

For fuses of tinned copper wire the ratio a varies between about 1·12 and 3·0. A group of fuses tested, whose symbol is X are rated at between 88% and 100% of the limiting current, and therefore the whole fuse-fitting became unbearably hot, with a current much below the rated value, whilst at the rated current of 25 amperes the fuse wire was red-hot and oxidising rapidly. On the other hand, another group of fuses, marked T_5, which are rated at between 36% and 42% of their limiting current, contained about 2·9 times as much copper as the X_1 fuses, and are consequently far more dangerous on a high-voltage overload or severe short circuit.

(*b*) Standard Rated Current Values and Voltages.

For the limits of capacity now under consideration the standard voltages of 250 and 500 volts are certainly sufficient for all requirements at the present time. Whether two standard voltages are necessary is very doubtful, and the average performance of many types of fuse on 500 volts is such as to suggest that they might act better on a considerably lower voltage. An excellent plan seems to be the adoption of a standard voltage of 500 for all sizes, and the addition of a range of small capacity fuses for 250 volts for use on lighting circuits where small size and cheapness are important and very severe short-circuit conditions do not often occur.

In proposing a standard range of rated currents the important point is to reduce the number of sizes to a minimum while providing for all current values with a reasonable margin of overload capacity. It is necessary to take into account the values of the $\frac{\text{limiting current}}{\text{rated current}}$ ratio discussed above, but provided the standard current values now commonly used are compatible with the adopted values of this ratio, there is little reason to do anything further than eliminate any redundant steps and put forward for general use the range settled upon. With bare wire, of course, any size will be used, finally the size which will not blow; but so far as the use of this type of fuse is allowed, any regulations or standards are useless.

A convenient subdivision is with steps differing by multiples of 5 amperes, giving, say, 5, 10, 15, 20, 30, 40, and 50 ampere sizes. At least one smaller capacity than 5 amperes is required, and since 4 and 6 amperes are standard values with a large number of manufacturers, a satisfactory completion of the range will be to adopt multiples of 2 amperes up to a value of 6 amperes, the complete standard line becoming:—

2, 4, 6, 10, 15, 20, 30, 40, 50 amperes.

(*c*) Definition of One or more Points on the "Time-current" Curve of Each Fuse.

It is necessary to ensure that the fuse shall give adequate protection against very heavy overloads or short circuits, and to restrict within limits its sluggishness of action or "time element." From a practical point of view a regulation of this kind is useful because compliance with it can be readily checked, and it may be so framed as to eliminate the use of too large a mass of fusible metal and other faults of design. In order to be of real value such a regulation should require that a fuse shall melt within a fixed time—say one minute—when loaded with a certain multiple of its limiting current—say double that value. The actual time interval between the moment of switching on this overload and the blowing of the fuse would at the same time be taken as a practical measure of the "time element."

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although for this purpose a current less in excess of the limiting current would give a longer time interval capable of more exact observation. It will be convenient to return to this clause of our standard specification when finally deciding upon the question of rating.

(*d*) General Regulations for Construction and Operation.

While it is not desirable to specify too rigidly the constructional details to be embodied in standard fuses, yet it appears imperative that a few general principles should be laid down for the guidance of manufacturers, and one or two essential features should be demanded.

The extreme necessity of directing attention to some fundamental principles before fuse standardisation can be accomplished, is illustrated by two examples taken from samples tested by the author. A fuse (T_5 and T_6) made in several sizes for rated currents of over 20 amperes is of the protected or tubular type and of thoroughly substantial design, the fuse wire, however, consisting of stranded tinned copper wire, is *soldered* at each end into a small terminal plate. The distribution of the masses of metal is such that all the fuses of this type which were tested opened the circuit by melting the soldered connection: had the full rated pressure of over 500 volts been maintained, the arc consequent on the separation of the wire from its terminal plate would have spread speedily and consumed the entire fuse fitting and terminals until the circuit was broken elsewhere. In a second line of fuses (R) of the totally enclosed or cartridge type, also rated for over 500 volts maximum pressure, a solid single link of soft fusible metal is used, containing a volume of metal nearly fifteen times as great as that contained in another make of cartridge fuse of the same rating. This protective device is completed as an explosive of a most dangerous kind by the provision of a number of vent holes in the metal cap at each end. Every principle of the design of enclosed fuses is ruthlessly violated, and, needless to say, the behaviour of these fuses on short circuit was of a violent description.

If any efforts to increase the efficiency and serviceableness of fuses are to be successful it is inevitable that bare wire fuses should be abandoned, and the logical consequence of the standardisation of small capacity fuses is the introduction of a simple method by means of which the control of the fuse capacity on any circuit is placed in the hands of competent persons only. This requirement of non-interchangeability is far-reaching in its effect on fuse design since it involves the abolition of all fuse fittings having two exposed terminals, and in so doing leads half-way to the requirement dictated by safety, namely, that no terminals whatever should be exposed on fuse-fittings intended for use in private houses or public situations. Attention was drawn on page 697 to the fact that if an overload of 200% is permitted before the fuse comes into action, non-interchangeability becomes of the highest importance, since for small currents up to 10 amperes we may assume that fuse wire of " the next larger size " will increase the possible overload by some multiple of 200%, rendering the circuit liable to overloads up to 400% or 600%.

If the permissible overload is reduced to a much lower figure, for example, 50%, less risk is indeed incurred by inserting the next size larger fuse, but if the circuit is faulty this process will be repeated several times until the size is arrived at which does not blow. An ideal system for safeguarding a circuit against overfusing should consist of some small separate part or adjustment which can be suitably set by an electrician either to restrict the capacity of the fitting to the present current or so as to allow a definite margin for increasing the size of fuse consistent with the dimensions of the wiring or apparatus. It is difficult to see how the requirement of non-interchangeability can be met to an adequate degree by any form of exposed wire fuse when we consider that enclosure of the terminals must not prevent the non-technical user replacing a blown fuse by one of the correct size. Although it is admitted that no non-interchangeable system will do away with the deliberate overfusing of the circuits, yet sufficient will have been attained if accidental over-fusing is made impossible and an obstacle is placed in the way of using hairpins and similar well-known substitutes for the legitimate article. In their own interests, insurance companies should require the use of some system for preventing overfusing and should strictly forbid the use of any other conductor than the proper one intended for the fitting installed. A requirement of this kind would lead to the general use of the standard types which would become generally stocked and easily obtainable; the idea that the ubiquity of metal wire in some form or other justifies its indiscriminate use to nullify the purpose of a protective device would be gradually dispelled.

Bare wire fuses, or rather fuse fittings, in which a conductor can be easily inserted by the user, are incompatible with protection against overloading. Two other objections of equal weight against exposed fuse wire are:—

1. Their liability to scatter molten or hot metal.
2. The rapidity of corrosion unless certain non-active metals are used.

The first objection holds good of all metals, but more particularly of low melting-point metals, of which a larger volume is required than if copper or silver were employed. The second objection is especially applicable to copper, which in many other respects is an excellent fusible metal.

If, on the other hand, we examine the case for fuses of the totally enclosed type, we have the following outstanding advantages:—

1. The fuse wire is less liable to corrode or become injured, and therefore enclosed fuses lend themselves to exact calibration.
2. Tampering with the fuse wire is difficult, and a system of non-interchangeability is greatly facilitated.
3. If properly designed no molten or hot matter can be thrown about.
4. Perfect operation can be obtained on heavy overloads at full voltage.
5. Less metal is required, and the weight and size of the complete fuse fitting is reduced.

The principal objections raised against enclosed fuses are mainly questions of cost, the impossibility of inspecting the fuse wire, and the difficulty of ascertaining with certainty when the fuse has blown. The first-named objection appears to be almost wholly fictitious if account is taken of the frequency with which not only the fuse wire of an open fuse is melted, but the holder itself is either cracked or so fused as to be useless. Engineers do not seem fully to recognise how much more severe in many cases is the effect of fusion produced by a heavy gradual overload at full voltage as compared with the effect of a severe sudden short circuit. Fuses of the china holder type are often reduced to a useless condition by an overload, whereas they may withstand repeated short circuits of a severe character without great damage.

This is attributable partly to the fact that when fusion occurs on an overload the fuse wire melts at the centre and an arc is drawn out and partly to the fact that the voltage is maintained on an overload, but a short circuit usually causes a main circuit breaker or another fuse to operate simultaneously, so that the circuit is broken in several places. The fact that a gradually increasing overload heats up the fuse fitting and diminishes its power of cooling the arc and vapours is also influential.

With regard to the deficiency of enclosed type fuses in not permitting inspection of the fuse wire or giving reliable indication of fusion, the latter is a mechanical detail, which can be quite satisfactorily solved, as is shown by the arrangement adopted in a new type of enclosed fuse recently put on the market. Fig. 8 shows the design of indicator referred to. The diagrams are self-explanatory, and show that this device possesses the important advantage of being self-testing.

The demand for exposure of the fuse wire has arisen from the custom of inspecting a fuse, say of copper, either for the purpose of seeing what progress oxidation has made or to determine by its red glow or otherwise whether it was being unduly overloaded. The oxidation of a fuse is, as we have seen, harmful and unnecessary, and the rating and design of standard fuses should be directed towards minimising its occurence; similarly a well-considered and consistent rating will in time enable the user to become familiar with the overload capabilities of a fuse of certain capacity.

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For fuses of the capacity under discussion a completely enclosed design is the only one which enables any set of standards to be followed or enforced with reasonable success. In discussing the subject of the standardisation of fuses for the National Association of Underwriters, Lacount states of a well-known type of enclosed cartridge fuse, which is widely used in the United States, that the "rarity of its misuse" is due to: (1) The Underwriters and Inspector's rules; (2) the readiness with which the cartridges can be secured in any location; (3) their reasonably low price; (4) the ease of replacement; (5) the difficulty in replacing the fusible wire.

Stress may be laid on four points essential to the satisfactory operation of any fuse whether of the open-wire, tubular, or totally enclosed type; these are:—

1. The volume of fusible metal should be reduced to the minimum compatible with correct rating and moderate temperature rise.
2. The fusible metal should be sub-divided so that the ratio of exposed surface to cross-section does not fall below a figure depending on the design.
3. The provision of cooling arrangements adequate to extinguish the arc formed on overload.
4. In exposed wire fuses the provision of sufficiently free expansion space to prevent explosion when a short circuit occurs. In enclosed fuses the same end must be attained by precisely opposite means, and no opening or weakness of any kind is permissible in the enclosing case.

The means at disposal for cooling an arc and condensing the vapours are three in number: by mechanical draught, by the surface condensation and cooling action of masses or porcelain, metal, or asbestos, and by the analogous use of an absorptive condenser in the form of filling powder. When the last method is adopted it is important that the fuse wire and filling should be free from any mutual chemical action even when subjected for a long time to alternate heating and cooling.

Fillings containing a capsule of liquid, or any hygroscopic or moist substance are bad in principle, and may be the cause of violent explosion or of chemical corrosion of the fuse wire. Tests carried out on a very large number of filling materials lead to the conclusion that the most suitable for use in enclosed fuses are thoroughly dry uniform powders of completely inert substance.

(*e*) Tests of Fuses.

The reliability and merits of a fuse are essentially matters to be submitted to the verdict of practical tests, which can be arranged to reproduce the exact conditions to be dealt with. The most important tests which a fuse must pass successfully in order to demonstrate its reliability are three in number:—

1. An insulation or pressure test (*a*) between all live metal parts and earthed metal parts, (*b*) between the two opposite poles of the fitting when no fuse is in place and when a blown fuse is inserted.
2. Tests for operation with gradually increasing current at normal voltage until fusion occurs.
3. Short-circuit tests at normal voltage.

In addition to the above tests measurements should be made of the temperature rise of accessible parts of the fitting and of the voltage drop. From the fire risk point of view the temperature rise of a fuse fitting should be taken as the maximum rise of temperature of any part of the fuse or fitting which is accessible when the fuse fitting is complete with its fittings and covers, etc., as in normal use.

Compliance with Test I. can be satisfactorily secured, and having been once demonstrated with a particular type or design, good insulation depends upon the maintenance of quality of the insulating materials and manufacture. A pressure test of at least 1,000 volts above the working pressure should be withstood without breakdown. Experience shows that under certain circumstances a risk of dangerous shock may be created by the use of hygroscopic materials like fibre, asbestos, or strawboard between the terminals; leakage may occur sufficient to give a severe shock when it is thought that the operation of the fuse has rendered one terminal "dead."

Test II. is of extreme value as an indication of the behaviour of the fuse under the conditions which in practice most frequently lead up to fusion. The fuse under test should be connected in circuit with an adjustable resistance and a battery or generator giving the maximum normal voltage for which the fuse is designed. The current is increased gradually so that the fuse has time to attain approximately its steady temperature for each value of the current. This procedure is followed in three or four steps until the fuse blows. The circuit should not be opened by other means until all arcing or glowing has ceased. This test is a most useful one, and has great commercial importance since it represents the ordinary blowing of a fuse due to continued or slowly increasing overload. The whole of the fuse attains a high temperature favourable to the production and existence of metallic and other vapours, and the relative slowness with which the fuse wire heats, becomes molten, and is dispersed in vapour, is also, as compared with the rapid severance of the circuit produced by a sudden heavy overload, favourable to the continuance of an arc across the terminals. The formation of a continuous arc after fusion must be considered as a property even more dangerous than faulty performance under short-circuit conditions, the latter consisting generally of a violent explosion and scattering of the fuse fitting without necessarily giving rise to the great fire risk which always attends imperfect operation under gradually increasing overload. It is surprising how large a percentage of sample fuses utterly fail under this test.

The carrying out of the overload test calls for no special precautions; the voltage of the generator and the current should be observed throughout the test, and the current at which the fuse blows noted, as well as the duration of any arc which may occur, and the point at which it originates. For practical purposes this test furnishes a means of obtaining an approximate value of the limiting current.

Test III. The value of a short-circuit test as a criterion of the goodness of a fuse depends to a large degree upon the manner in which the term "short circuit" is interpreted. The difference in the severity of the test is obvious, for example, between the case of a 10 ampere fuse short-circuited across a wall plug in a house installation and a fuse of the same size connected directly across the terminals of a 500 kw. generator or battery. The latter test is very much more severe owing to the lower impedance of the circuit, which is responsible for a momentary short-circuit current of great magnitude, while the voltage across the fuse terminals is maintained at a high value.

A fuse of the smallest size may be inserted in an auxiliary circuit on the switchboard of a central station, in the closest proximity to the busbars transmitting thousands of kilowatts, and the safety of the whole plant may be imperilled by the failure of the fuse to sever a faulty circuit cleanly and promptly. Perfect operation on short circuit is a matter of careful design, and entails neither increased cost nor elaboration.

Since fuses of all capacities from the lowest to the highest are liable to be subjected to short-circuit conditions of the same severity, it is not advisable in specifying the method of carrying out short-circuit tests to differentiate between fuses for various rated currents. Thus the "standard short circuit" should not be defined as a maximum possible short circuit current twenty or thirty times the rated current of the fuse under test, but all fuses for the same rated voltage should be tested in exactly the same circuit. An adequate but not too severe short-circuit test for fuses up to 50 amperes rating is provided by the following rules, which have been followed in all tests carried out by the author:—

1. The source of current should be a battery having an open-circuit potential difference 10% higher than the rated maximum voltage of the fuse under test, and capable of giving 500 amperes without the terminal voltage dropping by more than 5%.
2. The total resistance of the test circuit including the fuse should be adjusted to correspond to a steady current of 1,500 amperes produced by an E.M.F. equal to the rated maximum voltage of the fuse.

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3. On closing the main switch the fuse should blow without a continuous arc being formed or any explosive violence.

The following suggestions are put forward as a basis for the discussion of a specification for standard fuses :—

1. (*a*) *Material for Fuse Wire.*—The fuse wire must not corrode or permanently change its conductivity or physical structure.

(*b*) *Non-interchangeability.*—Fuses up to 50 amperes rated current should be provided with a simple arrangement by means of which the capacity of the fuse which can be inserted by a non-technical user is restricted within definite limits.

(*c*) *Type of Fuse Recommended.*—To facilitate compliance with (*a*) and (*b*) above and generally to render standardisation practicable and useful an enclosed cartridge type of fuse is recommended.

(*d*) *Indication of Fusion.*—All fuses must be provided with a simple means for detecting fusion simply by inspection of the fitting.

2. (*e*) *Rating.*—The rated current marked on the fuse shall bear a definite relation to the limiting current or least current which will produce fusion within 4 hours. The minimum value of the ratio $a = \frac{\text{limiting current}}{\text{rated current}}$ shall be 1·54 and the maximum value shall not be higher than 30% above the minimum. In a correctly proportioned line of fuses *a* should decrease from the maximum to the minimum values specified, as the size of the fuse increases from the lowest to the highest capacity. This regulation is based on the assumption that silver is the best metal for fusible links, taking into consideration its permanent character, the small volume required, and its "clean" action when breaking the circuit.

(*f*) *Sluggishness of Action and Time Element.*—Standard fuses shall be so rated and constructed that when loaded with 50% above the limiting current they will fuse within 1 min. The actual time required for fusion shall be taken as a measure of the "time element" of the fuse.

(*g*) *Standard Rated Currents and Voltages.*—Every fuse shall be clearly marked with its rated current and the maximum voltage for which it is suitable. The standard rated currents and voltage suggested are as follows :—

Maximum Voltage, 250.—2, 4, 6, and 10 amperes.
Maximum Voltage, 500.—2, 4, 6, 10, 15, 20, 30, 40, and 50 amperes.

3. (*h*) *Temperature Rise.*—When loaded continuously with 80% of the limiting current no exposed part of any fuse fitting shall attain a temperature exceeding 100° C. above that of the atmosphere.

(*k*) *Insulation.*—Fuse fittings shall be tested for insulation between terminals with the fusible portion removed and between the live parts and "earth" with the fusible portion in place.

(*l*) *Operation.*—Fuses shall be tested for satisfactory operation on overload and short-circuit in accordance with the specified arrangements for carrying out such tests.

NEWS FROM GERMANY.

The Felten & Guilleaume-Lahmeyerwerke have invented a plan for making electrical machines in any number working together when similar windings are shunted parallel. The principle of the method is to regulate the windings according to the number of machines, and to connect them so to the branch currents that each branch is derived entirely from one winding. The A.E.G. on the other hand, proposes an arrangement whereby the excitation of a generator supplying a network system or a series of such parallel-connected generators remains nearly or almost unaltered. The compounding is effected by means of condensers put into the circuit of each separate dynamo or into their common conductor.

Electric Winding.

Brown, Boveri & Co., have installed an electric winding plant at Heinitz mine at Beuthen, designed for lifting 230 tons a day from a depth of 840 yds. At present the lifting is 115 tons from 590 yds. The head wheel is 26 ft. in diameter. There are two motors of which only one is in use so far. Both are 16-poled with auxiliary poles and at 490 volts and 24 r.p.m., each supplies 565 h.p., but can work up to 1,365 h.p. The brake is worked by compressed air and acts on the wheel axle. The air is compressed to six atmospheres pressure by a 8 h.p. motor, which can deal with 60 cu. metres a minute. The winding motor is supplied with current from a distance of about 100 yds. by a dynamo worked by a steam turbine and capable of yielding 1,240 kw. At present they are giving 475 kw. at 500 volts and 1,500 revs.

Electric Clocks.

As is well known there are two systems: sympathetic clocks in which the dial train is put forward at regular intervals, the clock having no driving power, and the synchronised clocks in which the position of the hands is merely adjusted from time to time. The A.E.G. has constructed a clock on the former principle in which two coils carrying a current oscillate between the poles of a permanent magnet, and transmit their movement by a train to the hand. This is a very compact method of construction and as the coils have no iron in them, there are no difficulties from remanence. The hands are moved once every minute.

Testing Arc Lamps.

Presser recommends the use of a selenium-cell for judging arc lamps for constancy of light. The graphs obtained from the readings of the galvanometer give, according to him, very accurate indications of the comparative value of different arc lamp systems, and especially, of course, where absolute steadiness of illumination is quite as necessary as a powerful light. The arc lamp is never at fault as regards the absolute emission of light, but it often discounts its otherwise great value by sudden fluctuations, which in some cases are of much importance even if they do not appeal to the eye to any great extent.

Selenium Cells.

The value of selenium in telegraphing photographs is well known. In fact, this latest development of telegraphy would have been impossible but for the sensitiveness of the selenium to light. It has the great disadvantage, however, of being slow to respond to the electric stimulus. Korn, of Berlin, has rendered good service to electricity and to certain engineering applications thereof particularly by inventing a process for avoiding this difficulty to a great extent. A minute even, a long time in telegraphy, is often wasted by the slowness of the response. The remedy appears to be to excite the cell by a secondary light to which it is subjected just before actual use, so that the cell is so far excited to begin with that it will respond at once. The process has been developed in two German patents, Nos. 180219 and 211836 respectively, and bids fair to be of extreme importance. It would seem, too, that it affords a means not only of getting a preliminary excitement of the cell, but of regulating the stimulation for special purposes.

Development of Water Power.

An unusually important lecture was recently given by Herr Loacker to the Bodensee-Bezvikverein of German engineers on this subject. After calling attention to the cheapness of water power in favoured localities, in comparison with its only possible rival, viz., steam power, Herr Loacker shows that the present method of using water power is extremely wasteful. He estimates that the present method of using waterfalls never utilises more than 10% of the gravitation energy, even working 24 hours a day all the year round. With an eight hour day, therefore, 95% of the falling weight of the water passes away just as if there were no turbines in its way. According to Herr Loacker the mistake made is to suppose that the waterfall is the chief source of power. He would prefer to see slow accumulation of water at high levels, and thence an artificial and regulable waterfall. A big reservoir made by damming a valley at a suitable height above sea level, and a waterfall consisting of the outflow of this reservoir over the dam apparently make the ideal method of using water power for driving dynamos or machinery of any kind.

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Electrical Progress at Home & Abroad.

A Review by our Special Correspondents.

TYNESIDE.

NEWCASTLE-ON-TYNE.

The increasing growth in importance of scientific and engineering societies in this area has led to a need for increased accommodation of a sufficiently impressive description, and to meet this requirement a very fine block of buildings known as the Bolbeck Hall has been erected close to the premises of the Newcastle Literary and Philosophical Society in Westgate-road, Newcastle. Among other institutions finding thier new home in this building is the North-East Coast Institution of Engineers and Shipbuilders, and during the past week the inauguration ceremony in connection with their new rooms has taken place. The premises of the Institute occupy the whole of the third floor. Besides the rooms devoted to the Executive staff is a finely appointed council room, committee and smoke room, and a library for the use of members. In view of the present-day intimate relations between electrical engineering and shipbuilding, this development is of interest.

Electric Lighting Equipment of a Dockyard.

Although the main portion of the electrical equipment of Messrs. Smiths' Docks, Middlesbrough, was accomplished some time ago, according to the consulting scheme of Mr. C. W. Fairweather, of this city, it is satisfactory to note that a recent extension to the electrical gear installed has been made by the use of twenty-four ten ampere "Davy" arc lamps burning in series circuits on a 220-volt supply given by a motor generator, together with 60 enclosed "Davy" lamps for the interior shop lighting. This has been rendered necessary in order to facilitate working on overtime in loading, unloading and repairing vessels. The Davy Arc Lamp Co., Ltd., are introducing in this area one or two usefully improved types of lamps, one of which, the lantern type, is specially useful for dockyards and engineering works where in the case of breakage only one panel of glass is affected and this can be speedily replaced by sliding in a spare sheet. Another compact lamp for series burning has an interesting arrangement of automatic cut-out and compensating resistance places immediately over the lamp. Its compactness is such that the lamp burning 20 to 22 hours is only 33 in. long. About 350 "Davy" lamps have up to now been supplied to the Newcastle-upon-Tyne Electric Supply Co., Ltd., while Messrs. Reid, Ferens & Co., of this city, have ordered about 130.

Shipbuilding Orders for the Tyne.

During the period of the recent trade depression upon Tyneside, it was remarked in these notes that the partial or total stoppage of work in the large shipyards on the Tyne had a very serious influence upon electricity supply. There are now indications that owing to the activity principally induced by large Government contracts, the shipbuilding yards will be in full swing for a considerable time. It is now announced in the *Newcastle Chronicle* that Messrs. R. & W. Hawthorn, Leslie & Co., Ltd., of St. Peter's, Newcastle, have received a very important order from the Admiralty for turbine engines of 18,000 h.p. to be installed on the first of the unprotected cruisers shortly to be built at Pembroke Dockyard. The same firm is also busy at present with the turbines for the *Monarch*, the "Dreadnought" type battleship now under construction by Messrs. W. G. Armstrong, Whitworth & Co., Ltd. Another item of interest is that the Cunard Co. of Liverpool have given a contract to Messrs. Swan, Hunter & Wigham Richardson, Ltd., of Wallsend, for a sister ship to the *Franconia* (now being built by the same firm) and the engines are also to be built on Tyneside by the Wallsend Shipway Co., Ltd., these being of the twin screw quadruple expansion type of 12,500 i.h.p. The work indicated above means increased demand for electric power and an opening for electrical auxiliary apparatus of many descriptions.

Colliery Electrical Equipment.

In connection with the Trimdon Grange Colliery, owned by Messrs. Walter Scott & Co., Ltd., a commencement was made some two years ago in the modernising of the engineering arrangements of the mine by the installation of turbo generators by Messrs. Parsons and the provision of an electrical distribution system. This has recently been carried a stage further by the installation of five 3,000-volt switch cabinets, constructed by Messrs. J. H. Holmes & Co., Ltd., of Newcastle, for the conversion of steam haulages to electric drive. Each cabinet is capable of dealing with 150 h.p., and is of a very substantial construction, with cast-iron doors so interlocked with the three-pole isolating switch that the latter can only be operated when the door is closed, and all switches must be in the "off" position before the door can be opened. On the top of the cabinet are placed an ironclad ammeter and voltmeter, together with a trifurcating box for the high tension leads, and bushed exits for the low tension conductors. The gear is fitted with no volt and overload features on two phases, with adjustable time-limit features, and the apparatus is a good example of compact but safe design.

THE MIDLANDS.

BIRMINGHAM.

The annual meeting of the Birmingham Local Section of the Institution of Electrical Engineers was held on Wednesday in this week, at the new University Buildings, Edgbaston, Mr. R. K. Morcom, presiding. The Committee reported that during the past session there had been seven general meetings, in the course of which a number of papers had been discussed. The average attendance at meetings was 54. The area of the section had been recently altered to include towns within a radius of 50 miles of Birmingham, excepting the Pottery towns and Nottingham. The membership now stands as follows: Members 50, an increase of 13; associate members 161, an increase of 36; associates 59, an increase of 11; students 128, an increase of 8; total 398, an increase of 68.

Improvements at the Electricity Works.

A good deal of work in the way of change over from steam or gas to electrical power has been done by the Birmingham Electric Supply Department during the holiday week. As mentioned last week, considerable extensions are contemplated in the Department's central and sub-stations. At the Summer-lane station, the new plant will include two 2,500 h.p. engines, condensers and air-pumps, estimated to cost, with the necessary foundation work, £23,650. The other principal items estimated for are: Two 1,500 kw. alternating current generators £5,400, eight 1,000 kw. exhaust steam turbo-generators £44,000, alternating current switch gear £5,400, direct current switchgear £800, seven water-tube boilers, including mechanical stokers, driving gear, superheaters, coal shoots and gangways, £17,800; set of four economisers £2,900, brickwork and flues for same £1,800, steam piping and valves £3,000, eight cooling towers with pipe connections £18,000, extension of boiler house to accommodate three new boilers, with coal bunkers, £4,250, making, with the subsidiary structural work, feed pumps, piping, valves, etc., a total for Summer-lane, £129,450.

Sub-Stations.

The expenditure proposed for the sub-stations includes for Court-road, Balsall Heath, one 300 kw. rotary converter without transformers, £700; one 500 kw. rotary converter with transformers, £1,650, making, with the foundations, switchgear, cables, and two high tension ring main panels, a total of £3,340. At the Upper Trinity-street sub-station, Bordesley, there are to be a 500 kw. rotary converter with transformers to cost £1,650, two high ten-

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sion ring main panels £300, two high tension incoming feeder panels £300; total expenditure £2,730. A similar equipment for the Camden-street sub-station, but with only one high-tension incoming feeder panel, is estimated to cost £2,580. At Scholefield-street sub-station, two high-tension ring main panels and one high-tension incoming feeder panels are to be put in at a cost of £450. The sub-station to be provided for the new supply district of Harborne is estimated to cost £4,600, including land £1,000, buildings £1,500, two 200 kw. double-ended motor generators £1,600, switchgear and cables £500. The total expenditure for new plant and stations is £143,250. The rate of the installation of the new plant will depend upon the growth in the demand for current. Orders for the first instalment, to meet the expected demand for the winter of 1911–12, are to be placed towards the end of this year. At the meeting of the City Council on Tuesday the proposals of the Committee were approved.

Yardley and Electricity.

The Yardley Rural District Council have declined to purchase the power station of the City of Birmingham Tramways Co. in Yardley-road. This postpones the possibility of a general supply of electricity to the district, in which, as was shown at the Birmingham Extension Enquiry, there should be a large demand not only for lighting, but for power, as a number of important factories have recently been erected in the district. On the other side of the city, a contrast is furnished by the enterprise shown by the Handsworth Electricity Committee, which is doing its utmost to promote the use of current for all conceivable purposes. Since the matter was last referred to, eight additional private house services have been laid on, some under the free wiring scheme, and others on the hire purchase system, the houses being of the class ranging from £30 to £45 per year.

Data Required.

In endeavouring to push forward the use of electricity for domestic purposes such as cooking, heating and ironing, the Handsworth authority finds itself confronted with a difficulty in obtaining data on which to base an estimate of the cost to the consumer as compared with gas and other methods of heating. The data so far available do not appear to be based to any great extent upon actual use under ordinary domestic conditions. Mr. Nixon, the engineer of the Handsworth Electric Supply, has, therefore, obtained the sanction of his Committee to an experiment under such conditions, and he suggests that results of great value to electric supply stations generally might be obtained if other engineers would institute similar trials, so that something like an average standard might be available.

Improving Business.

Business among the electrical engineering and manufacturing firms in the district seems to be looking up considerably. At the Stafford works of Siemens Bros. Ltd., work is being carried on night and day, and also during the week-end. The output during March was twice as much as the average monthly output since the establishment of the works. A good deal of work is being done for Japan. The firm has also a contract in hand which is believed to be the largest ever yet given out for rolling mill plant, including a motor having an overload capacity up to 15,000 volts. There is an enormous run in this district upon the Siemens tantalum lamp, and the firm to meet the requirements of those who prefer a higher efficiency to a greater durability, have recently brought out with success a tungsten lamp. In this lamp, as in the tantalum lamp of the same firm, the filament is not produced by any of the customary "building up" processes, but is an actual drawn wire, a method of production which has obvious advantages in respect of efficiency and durability.

LANCASHIRE.

MANCHESTER.

Manufacturers report a fair amount of work in hand, and it is the general opinion that business has taken a decided turn for the better. If the percentage of unemployment recorded is any reliable indication of the industrial activity of the country, a glance at the last Board of Trade Report dealing with the matter shows that this percentage has been dropping very rapidly and at an even rate for the past three months. It now stands at about 5%, as against 9% a year ago. From the slope of the curve, it would seem that even the year 1900 figures (about 2%—the lowest in the last 10 years) would be beaten in another three months' time. It is also pleasing to note that as employment is increasing, so is the amount of exports. This would seem to imply that in trade in general the improvement is due largely to the expansion of foreign trade, and apparently the business tours abroad in which the heads of English business houses have been indulging are already bearing fruit.

The Education of Engineers.

With reference to the report of Dr. Samuel Sheldon's paper at the American Institution of Electrical Engineers, advocating a broadening of the education of the electrical engineer, it should be noticed that for some years past it has been the tendency to raise the standard of the entrance (matriculation) examination to the School of Technology here, and also to the Manchester University engineering courses. Also as emphasising the remarks made as to the importance of building up the scientific training on a good general education, it is interesting to note that until this higher initial standard was introduced it was found impossible for the students as a class to derive the maximum benefit from the instruction given.

UNITED STATES.

NEW YORK.

The United States Navy is sending emissaries to the manufacturing centres on the look-out for promising young electricians for warship service. Now that practically every kind of labour in the Navy is accomplished with the aid of electricity, the demand for skilled men is constantly growing, and as an unusually large number of vessels are to be put in commission this and next year the demand for electricians of suitable age, character and physique is so greatly in excess of the supply that the Naval authorities are offering exceptional inducements to young men to join the service. The minimum rate of pay offered to young men works out at about thirty-two shillings per week, and rises pretty quickly to £4 and in the higher grades to £8 per week, while promotion goes on as far as the post of rear-admiral. Young men ambitious to become electrical experts, but lacking the necessary funds for technical training, are given every advantage by the naval authorities. They are sent to the school in the New York Navy Yards for a five months' course of instruction, and not only receive their tuition fee, but are paid a small sum in addition, and upon graduation are immediately placed in lucrative berths. With the easy method of starting in the service and prospects of advancement, an unusually fine grade of men are enlisting in the United States Navy.

Temperature Co-efficient of Copper.

In a paper read last week before the American Physical Society, Professor J. Dellinger pointed out that the conductivity and temperature co-efficient of copper are proportional. The samples thus far investigated represent a number of the chief sources of supply of copper wire. Native lake copper, and copper refined by smelting and by electrolysis, are included. The relation holds for differences of conductivity due to differences in physical properties, as well as for those due to differences in chemical composition. For example, hard-drawing and annealing, said Mr. Dellinger, are found to produce proportional changes in the conductivity and the temperature co-efficient. The range of conductivity is from 94·5% to 101·8% (on the basis of 100% conductivity corresponding to 0·15302 ohm per metre-gram or 1·7213 micro-ohms per centimetre-cube, at 20° C.). The samples investigated are accordingly fairly representative of the copper now in use for electrical purposes. Using this result, a measurement of the conductivity of a sample gives also its temperature co-efficient. Thus, a_{20} (in the formula, $R_t = R_{20}[1 + a_{20}(t-20)]$ for a sample of copper is given by multiplying 0·00393 by the percentage conductivity. The

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relation also indicates that the measurement of conductivity may be replaced by the often more easily made determination of temperature co-efficient. We have herein an explanation of the disagreements of previous determinations of the temperature co-efficient of copper. The value assumed by the American Institute of Electrical Engineers, $a_0 = 0{\cdot}0042$, or $a_{20} = 0{\cdot}00387$, is the true temperature co-efficient for copper of 98·6% conductivity.

Cooking by Electricity.

In the course of a striking editorial on the electrical cooking question, the *Electrical World* points out that the crux of the whole matter is the cost. Electrical cooking devices, says the writer, are admirably efficient, both from the thermodynamic standpoint and from that of practical use. Most people who make the trial find the utensils extremely convenient and like them until the bills come in. At that point the electrical stove frequently gets laid upon the shelf. . . . A charge of 8 to 10 or 12 cents per kw.-hour simply drives away business. If actually secured at all, cooking and heating business must be taken at rates approximating rather motor than lighting rates. "At 5 cents per kw.-hour electrical cooking or heating becomes a practical matter, and at 3 cents or 4 cents should be a considerable source of profitable added load. Supplying such load on the basis of motor service is, however, no easy matter. For instance, it involves breaking away from the familiar methods of charging and may add considerably to the burden of metering if one undertakes to supply separate meters. Most popular systems of charging for electrical energy are attended with a complication that makes it particularly difficult to get business of highly specialised character. In Hartford, which is rather a hot bed of startling and profitable heresies, cooking apparatus, like domestic lighting, is taken on a contract basis with results that are reported to be rather gratifying to all parties concerned. Some other stations have tried special meters for heating and cooking service, but whatever the particular method preferred may be, the general situation is that one here has a class of load of a character quite distinct from ordinary lighting load, and approximating motor conditions. It ought to be worth getting, and some day it will so prove. At present the main difficulty is in finding a place in the scheme of charges to meet the particular requirements demanded. A scheme of primary and secondary rates skilfully adjusted, as it is in some cities, to give the consumer a chance at the secondary rate if he is a fairly liberal user of energy, will often meet the requirements; but the individual central station manager must face this problem and solve it in his own way. The fact is, however, that in electrical cooking and heating one has a class of business that demands special treatment in the matter of rates; and the fault of most current methods of charging is that whether by statute, or by custom, or on theory, the requisite variations of rates for different classes of service are not easily applied. The result in cooking and heating, as in domestic lighting, is that the gas companies get the business of the small consumer, who individually seems trivial, but collectively is a valuable and profitable friend.

The American Patent System.

To the comparison between United States and British methods in the matter of patents to which reference was made in these Notes last week, there comes a further contribution this week in the shape of a letter written to President Taft by Mr. William Fetzer, a plough manufacturer, of Springfield, Illinois, who frames a very frank and uncompromising indictment of the American system. He declares that while in 1909 $1,309,735 was paid to the Patent Office for 37,241 patents, and as much again and more paid to attorneys, the issue of 99½% of these patents indirectly involved fraud on inventors. Of farm machinery patents that are issued not more than 5% are ever actually applied; not more than 2% go permanently into manufactures put on the market; not more than 1% are tested out in the Federal courts, and of these latter hardly one-half are upheld by the Government which granted and issued the patents. The writer relates that, finding patents issued to him were being flagrantly infringed, he was finally driven to commence suit against a competitor upon one which appeared the strongest of a large number of his inventions supposedly protected by patents. He has found, however, that the defence was taken over by the agricultural machinery trust, which furnished its chief patent counsel to take charge of the case, and one of the largest component companies sent its officers to testify against the patent. Moreover, he states that the plough combination threatened to destroy his other patents unless the suit were withdrawn. The only real protection the Patent Office now grants is, he said, the protection of the lawyers in their fees. A lawyer, he declares, may agree in writing to take an inventor's patent application through to issue for $50, then subsequently demand $50 more and refuse to allow the issue of the patent until this amount is paid, in which refusal the Patent Office will sustain him. The Patent Office, in fact, according to Mr. Fetzer, does not afford the inventor any recourse against lawyers' dishonesty. "Whereas," he asserts, "our forefathers originally intended the patent department as a protection and blessing to the young men of industry, it gradually has been changed into a hog trough for the liberal feeding of low-grade lawyers who are being upheld to gold-brick the inventor." Mr. Fetzer adds that he does not wish in any way to reflect upon the examiners or officials of the Patent Office, whom he has always found to be capable and thoroughly honest, and seeming to have nearly as much interest in their work as if they owned the department. The difficulty is in the intervention of the courts, and he urges that exclusive control and disposition of patent matters, including all patent litigation, be confined to the Patent Office.

Electrical Developments.

An American electrical engineer who has just returned from Japan expresses the conviction that there is a large future in that country for electric railways as supplemental to the Government steam railroad system. For a number of years, the Government has been taking over the steam railroads belonging to private corporations and has been building connecting links to complete the system. The Imperial Government railways now consist of 5,248 miles of road, and there are now only 445 miles of road under private ownership. These lines are widely scattered and have been built to serve private interests, such as mining propositions, rather than public needs. Ten years ago, Japan owned but 979 miles of the 3,172 miles then in operation. One reason for believing that the future roads will be largely electric is that Japan has many water-powers which are going to waste, and these powers could economically be used to operate electric feeders for the steam lines into districts which are not reached by them. These lines should be cheaply constructed for, apart from the rail, material is plenty and labour is cheap. The Government now operates about 25 miles of trolley lines about Yokohama Bay and is extending these lines. The trolley cars use the some stations as the steam railroads in many places and connections are made between the two systems of transportation. Another reason why electric roads are well suited to supply the needs in Japan is that the chief function of the steam railroads now is the transportation of passengers. There is provision for three classes of passengers, and an analysis of earnings shows that the third-class passengers were carried at the rate of a little more than 0·7 cent per mile and that the average fare paid by each passenger of this class was about 15 cents. Certainly this is interurban traffic and the kind of business which can be best handled by electric lines.

An Improvised Tachometer.

Writing from Colorado to some of the technical journals, Mr. W. J. Hazard describes the ingenious way in which a tachometer was recently improvised at the Colorado School of Mines. A rotary engine recently tested at the school had to be run at all speeds from 400 r.p.m. to 1,000 r.p.m. and the brake horse-power maintained at a constant value throughout this range of speed. This requirement made it necessary to adjust the speed of the engine—by means of the cut-off—to a predetermined value corresponding with the assumed horse-power and weight of the Prony brake. With the common revolution-counter this adjustment would be an almost endless task and some form of tachometer was necessary. At the time of the test no tachometer was available, and, therefore, a ½ h.p., 110 volt direct-current motor having a normal speed of 1,650 r.p.m. was

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belted to the engine shaft, and the field circuit was left open. The armature was connected to a voltmeter having a range of 0 volt to 15 volts by tenths. Various speeds of the engine were found by a revolution-counter and the corresponding voltmeter readings were noted. A curve was plotted showing the relation of speed and volts; as expected, this calibration curve was a straight line through the origin—1,000 r.p.m. was found to give 13·33 volts. From this curve the speed at any instant could be read at a glance and the engine could be brought to any desired speed. After several days' use, when the tachometer was tested again, it showed no change, the residual field of the motor having remained constant. The power required to drive the small armature was a negligible portion of the power developed by the engine tested, and the apparatus was very satisfactory.

$5,000,000 Trolley System.

It is announced that an interurban trolley system to connect the cities of the Piedmont section of North and South Carolina from Anderson, S.C., to Durham, N.C., at a cost of approximately $5,000,000 is planned by J. B. Duke, president of the American Tobacco Company and of the Southern Power Company, and others. The Dukes propose to furnish the greater part of the capital for the proposed system. Bonds will be issued to the extent of $2,500,000, the Dukes agreeing to place these on the market at not less than par. Of the remaining $2,500,000 necessary, the Dukes agree to take one-half in stock, the remainder, one-fourth of the entire amount required, to be subscribed by manufacturers and capitalists in the cities and towns to be benefited by the operation of the new line. The proposition has been put up to business men, and the subscription of the required amount of stock is assured. The new trolley system will have a mileage of about 250 miles, connecting the cities of Anderson, Greenville and Spartanburg, S.C., Charlotte, Salisburg, Concord, Greensboro and Durham, N.C., with intervening cities and towns of less importance. A fast passenger and freight service will be given on the new line, it being planned to operate trains each way every half-hour. The power will be furnished by the Southern Power Company, which has available at present 100,000 h.p. of electricity, with power sites that will furnish an even larger amount in addition. The Anderson, Greenville & Spartanburg Traction Company, which has already begun work on a system connecting those cities, will be merged into the larger enterprise.

Pullman Shops Electrification.

Interesting details are published of the progress of the work of equipping the great Pullman railway car shops in Chicago for electric drive. The works consist of a large number of buildings, and among the plant extensions are two steel passenger-car shops, each 220 ft. wide and 420 ft. long. These shops, just completed, have increased the capacity of the company to turn out passenger cars about two-thirds, making the total capacity about 150 cars a month. In addition, an independent steel freight-car plant has been erected about a mile from the remainder of the works. This plant consists of a main building 400 ft. by 1,175 ft., and two other buildings, one a wheel and axle shop, and the other a mechanical building, including a power plant for the steel freight-car department and a machine shop. This steel freight-car department is entirely new throughout and will be operated very largely by electric motors from the beginning. This general power house will supply energy to motors having a rating of about 3,000 h.p. and used for driving the machinery in the various metal-working, wood-working and other operations in the manufacture of cars, as well as blowers, cranes and the various power apparatus used in a large manufacturing establishment. It will replace several existing steam engine units, and it is of interest to note that among these is the 1,400 h.p. Corliss engine which was exhibited at the Centennial Exhibition of 1876, and which was at that time the largest steam engine in existence. It is not known at present what disposition will be made of this interesting historical exhibit.

The Equipment.

The ultimate equipment of the general power house will consist of three 1,500 kw. horizontal Allis-Chalmers turbo-generators, the output being three-phase, 60-cycle, current at 2,200 volts. In addition the plant will contain four 4,000 cu. ft. air compressors. The initial installation consists of two of the generating units and three of the compressors. This power house is built about 200 ft. from the existing boiler house of the works, equipped with eight 400 h.p. Stirling boilers and having room for 14 boilers of the same size. There will be at first two exciter units in the general power house, each of sufficient capacity for two of the main generators. The dynamos of these equipments will be of 60 kw. each, and one will be steam driven and one driven by a 60 kw., 2,200 volt induction motor. When the third generating unit is installed another electrically driven exciter set will also be placed in position. For supplying direct current to crane motors and a few other direct-current motors, a motor-generator set has been placed in the general plant. This consists of a 300 kw., 220 volt, direct-current generator driven by a synchronous motor. The switchboard is of Italian marble and is under construction by the Delta Star Electric Company. The board consists of three generator panels, five exciter panels, six motor-generator panels, one Tirrill regulator panel, one station-lighting panel, about 20 feeder panels for both alternating current and direct current, and one blank panel which will be used ultimately to control the tie line to connect the general power house with the steel freight-car works power house. The alternating-current switches are electrically operated and are placed in a switch-room under the switchboard, which is on the engine-room floor. In the new steel freight-car works there will be three air compressors of the same size as in the general plant, and there will be three 1,000 kw. Westinghouse horizontal turbo-generators, each producing 440 volt, alternating three-phase, 60 cycle current. There will be two 500 kw. motor-generator sets, while the arrangement of exciters will be practically the same as that in the other power house. Electricity from this plant will be transformed down to 110 volts for lighting service, but will be used at a generator voltage for the motors. The proportion of direct-current load is larger here than in the general plant, there being 13 or 14 cranes in the main building operated by 220 volt series motors. The Pullman Company is itself designing, installing and operating these large electric installations.

New Electiric Locomotive.

A new type of side rod electric locomotive for the New York, New Haven & Hartford Railroad is nearing completion at the Westinghouse works. The locomotive consists of two separate units each complete in itself, but designed to be operated in pairs. Each unit comprises two pairs of driving wheels and a leading pony truck mounted in a forged frame of the locomotive type. An A.C.-D.C. motor of 750 h.p. is mounted on top of the frame with its centre line 18 in. in the rear of the forward driving axle. Forward of the front driver is a jack shaft extending across between side frames and carrying on each end a crank arm and counterweight casting. The motor shaft has a crank arm keyed to each end and connecting rods on each side extend down through the cab floor to the jack shaft crank arms. The two driving wheels on each side are coupled to the jack shaft crank pin by locomotive side rods of the ordinary type. The driving mechanism is almost exactly the same as that employed in the Pennsylvania Railroad Company's tunnel locomotives, which was recently described in these Notes. The auxiliary apparatus on the locomotive is distributed between the two halves of the cab, but each unit is supplied with independent current collecting devices for both A.C. and D.C., ventilating blower, auto-transformer, unit switches, controller and change-over panel. Either motor may be operated without the other. A boiler for furnishing steam for the steam heating of passenger trains and an oil tank are mounted in one half, while the air compressor and a water tank are mounted in the other half.

Telephones on the Santo Fé.

Contracts have been let for equipping the Santa Fe system with telephone service, to replace the telegraph for the dispatching of trains between Albuquerque and Mojave. With the completion of this section and the closing of a few gaps between Albuquerque and Newton, Kan., the Santa Fe will have superseded the telegraph with the telephone on the entire system, between Chicago and the Pacific coast, save between Mojave and Bakersfield, where the tracks of the Southern Pacific are used.

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Business Notes and News.

LIGHTING AND GENERAL—Home.

CARLISLE.—The Central Electric lighting station in James-street is about to be enlarged.

DEVONPORT.—The accounts of the Borough Electricity Department show a net profit of £1,010 on the year. A saving of £627 has been effected by installing mechanical stokers. It is proposed to reduce the price of electricity from 4d. to 3½d. per unit.

EAST BUDLEIGH.—A proposal is on foot to light the village by electricity, and an electrical engineer has been invited to attend a public meeting and explain the project.

ERITH.—As a result of the electrical engineer, Mr. A. Coveney, pointing out that the plant was inadequate at the electricity works for another winter, the Council have decided to apply to the Local Government Board for sanction to borrow the following sums, amounting to £10,000, for the purposes of the electricity undertaking, namely: One 750 kw. turbo alternator, with condensing plant, circulating pump and other accessories, and Lancashire boiler, £7,000; prospective mains, meters, services, arc lamps for transformers, £2,170; amount overspent in respect of loan sanctioned on June 19, 1908, £830; total £10,000.

EXETER.—The surplus for the year ending March 31 is £2,763, and now the borough electricity accumulated profits and reserve amount to £7,416.

GLASGOW.—The Electricity Committee recommend that the necessary cables for giving a supply of electricity to the Scottish Exhibition of National History, Art and Industry be laid, and that a supply for lighting be given at the rate of 2d. per unit, and a supply for power at 1d. per unit, which rates, it is anticipated, will yield a revenue of £4,600.

LONDON: FULHAM.—The Fulham Borough Council Electricity undertaking made a net profit of £4,716 by last year's trading.

PEMBROKE.—At the suggestion of the electrical engineer, an arrangement has been made whereby the candle-power of the lamps on 176 of the present public electric incandescent lamp-posts will be doubled—that is, increased from 2·16 c.p. lamps to 2·32 c.p. lamps—and the 15 additional lamps, which are at present 32 c p., will remain as heretofore, the payment, until otherwise decided, to be the flat rate of £4 per post per annum, or a total of £764, as against £752 under the old arrangement.

SOUTHEND.—In order to meet the large demand for current by the Luna Co. for illuminating the park and providing various amusements, the Borough Surveyor has been authorised to lay down an extra feeder at a cost of £263.

STIRLING.—The Burgh Electrical Engineer reports that the total number of 8 c.p. equivalent connections now stands at 27,134, as compared with 25,680 at this time last year.

WALTHAMSTOW.—A Local Government inquiry has been held into an application for powers to borrow £950 for additional plant at the electric light station. The clerk explained that the application was originally one for sanction to borrow £1,210, representing the estimated cost of installing an additional booster set with the necessary connecting cables, together with switchboard and instruments, and an extension to the existing switchboard gallery. Since making the application the Council had invited tenders for the work, and a committee had provisionally decided to recommend the Council to accept the tenders of the General Electric Co. for the booster set, Bertram Thomas & Co. for the switchboard, and the General Iron Foundry Co., Ltd., for the constructional ironwork in connection with the extension to the switchboard gallery. The amount applied for should therefore be amended to £950. At a meetiog of the Lighting Committee in January last the Electrical Engineer reported that it was necessary to install a booster set to enable the Council to maintain a normal pressure in the Blackhorse-lane factory area. A cable had been laid to inter-connect the Higham Hill and Blackhorse-lane feeders, at a cost of £900. This was laid for a demand of 300 amperes, but the load in the area had increased to such an extent that the maximum demand had reached 550 amperes, and the Electrical Engineer estimated that by next winter the demand would reach 700 amperes. The booster set in use was installed for traction purposes, and designed to deal with fluctuating demands up to only 400 amperes. The set was considerably overloaded and the provision of a larger booster was now a matter of urgent necessity.

LIGHTING AND GENERAL—Overseas.

DUNEDIN, NEW ZEALAND.—A local correspondent reports that the installing of electric light in the southern area of Dunedin and its suburbs has been completed. The Mayoress of Dunedin (Mrs. J. H. Walker) formally switched on the 124 60 c.p. lamps, which are to illuminate South Dunedin, Caversham and St. Clair. Technically, the installation differs from the ordinary system of lighting, in that all the lamps are on the one wiring, forming really a system within itself. This ensures equal brilliancy, the last lamp receiving as much illuminating power as the first. The whole system is controlled from the converter station in Cumberland-street. The lamps are of the tungsten type. Other localities in the Dominion, with similar installations, have expressed their decided satisfaction with this class of lamp, while the cost of renewals experienced has been very moderate. The company supplying the lamps give the assurance that the average life of each lamp is 1,000 hours, and that has been exceeded locally. The filaments of the lamps have a total length of about 6 in.

TORONTO.—The Ontario Provincial Government Hydro-Electric Power Commission will very soon be ready to distribute power to the municipalities along the route of its transmission lines.

TRACTION—Home.

BELFAST.—Mr. Andrew Nance, General Manager of the City Tramways, has presented a further report to the Tramways and Electricity Committee on the proposed extensions of the service. He estimates the cost of construction of the new lines as follows: 1, Donegal-road tramways, £22,000; 2, Shaftesbury-square and Ormeau-road Junction tramways, £12,000; 3, Stranmillis-road extension, £6,000; 4, Ligoniel extension (tramway), £6,000; do. (road), £450; 5, tramway to M'Art's Fort (tramway), £56,400; do. (road), £29,700; 6, Castlereagh-road tramway, £23,000; 7, Bloomfield tramway, £17,000; 8, Old Lodge-road and Old Park tramways, £25,000—total, £197,550. Mr. Nance adds: No expenditure will be required for some years to come, under the headings of "equipment" and "machinery," except the gradual expansion of the equipment of the whole undertaking, which only amounts to about £7,000 per annum. The total route mileage of the above extensions is 10 miles, of which six miles are flat and four miles are on a gradient. The total route mileage of the present system is 38½ miles.

SOUTHEND.—Proposals for doubling the light railway track at various points, among others, between Leigh and the Kursaal, are being considered. Running powers over the borough lines are to be granted to the Southend and Colchester Light Railways Co., Ltd.

WATFORD.—The construction of the tramways at Watford has been deferred for six months in order that the result may be ascertained of the working of the railless traction system which has been adopted by the Leeds and Bradford Corporations. Some of the thoroughfares in Watford are so narrow that trackless tramways are being strongly advocated.

TRACTION—Overseas.

BUENOS AIRES.—A Bill was laid before Parliament on April 12 relative to a contract with Mr. Edwin Steer for the construction and working of an electric railway, to be called the "Ferro-carril Expreso Eléctrico Montevideo-Buenos Aires." The line will run from Montevideo *via* Libertad, Santa Ecilda, La Paz and Rosario to Colonia, whence there will be a steamship service to Buenos Aires. The concession includes powers for the carrying out of irrigation and water works, and also for hydro-electric works. The concession is for a term of 90 years.

COMPANIES' MEETINGS AND REPORTS.

HINDHEAD AND DISTRICT ELECTRIC LIGHT.

The accounts for the year show a gross profit of £1,912, to which is added the balance brought forward, making a total of £1,950. After allowing for various appropriations the directors propose to pay a dividend for the half year ended December 31 last at the rate of 6% per annum, making 5½% for the year, and carry forward a balance of £204.

HOLSWORTHY ELECTRIC SUPPLY.

The first statutory meeting of shareholders was held last week. Mr. Wm. Kivell (chairman of directors) presided, and explained the position of the company. On the motion of the Rev. T. S. Kendall, seconded by Mr. Lovell, the directors' report was adopted. There is every prospect of a

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successful future for the company, and a hearty vote of thanks was accorded the directors for their valuable services.

CALCUTTA ELECTRIC.

At the annual general meeting of the Calcutta Electric Supply Corporation, Mr. Edmund Boulnois said the shareholders must have read the report with much satisfaction. The sum of £59,153 had been expended during 1909, bringing up the total to £721,705 to the end of the year. The principal item included in the expenditure of 1909 was £42,500 for extensions of mains, which, of course, meant more business and more profit. The total length of mains at the end of 1909 was nearly 255 miles. The engineers advised the erection and equipment of a high-tension generating station at Cossipore, and in order to obtain the capital necessary for the large outlay this station would entail the board issued a prospectus in July last inviting subscriptions for the remainder of the Preference share capital. Up to date 40,350 of the new shares had been subscribed for and allotted. The directors had been advised that it would be advisable to carry out the work gradually, spreading the expenditure over a series of years, and the board confidently believed that an economical and comprehensive scheme would be the result. After giving the results achieved during the year, he said that the position of the company was most satisfactory, and that everything pointed to continued success. The report was agreed to.

SAO PAULO TRAMWAY, LIGHT AND POWER CO.

In their report for the year 1909, submitted at the meeting in Toronto on April 25 last, the directors state that there was an increase in gross earnings of $152,075·21, or 6·6%. The net earnings showed an increase of $88,499·32, or 5·9%. While the interest charge remained the same, the taxes and dividend payments show an increase of $148,847·22. The dividend payment increased $142,328·24, on account of the higher rate of 10% per annum having been paid throughout the year, whereas this rate was paid in 1908 for the last quarter only. The payment for taxes increased $6,518·98, being amount of business-tax paid the city of Sao Paulo. The amounts charged for actual maintenance aggregated $177,562·86, an increase of $16,141·61 over the corresponding charge of last year. In addition there was expended for renewals and charged against the renewal reserve the sum of $143,367·44. An appropriation from surplus of $150,000 has been made to this reserve, which, with the undistributed balance, leaves a credit of $288,664·55 to take care of renewals. There have been paid during the year four quarterly dividends of 2½% each. In the lighting department an increase is shown, largely accounted for by the reduction in rates charged. There were 1,528 houses wired for lighting purposes during the year. In the power department the percentage of increase is much larger, the number of customers being 428, an increase of 67, or 18·56%, while the number of horse-power connected shows an increase of 2,233 h.p., or 23·37%. The expenditure on capital account amounted to $767,000·65. The track mileage was increased by 9½ miles of new track, with the necessary poles, feeders, trolley wire, etc. Additions were made to the feeders, vaults, underground conduits, etc., for the light and power department.

IMPERIAL TRAMWAYS.

The report for the year ending December 31 last gives details of the subsidiary undertakings.

MIDDLESBROUGH, STOCKTON AND THORNABY ELECTRIC TRAMWAYS.—The gross receipts from this undertaking amounted to £49,670 3s. 10d., as compared with £50,904 19s. 8d. for the previous year, a decrease of £1,234 15s. 10d. The number of passengers carried was 9,834,213, against 10,014,056 last year, a decrease of 179,843. The net profit for the year is £16,142 1s. 2d., as compared with £16,871 14s. for the corresponding period. The decrease in the traffic receipts is due entirely to the unfortunate weather conditions which prevailed throughout the year.

CORRIS RAILWAY CO.—The receipts in this undertaking are again in sympathy with the adverse condition of the North Wales slate trade, although the greater portion of the decrease is attributable to the loss of tourist traffic consequent upon last year's unfavourable weather.

LONDON UNITED TRAMWAYS, LTD.—A reprint of the directors' report and statement of accounts of this undertaking is appended for the information of the shareholders of the Imperial Co. It will be seen that unfavourable traffic conditions and competition are apparently accountable for the serious decrease of some £30,000 in the gross receipts, and that the directors consider it essential to make provision from reserves for extensive renewals of the permanent way and rolling stock. These circumstances combine to prevent the company from making any distribution of Preference dividend for the past year. The accumulated arrears on the Imperial Co.'s holding of 44,446 Preference shares of the London United Co. now amount to 6¼% and represent in total £27,778.

GENERAL.—The directors regret that by the non-receipt of any income whatever from the London United investment, the Imperial Co.'s revenue account for the year suffered depletion to the extent of £21,111, and that they are consequently precluded from recommending any dividend on this company's Preference and Ordinary shares. The net revenue account for the year shows an available amount of £16,747 1s., and after payment of interest on the Debenture stock for the whole year, amounting to £12,740 12s. 6d., there remains a balance of £4,006 8s. 6d., which the directors consider it expedient should be carried forward to the current year's account.

ELECTRIC SUPPLY CORPORATION.

At the eighth annual general meeting, Mr. J. G. B. Stone (Chairman of the Company) presided. He said: We are now entering on a new stage of the company's history, as the final payment under the guarantee has been made, and the company will in future depend solely on its own earnings. Originally it was estimated that when the guarantee expired the company would be earning 5% on its shares. This has not been quite accomplished, and we may still have some lean years before we attain a 5% basis. However, the profits are steadily advancing. Our gross income is £23,801, and after paying all our working expenses, debenture interest, interest on loans, etc., there is a net balance of £3,780. This revenue, with the exception of £466 interest on the Preference shares we hold in the Dumbarton Tramway Co., is derived from the towns which the Supply Corporation works. We hold 3,793 £5 Ordinary shares in the Hendon Electric Supply Co., 29,940 £1 Ordinary shares, and 6,950 Preference shares in the Dumbarton Tramway Co. On these investments, representing £54,709, we have as yet received only £466 as interest to carry to revenue account. The Hendon Co., as you will see from our report, has nearly doubled its lamp connections, and an early return on the capital invested in that company is practically assured.

So far the Dumbarton Tramway Co. has not realised expectations, and no dividend has been received on the Ordinary shares which we hold, but we believe that the conditions of the past year have been particularly adverse; depression in local industries being accompanied by bad weather, so that both business and pleasure traffic have suffered. We are advised, however, that the shipbuilding trade, the principal industry, is becoming active, and given fair weather the situation may very quickly alter for the better. Our interest here, however, is a large one, and we propose to press for direct representation on the board of that company. The electric supply side of our business is making steady progress, and we can very profitably extend it as capital becomes available.

I propose now to add a very few remarks on the position generally. You are aware that shortly after this company started the electrical supply business was more or less revolutionised by the introduction of the metallic filament lamp, which consumes about one-third of the current required by the old carbon lamp. Consequently, the calcutions as to revenue, which were based on the conditions existing with carbon lamps were upset, and we had to face quite new conditions. The revenue per lamp on the then existing installation was much reduced, and it became necessary to increase the number of lamp connections to off-set this loss. The company was able to successfully accomplish this, so that in effect the net revenue has not

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only not receded, but has steadily progressed. I think this bears out our view that the metallic filament lamp is really benefitting us by bringing the light within the means of small consumers. With the reduction of the price of these lamps, our business should increase at a rapid rate.

Sir Home Gordon, Bart., seconded the motion.

Replying to some remarks by Mr. Tufnell, as to the advisability of increasing the charge for current in small towns.

Mr. K. A. Scott-Moncrieff, M.I.E.E. (chief engineer and general manager), said that at Jedburgh and Melrose they were charging the *maximum* rate, and the business at both places was increasing. Melrose put on 426 additional lamps last year. The advent of the metallic filament lamp came at a time when they were struggling against the inverted gas mantle, and it had proved a very useful weapon to them. He would like to emphasise what the Chairman said about the effect of a reduction in the price of the lamp. Its price was now the only obstacle to their opening up an entirely new sphere of business among the smaller houses in their districts. Turning to the table in the report showing the progress of the company's business he pointed out that during the past year they had had an increase in lamp connections equivalent to 15,921 8-c.p lamps, the total number of lamps connected at the end of 1909 being 113,600 odd. The rate of progress in 1909 was practically the same as that in 1908. In the past year Melrose, Dalkeith, St. Andrews, and Falmouth did better than in the previous year, and it was a welcome feature that the smaller towns seemed to be very much alive to an increase of business. So far during the current year this rate of progress had been well maintained, and the board were about to take an important contract which would largely augment the lamp connections. Although they defined their supply in the equivalent of 8-c.p. lamps, a considerable portion of the current sold was for power purposes.

The report was adopted unanimously.

CITY OF BIRMINGHAM TRAMWAYS.

The ordinary general meeting of the City of Birmingham Tramways Co., Ltd., was held last week at the Electrical Federation Offices, Kingsway, W.C. Mr. Emile Garcke (the chairman of the company), who presided, said: For a company operating tramways in this country the position of our company may be described as unique. Notwithstanding that our lines are being gradually taken over by the local authorities, and that we are exposed to increasing competition from municipal tramways, our traffic receipts are increasing and our net profits show an improvement as compared with the preceding year. The total receipts for the year were £172,031, as against £164,607, and the net profit, after paying the debenture interest and the preference dividend, was £38,516, compared with £36,977 in the preceding year. With regard to the division of the net profit of £38,000, we suggest that you should declare a dividend of 5% upon the ordinary shares and a bonus of 5%, making 10% return for the year, and that you should apply £24,181 in reduction of the paid-up capital of the £5 shares, by paying back £4 per share, and also that you should transfer the balance of £5,910 to reserve to provide for depreciation of assets and redemption of debentures and for general purposes. There will be a special meeting for the purpose of considering a proposition that the capital should be returned on the fully-paid ordinary shares, and that will be an opportunity for explaining the reasons why we are coming forward with that proposition. The Chairman then moved: "That the directors' report and statement of accounts for the year ended December 31, 1909, now before the meeting, be received and adopted," which was seconded and carried.

The Chairman next moved: "That the payment of £10,000, twelve months dividend on the 5% preference shares to October 15 last, be, and the same is hereby confirmed, and that a further sum of £2,083 6s. 8d. be set aside out of the year's profits to meet the dividend accrued at December 31 last," which was unanimously agreed to.

The Chairman then moved: "That the payment of an interim dividend on the ordinary shares at 5% per annum for the half-year ended June 30 last, amounting to £2,104 14s., be, and the same is hereby confirmed, and that a further dividend at the rate of 5% per annum for the six months ended December 31 last, together with a bonus of 5% for the year, making 10% for the twelve months, amounting to £6,314 2s., be paid on the 19th inst.," which was agreed to.

The balance of £5,910 0s. 9d. was carried to the reserve fund.

After this an extraordinary general meeting was held, for the purpose of considering the following resolution: "That out of the accumulated profits of the company the sum of £4 per share be paid to the holders of the 6,047 fully-paid ordinary shares, by way of reduction of capital, free of income tax."

The Chairman said: I now rise to move the resolution which is set out in the notice convening the meeting. The reason for putting forward this motion at this time is that we are now, as I have already explained, in a position of considerable financial strength. We have accumulated sufficient liquid assets out of the sale of properties, and this, with the accumulation of profits, will more than cover the whole of our debenture and share capital. As a matter of fact, we have already paid over to the trustees for the debenture-holders a sum larger than the outstanding debentures, and we have investments and other readily-convertible assets to an amount in excess of the preference shares, and there is no difficulty in providing for the repayment of the whole capital should that be decided upon. We cannot do that; we cannot go into liquidation, for various reasons. We have still many properties to realise, and the moment you go into liquidation the preference shareholders would cease to receive dividends, which would be a hardship for them, and very difficult questions would arise at the present time in connection with the liquidation of the company. The holders of the partly-paid shares have represented to us that the two classes of the ordinary shares should be put upon an equal basis. They are quite willing that the liability on their shares should be called up, but that would put the company in this position, that we should have to call up a very large sum of money—something like £240,000—for which we could not find profitable employment. The present fully-paid ordinary shares would consequently suffer very seriously, because we should not be able to continue to pay a dividend at the present rate on such an enormously increased capital for which we could not find profitable employment, at any rate to the extent of the dividends which we are now paying. The directors therefore gave this matter their very serious consideration. By Section 40 of the Companies Act, 1908, we are able to repay out of accumulated profits share capital, and we are proposing to repay £4 per fully-paid up share entirely out of this year's profits, with the result that, instead of enormously increasing the capital without any prospect of being able to pay a dividend on that increased capital, we shall slightly reduce the capital with every prospect, I hope, of being able to maintain the present high rate of dividend, at any rate until all the properties are realised, when we can reconsider the position.

Mr. Granville C. Cunningham, in seconding the resolution, said he had thoroughly investigated the scheme, and strongly recommended it.

After some discussion the resolution was put to the meeting and declared carried.

COMPANIES REGISTERED.

CHARLES A. DAY & CO., LTD.—Capital £2,000 in 2,000 £1 shares, 1,000 Preference 5% and 1,000 Ordinary; to acquire the business of ironmongers and electricians, carried on at 39, Mill-street, Macclesfield, under the style of Charles A. Day & Co. Signatories: Charles A. Day, Mrs. Selina Day, both of Macclesfield, one Ordinary share each.

GRINDE-MATTHEWS WIRELESS TELEPHONE SYNDICATE, LTD.—Capital, £20,000 in £1 shares. Objects: To carry on the business of electricans, electric and general engineers, manufacturers of apparatus and appliances for telephonic or telegraphic systems, and to adopt an agreement with F. Rouse Pool & Co. Minimum cash subscription, 1,000 shares. The first directors (to number not less than three nor more than seven) are: Sir J. Clifton Robinson, Kt., J.P., C.E., 15, Cockspur-street, S.W.; Sir William Bull, Kt., M.P., 474, Uxbridge-road, W.; Sir Frederick Frankland, Bart., 3, Queen's-gardens, Windsor; F. Rouse Pool, Chry-an-Kerris, Wolseley-road, Crouch End, N.; and J. Cameron. Qualification, 100 shares. Remuneration, £75 each per annum (chairman £100).

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PATENTS.

Rapid Make and Break Electrical Switch Movements.

8620.—1909. J. STEVENSON & O. R. WILLIAMS, Glasgow. The invention provides means for importing a rapid forward and backward throw to electric main switches, making and breaking electrical connections, by merely turning an axle round in one direction and back in the opposite direction. The switch movement is out of direct control of the operator and comprises a helical spring mounted on an axle, with means for engaging spring ends for winding the spring alternately in one direction or the other.

Transmission, Reception and Indication of Preconcerted Signals.

1948.—1909. A. E. VICKERY, Devonport. The electric signalling apparatus has a rotary receiving instrument comprising a stator which has three distinctive poles electrically energised by a three wire winding arranged on the known three-phase system combined with a rotor which has four distinctive poles. The transmission instrument successively energises all the poles of the stator of the receiving instrument alternately with two-thirds of those poles.

Dynamo Electric Machines.

6312.—1909. ALLGEMEINE ELEKTRICITATS AKTIENGESELLSCHAFT, Berlin. This continuous current dynamo electric machine has compensating or commutating windings which are energised by an auxiliary machine. The field of the auxiliary machine is excited by main current or by a current proportional thereto. The auxiliary windings and a fixed or adjustable resistance are located in the armature circuit of the auxiliary machine and are adapted for obtaining an exact adjustment of the compensation or an arbitrary variable compensation. Additional pole windings may be provided through which the main current passes.

Electric Accumulators.

8875.—1909. G. OKILL, East Ham. This is an improvement in the process of producing electric accumulators of the rolled grid type and consists in successively charging and discharging before rolling, formed or negative plates. The charging is effected at a higher rate than the plates will experience in use, and the plates are subjected to pressure after each reversal of current. After this treatment the flat negative plates will be found to be sufficiently flexible to allow of their being easily rolled. One of the plates which has the wider part of its spaces arranged upwards, is then covered with a perforated sheet of celluloid or other flexible acid proof insulating material. A second plate with its spaces similarly arranged is placed on the sheet of insulating material and covered by a similar insulating sheet. The plates and sheets are rolled into a scroll in such a manner that the wider part of the spaces for the active material are at the inner portions of the convolutions of the scroll, the parts of which will be effectually separated from one another by the insulating sheets. One of the grids is then converted in the well known manner into a positive plate. In order to prevent the positive plate from buckling and causing a short circuit, the margins are slotted from the edges towards the centre.

Semi-Automatic Telephone Exchanges.

9055.—1909. SIEMENS & HALSKE, A.G., Berlin. In a semi-automatic telephone exchange system in which the connection at the exchange between the subscribers is made by an operator instead of by the calling subscriber, and in which the operator's leads are retained in connection with the selector or connector leads only during the time occupied in ascertaining the desired number and effecting the required number, arrangements are made by which the subscriber is automatically connected to the operator's leads by means of a separate preliminary selector in each subscriber's circuit, which connects up with an idle selector. A separate service selector for each subscriber connects with the idle selector. The operator transmits the corresponding number if current impulses required to connect the subscribers at the exchanges by the number switch and keys fitted at each operator's station.

Electric Controllers.

9349.—1909. R. VAN R. SILL, New York. The sections of the armature of a pilot motor which drives a step by step electric current controlling means are each separately connected with one of the terminal points of a switch or master control. The pilot motor is equipped with constant fields and with governor fields which vary with the current passing through the controller. The steps of the controller are limited at the will of the operator only while the current which energises the constant fields is greater than that in the governor fields.

Carbon Electrodes for Galvanic Elements.

12677.—1909. S. BENKO. Budapest. This is an improved electrode for galvanic elements in which the electrolytic fluid is conducted through the pores of the carbon electrode. The electrode has a metal or metal and carbon frame surrounding it, and the fluid flowing under the action of press or suction forces its way through the part of the electrode surrounded by the frame. The part of the carbon to be provided with a frame is subjected to the action of a gaseous metal or a metal vapour.

Friction Clutches for Transmission of Power.

10140.—1909. T. FERGUSON, Altrincham. The driving torque is utilised correctly to vary the pressure between the friction surfaces so that the maximum torque which is transmitted may be constant.

Electric Relay for Railway Signalling.

13831.—1909. R. M. ABRAHAM, Battersea Park. A boss is provided on each armature at one side for interlocking the armatures of a pair of electric relays. The boss parts are placed adjacent to one another and form the bearings through which the pivot pins of the armatures pass. The bosses have upstanding lugs so constructed and arranged that when the armature of one relay is attracted its lug member comes in the path of the lug member of the adjacent relay and *vice versâ*.

Electric Reflector Lamps.

15115.—1909. C. C. REGNART, London, W. This is an improvement in reflectors, in which elongated electric lamps are arranged within semi-circular reflectors formed in lengths and connected together to form a continuous reflector, the means of connection also serving to effect the electrical connection of the lamps. According to the invention the reflecting surface consists of a concave body of glass or porcelain within which the lamps are disposed. The lamp supports are cast integral with the body, which is formed in any convenient length and provided with connections adapted to serve for the purpose of mechanical and electrical connection of the parts.

Reducing Electro-static and Electro-magnet Induction between Contact Wires of Electric Traction Systems and Adjacent Telegraph Circuits.

15158.—1909. J. SAYERS, Milford, Derby. Parallel to each contact wire on a double track railway and the telegraph or telephone wires a separate insulated wire is run. The two separate insulated wires, one for each track, are connected at the two ends, thus forming a metallic loop. At the point at which the current is normally supplied to the contact wires, the special wires are connected by means of a T connection to one pole of a separate alternator or transformer, which is so arranged with reference to the traction current that it supplies a pressure at the same periodicity as the traction current, but 180° out of phase therewith. The other pole of the alternator or transformer winding is connected to the rails similarly to the traction supply. By this means the separate insulated wires are kept charged with a pressure which is always in opposite phase to that of the traction supply, and by making suitable regulation to this pressure with regard to the various distances between the contact wires and the special wires and the telegraph for telephone wires to be protected, electro-static induction to the latter is practically entirely cancelled. This special circuit is also connected in series with the secondary coil of a transformer the primary of which is connected to the secondary of another transformer, the primary if the second transformer being in series with the main leads of the traction supply.

Switch Mechanism for Small Electric Lighting Installations.

18665.—1909. C. A. VANDERVELL & A. H. MIDGLEY, Acton. This switch mechanism consists of a casing which carries an insulating base on which are mounted a series of circuit closing devices and terminals and a detachably attached cover for enclosing the mechanism carrying an electric measuring device. A series of contact devices make automatic electrical connection between the measuring device and source of electrical energy when the cover is placed on the casing.

Electric Gas Igniter.

24500.—1909. F. DEIMEL, Berlin. The battery element, the igniting device, the contact device and the protecting cap for the inlet of gas are arranged in axial alignment with one another in the same casing. When ignition is required one of the igniter terminals is caused to make direct contact with one pole of the battery.

Wireless Telegraphy and Telephony.

25542.—1909. COMPAGNIE GENERALE RADIOTELEGRAPHIQUE CARPENTIER, Gaiffe, Rochefort, Paris. This is an improvement in wireless telegraphy and wireless telephony reception, and consists in arranging four detectors forming electric rectifiers arranged so as to connect the metal of the first rectifier to one of the ends of a bipolar resonator, and the contact of the electrolyte of the second.

Telephone Exchanges.

3400.—1910. SIEMENS BROS. & HALSKE, Berlin. This is an improvement in exchanges provided with registers which record the time of conversation occupied between the subscribers, which registers are operated through a common rotating switch. When the calling relay of a calling subscriber is energised a contact is closed which prepares the circuit of the register, a second contact completing the circuit is closed as a result of the operation of the calling relay of the called subscriber.

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TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns per week.			Increase or decrease.		Miles of track open.		Accounts for past year.						
	Ending	1909-10.	1908-9.	Week.	Current year.	1909.	1908.	Ending	Total receipts.	Passengers carried.	Car miles run.	Receipts per Passenger.	Car mile.	Mile of track.
		£	£	£	£				£					
Aberdeen Corporation	May 18	1,350	1,248	+ 101	— 624	27½	27½	May 31	71,930	17,517,304	1,566,119	·98	11·02	4,940
Ayr Corporation	Sept. 18	671	562	+ 108	—	8	8	—	—	—	—	—	—	—
Baker Street and Waterloo Ry.	Nov.	8,141	6,070	+2,071	—	4·25	—	—	—	—	—	—	—	—
Birkenhead Corporation	May 15	1,037	985	+ 52	— 230	24·003	13·52	—	—	—	—	—	—	—
Birmingham Corporation	May 14	6,712	6,384	+ 328	—	56·792	58·52	—	—	—	—	—	—	—
Blackburn Corporation	Oct. 6	1,100	1,293	— 173	—1,036	24·53	28·3	—	—	—	—	—	—	—
Blackpool Corporation	Aug. 26	2,152	2,050	+ 102	+ 732	—	—	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams	„ 8	2,304	2,309	— 24	—	—	—	—	—	—	—	—	—	—
Bolton Corporation	Oct 10	2,416	2,337	+ 79	— 259	42	42	Mar. 31	117,799	25,492,902	2,492,147	1·1	11·34	2,804
Bournemouth Corporation	July 21	1,681	1,723	— 42	— 23	29¼	29¼	„ 31	86,225	13,991,328	1,766,068	1·47	11·71	2,912
Bradford Corporation	May 7	4,937	4,733	+ 204	—1,504	98	54·81	„ 31	235,258	47,839,569	5,331,007	1·17	10·59	2,378
Brighton Corporation	May 15	981	837	+ 144	— 640	9·5	—	—	—	—	—	—	—	—
Bristol Tramway Company	May 20	7,967	5,437	+ 2,530	—	57	51½	Dec. 31	265,362	46,652,389	5,756,842	—	—	—
Burnley Corporation	May 21	1,567	1,231	— 336	—	19½	19½	Mar. 31	64,261	12,355,958	1,202,330	1·23	12·83	5,077
Burton Corporation	May 22	327	261	+ 66	+ 22	6½	6½	„ 31	14,918	3,221,595	430,913	1·04	8·30	1,440
Cardiff Corporation	April 3	2,000	1,957	+ 43	—	—	—	„ 31	109,979	25,058,146	2,497,169	—	10·57	—
Carlisle Tramways Company	June 19	170	175	— 5	— 89	—	—	—	—	—	—	—	—	—
Central London Railway	May 21	6,737	5,766	+ 971	+ 1,945	6·32	6·32	Dec. 31	350,150	41,898,373	1,456,781	2·01	5·769	55,404
Charing X, Euston, & Hamp. Ry.	Nov.	6,822	6,092	+ 730	—	7·75	—	—	—	—	—	—	—	—
City and South London Railway	May 22	3,061	2,983	+ 78	+ 46	7·26	7·26	—	—	—	—	—	—	—
Colchester Corporation	July 14	200	219	— 39	—	8	—	Mar. 31	10,983	2,308,721	349,539	1·09	7·74	1,477
Cork E. T. and L. Company	May 19	557	314	+ 243	+ 1488	9·89	9·89	Dec. 31	24,044	5,737,478	896,945	—	6·43	—
Croydon Corporation	May 6	1,612	1,401	+ 211	+ 42	11½	—	Mar. 31	74,132	16,277,418	1,884,137	1·06	9·56	3,703
Darwen Corporation	Oct. 1	239	256	— 17	— 201	7·23	7·23	„ 31	13,899	2,557,654	245,584	1·20	13·68	1,922
Dover Corporation	Sept. 18	230	252	— 22	— 395	7	—	„ 31	11,593	2,697,672	316,754	·98	8·78	—
Dublin and Lucan Electric Ry.	May 20	205	146	+ 59	+ 76	7	7	—	—	—	—	—	—	—
Dublin U.T.	May 20	6,197	5,245	+ 951	+ 3,945	54½	54½	—	—	—	—	—	—	—
Dundee City Tramways	Oct. 6	1,332	1,305	— 27	— 569	—	26½	May 15	60,573	16,367,911	1,281,552	·875	1·9	2,371
East Ham Corporation	May 21	1,356	1,026	+ 330	+ 189	15	15	Mar. 31	47,430	15,355,703	1,091,586	·73	10·26	—
Glasgow Corporation	May 14	18,294	17,605	+ 689	+ 3,907	193½	189	May 31	907,494	226,948,290	20,766,722	·96	10·49	5,060
Gloucester Corporation	Oct. 6	395	425	— 30	+ 535	15	—	—	—	—	—	—	—	—
G.N., Piccadilly and Brompton	Nov.	13,429	9,354	+4,075	—	9·25	—	—	—	—	—	—	—	—
Halifax Corporation	—	—	—	—	—	52·574	37	Mar. 31	81,872	20,378,672	1,786,390	11·40	11·13	1,529
Huddersfield Corporation	Dec. 4	1,613	1,357	+ 256	+ 2,663	28	28½	„ 31	84,704	16,200,020	1,960,329	1·29	10·37	2,421
Hull Corporation	May 21	2,975	2,330	+ 645	+ 1,020	29	26	„ 31	128,722	30,964,254	3,022,844	1·	10·22	—
Ilford Corporation	Feb. 12	451	391	+ 60	+ 1,969	10	10½	„ 31	25,328	6,385,466	634,446	·87	9·58	2,066
Ilkeston Corporation	May 11	116	121	— 5	— 89	4	4	„ 31	7,214	1,968,850	198,415	9·1	7·9	1,803
Kirkcaldy Corporation	Sept. 8	259	266	— 7	—	7½	7½	May 15	14,993	4,874,199	459,066	·711	7·838	1,854
Lancashire United Tramways	May 11	1,198	1,313	— 115	— 206	39	39	Dec. 31	68,904	12,554,593	2,244,344	—	—	—
Leeds Corporation	Sept. 18	6,896	6,624	+ 272	+ 3,662	108	96½	Mar. 31	340,368	75,734,083	7,694,989	1·06	10·62	3,627
Leicester Corporation	Sept. 11	2,162	2,130	+ 32	—	—	—	—	—	—	—	—	—	—
Liverpool Corporation	Nov. 19	10,803	10,687	+ 116	—1 977	109	104	Dec. 31	572,822	124,043,239	12,231,799	1·108	11·24	5,506
Liverpool Overhead Railway	May 15	1,470	1,261	+ 209	+ 432	6·65	2·40	June 30	79,004	11,171,515	1,106,386	—	—	—
London County Council	May 7	40,802	35,395	+ 5,407	+ 23,837	132½	123½	Mar. 31	1,274,660	279,166,461	25,591,028	1·08	11·74	—
Lowestoft Corporation	Dec. 11	155	150	+ 5	+ 30	3½	—	Sept. 30	11,399	2,645,206	370,320	1·03	7·36	2,279
Maidstone Corporation	Mar. 6	157	100	+ 57	—	7·4	—	—	—	—	—	—	—	—
Manchester Corporation	Sept. 11	15,631	15,297	+ 334	— 2,871	183	181	—	—	—	—	—	—	—
Metropolitan District Railway	May 21	12,486	10,011	+ 2,475	+ 22,520	24	24	—	—	—	—	—	—	—
Metropolitan Railway	May 22	18,463	16,552	+ 1,911	+ 12,489	24½	24½	June 30	680,357	99,846,735	—	1·46	—	—
Nelson Corporation	Oct. 16	151	131	+ 20	+ 7	2½	2½	Mar. 31	7,362	2,060,712	204,740	·85	8·63	1,907
Newcastle-on-Tyne Corporation	May 14	3,789	3,701	+ 88	— 1,643	60½	59½	„ 31	211,085	46,203,164	4,411,745	1·10	11·48	3,504
Newport (Mon.) Corporation	Oct. 9	663	638	+ 25	— 311	14½	14½	„ 31	35,531	8,174,003	798,029	1·04	9·89	2,456
Oldham Corporation	Jan. 24	1,778	1,516	+ 262	— 386	—	—	—	—	—	—	—	—	—
Portsmouth Corporation	Oct. 10	2,046	1,809	+ 237	—	28½	28½	Mar. 31	97,741	21,247,048	2,309,439	1·10	10·15	—
Reading Corporation	May 19	764	558	+ 206	— 5	13½	13½	„ 31	32,769	7,933,572	915,481	—	8·93	—
Rochdale Corporation	Dec. 26	1,240	1,126	+ 114	+ 746	20·9	20·93	„ 31	56,558	10,196,148	1,252,925	1·32	10·83	2,699
Rotherham Corporation	Feb. 4	555	587	— 32	—	—	—	—	—	—	—	—	—	—
Salford Corporation	Sept. 27	4,696	4,662	— 66	— 3,326	78	74½	Mar. 31	244,065	45,771,611	5,486,150	1·25	10·67	3,135
Scarborough Tramways Co.	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Sheffield Corporation	May 15	5,904	5,409	+ 495	+ 1,711	39½	37	Mar. 25	289,745	17,568,686	7,065,380	·896	9·842	4,225
Southampton Corporation	May 11	975	1,001	— 25	— 149	18	18	„ 25	52,647	10,121,887	1,157,451	1·25	11·33	—
Southend-on-Sea Corporation	Aug 21	995	557	+ 438	+ 1,483	—	—	—	—	—	—	1·34	9·842	1,830
Stockport Corporation	—	—	—	—	—	25	25	Mar. 31	52,004	9,155,172	1,335,911	—	—	—
Sunderland Corporation	Jan. 27	1,310	1,336	— 26	— 7,984	—	—	—	—	—	—	—	—	—
Swindon Corporation	May 11	129	125	+ 4	—	—	—	—	—	—	—	—	—	—
Torquay Tramways	Aug. 26	630	647	— 30	—	8·41	—	Dec. 31	15,065	2,880,420	353,297	1·40	1·023	—
Wallasey U.D.C.	May 14	897	880	+ 17	— 595	12·68	12·45	Mar. 31	43,923	8,331,038	891,540	1·2	11·79	3,453
Warrington Corporation	—	—	—	—	—	—	—	—	—	—	—	—	—	—
West Ham Corporation	May 5	2,361	2,248	+ 113	— 401	27	14·7	Mar. 31	122,881	35,502,836	2,556,854	·789	10·96	4,417
Wolverhampton Corporation	Nov. 3	841	823	+ 18	— 206	21½	—	„ 31	44,432	9,440,·69	975,714	—	10·929	2,199

a Train Miles. *h* Half-year's figures.

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NOTES.

Manchester's Electricity.

A good deal of animosity has been displayed against the Manchester Corporation Electricity Undertaking, apparently chiefly the result of jealousy on the part of friends of the Gas Committee. It is alleged against the Electricity Department that it is selling current at too low a figure, and in the same breath we are told that contributions to the suspense account are too low, and that the payment in relief of rates should be increased from £15,000 to at least £20,000. It is decidedly unfair to say that ratepayers have expended £2,500,000 for the benefit of about 9,000 well-to-do consumers. To begin with, the citizens as a whole benefit by better and cheaper illumination of the streets, cheaper tramway service, and so on. Then the lowering of price for current is steadily broadening the basis of supply, so that more and more citizens are benefiting directly. As regards the relative positions of the gas and electricity undertakings, it must be remembered that the Gas Committee commenced when there was little competition, and has been accumulating reserves for years and years. Much of the capital expenditure has been wiped out, and the upkeep is not so heavy. At present the electricity undertaking has to pay between £150,000 and £155,000 per annum in interest and sinking fund. This is very heavy, and in excess of the gas undertaking or any trading concern. In a few years, what with reducing capital charges and extending number of consumers, the Electricity Department will be in a flourishing condition.

Canal and Dock Work.

Mr. J. Watt Sandeman, M.Inst.C.E., spoke before the North-east Coast Institution of Engineers and Shipbuilders on a project for a ship canal between the Tyne and the Solway Firth. His project is a fine one and would undoubtedly prove of immense commercial benefit. But for the moment we are particularly interested with one phase of the proposal. He provides for the rock drilling to be worked by electricity. He says: "The water supply for locking purposes would be ample, being obtained from the following rivers: the North and South Tyne, the Allen, Irthing, Eden and Caldew, and several small streams. The power required for working the rock drills and for lighting the tunnel and canal would be obtained from the rivers South Tyne and Irthing by advancing the cuttings sufficiently to obtain a head of water on each side of the tunnel. At these points water turbines and electric installations for light and power could be provided. The canal would be lighted during the night, throughout its entire length, and the tunnel continuously." This opens up a subject worth consideration: whether, so far, canal owners and managers have made sufficient use of electricity? If this were done more generally and on a bold enough scale it would help to popularise, and therefore to make canals more profitable. For general dock work electricity is being more and more used, and it is capable of rendering considerable service to canals, not only in the matter of locking and working capstans, but loading and unloading, as well as extension of the various haulage schemes now in use.

C.P.E.I.

At a meeting of the Committee for the Protection of Electrical Interests held at Faraday House on the 25th inst., Mr. Robert Hammond in the chair, Mr. Arthur Preece was elected Hon. Treasurer, and Mr. R. Borlase Matthews, who has acted as Hon. Secretary *pro tem*, was elected Hon. Secretary of the Committee.

"Wireless" in Peace and War.

We were pointing out the other day the use of electric waves in the steering of boats and ships, and the suggestion that the system would be used as a special form of piloting into and out of port in war-time. Another suggestion for the use of electric waves is to propel them against balloons or dirigibles in order to explode gas, and bring about collapse. It is also hinted that a modification of this principle might be applied to exploding magazines on board ship or on shore. Meanwhile, radio-telegraphy and telephony is receiving fresh applications in aid of the arts of peace. One of the latest of these is signalling the hour of midnight from the Eiffel Tower to all ships supplied with receiving apparatus within a certain distance of the French coast. This will prove an invaluable aid to safe navigation. As we mentioned last week, the Helsby wireless telegraphic and telephonic systems are most promising for the future, holding out hopes of cheap installations and easy communication on land and sea. The earth-induction system demonstrated is especially captivating owing to its elasticity in application.

Co-operative.

It is curious to contrast two very different co-operative movements, one in England and the other in France. With us, as we have lately seen, a very influential Committee for the Protection of Electrical Interests has been formed, frankly on the basis of promoting industrial development. In France, on the other hand, we find an Association of Users of Electric Lamps has been formed. Its objects are just as frankly utilitarian, only in this case it is a kind of league of consumers to counteract manufacturers' combines. In other words, its efforts are to be turned to reducing prices. Its mode of operation is as follows: Consumers become members on paying a small annual subscription. On May 1, the Association is notified by each member the number and kind of lamps and other fittings required during the ensuing year from July 1 to June 30, and the Association then asks for tenders, dates of delivery being specified. The Association will draw up specifications and will examine samples. Orders will be given to the lowest or most suitable bidder. Deliveries are to be made direct to members and payments will also be made direct. But the Association will carry on all negotiations and take action for non-delivery or improper delivery. While at present the activity of the Association is to be confined to lamps and lamp accessories, it is foreshadowed that later all kinds of electrical appliances will come within its purview. Membership is, we understand, to be confined to traders, dealers and trading consumers; that is to say, manufacturers, shopkeepers and others. But it is not quite clear where the line is to be drawn: whether, for instance, hotel and restaurant keepers, or ordinary retail general shopkeepers will be admitted. If this latter wide scope is allowed, the Association will do much harm to contracting firms. It remains to be seen, however, whether responsible electrical manufacturers will recognise the Association at all.

Studs at Torquay.

Torquay's experience with the Dolter surface contact system of electric traction has had no better luck than the London County Council experiment with the "G. B." system. The Board of Trade have definitely decided not to renew the Torquay Tramway Co.'s licence, owing to the difficulty in preventing the studs becoming "live" at

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inconvenient moments. The peculiarity about the situation is that the Company's Act of Parliament authorises the use of the Dolter stud system; it, however, provides that if after a year it proved a failure and remained so for a month, it was to be taken up and replaced by another system. Presumably the refusal of the Board of Trade to renew the licence must be looked upon as equivalent to failure. Under the circumstances the Company can adopt an overhead trolley or a third rail conduit system, but this has to be done to the satisfaction of the Corporation. We understand that the Company has more than paid its way, and on the other hand the Corporation have a very friendly feeling for the Company. The question is what is best to be done? There are opponents to the overhead system, and also friends to the trackless trolley system. So far nothing has been settled—except, apparently, that the Dolter surface contact system must go. We understand that the system is giving satisfaction at Hastings, on the link between St. Leonard's and Bexhill-on-Sea.

TRAMWAYS USERS.

In the case of the Eccles Corporation *v.* South Lancashire Tramways Co., in which the plaintiffs sought for a declaration that the Salford Corporation were not entitled to grant the defendant company the use of the plaintiff's tramway line, Mr. Justice Eve (as reported in THE ELECTRICAL ENGINEER, p. 145, No. 5, Vol. XLV.) was of opinion that the terms of section 28 of the Salford Corporation Act, 1899, conferred upon the defendant corporation authority to make the arrangement embodied in the licence of June 2, 1908, and the fact that the arrangement assumed the form of a revocable licence was not material. Similarly the terms of section 41 of the South Lancashire Tramways Act, 1903, authorised the arrangement on the part of the defendant company. His Lordship came, therefore, to the conclusion that the plaintiffs could not succeed on the ground that the impeached transaction was one *ultra vires* of the defendants or either of them. He was further of opinion that the validity of the arrangement could not be successfully assailed on the ground that it was a breach of the agreement of April 11, 1902, and accordingly dismissed the action with costs.

The plaintiffs appealed.

In the Court of Appeal on May 26, the Master of the Rolls said that this was an appeal from a decision of Mr. Justice Eve, which raised a question of general importance as to the extent to which persons, or corporations, who might for convenience be referred to as persons, in whom Parliament had vested certain Parliamentary franchises with reference to tramways, could of their own will and pleasure authorise other persons to use those tramways on such terms as the persons granting the licences might think fit. They must start with the proposition, which was not challenged, that a franchise of this kind was not a bit of property which could be disposed of by the owner of the franchise like a stick or a table or an acre of land. The proposition could not be better stated than it was by Lord Herschell in "Edinburgh Street Tramways Co. *v.* Lord Provost of Edinburgh" (1894, A.C., 456). After referring to Section 34 of the Tramways Act, 1870, he said, at p. 463:—"It will be seen that the power thus conferred is limited to the promoters and their lessees, the promoters being the person or company authorised to construct the tramways. The right conferred is a personal one, and cannot be claimed by any persons who do not come within the designation of promoters or lessees of promoters. It is not conferred upon the promoters' assignees. A conveyance, therefore, by the promoters of their tramways, or even of their undertaking, would not carry with it the right to the statutory monopoly conferred upon the promoters by the section to which I have referred."

The Tramways Act of 1870 contained various provisions which were entirely consistent and were only consistent with that view. In the first place, Section 19, which, it was true, did not apply to this particular tramway, provided that a local authority might, but only by lease to be approved by the Board of Trade, demise the right of user of a tramway. Section 35 provided that the Board of Trade might grant licences to any company or persons to use a tamway in addition to the promoters or their lessees. By Section 54, "If any person (except under a lease from or by agreement with the promoters, or under licence from the Board of Trade, as by this Act provided) uses a tramway or any part thereof with carriages having flange wheels or other wheels suitable only to run on the rail of such tramway," such person was liable to a penalty. So far as this Act was concerned it seemed plain that the first defendants, the South Lancashire Tramways Co., were liable to a penalty because they were using on a tramway carriages of this nature not under a lease from or under any agreement with the promoters or under licence from the Board of Trade, for the Tramways Act, 1870, drew a clear distinction between promoters and lessees, and there was nothing which could justify anyone in saying that promoters included lessees and that it was sufficient for a person to get a licence from the promoters. Then came the Eccles Corporation Act, 1901, which incorporated the provisions of the Tramways Act, 1870, so far as there was nothing inconsistent with them in the Act itself. That Act authorised the plaintiffs to make tramways within a district which was bounded, so far as tramways were concerned, by the Salford Corporation on the east and the South Lancashire Tramways Co. on the west. By Section 13 the corporation were bound to maintain the rails, and Section 19 provided for the mode in which the carriages were to be worked. By Section 24 the Corporation were empowered to enter into and carry into effect contracts and agreements with the owner and lessee of any tramways in any adjacent district which could be worked with any of the Corporation tramways and the local authority of such district with respect to the alteration, construction, maintenance, purchase, sale, lease, working, use, and management by the contracting parties of all or any of their respective tramways and works. Then came this proviso:—"Provided that the term of any such lease or working agreement shall not exceed forty-two years, and that the conditions thereof shall be subject to the approval of the Board of Trade." It was under this section that the arrangement of April, 1902, was entered into, which arrangement was duly approved by the Board of Trade. When it was once recognised that it was plain that the Eccles Corporation could not have made an agreement authorising the South Lancashire Co. to use their tramways without the licence of the Board of Trade, it seemed quite hopeless to say that the Salford Corporation, to whom the Eccles Corporation had granted a limited use of the tramway, had greater powers than the Eccles Corporation had, and could of their own will and pleasure and on such terms as they thought fit, without asking for the consent of the Board of Trade, give a licence to the South Lancashire Tramways Co. Mr. Justice Eve seemed to have thought that this conclusion was justified by the fact that the Salford Corporation, on the one hand, and the South Lancashire Tramways Co. on the other hand, had powers conferred on them making it *intra vires* for them to enter into contracts of this nature outside the limits of their own districts; but that did not render inoperative the general provisions that no such agreement should be entered into without the licence of the Board of Trade. In short, these powers only put the defendants into the position of individuals who were not fettered by the limitations which otherwise attached to all statutory corporations; but with the greatest respect to Mr. Justice Eve, he (the Master of the Rolls) was unable to assent to the view that a clause which authorised corporations to enter into agreements with the consent of the Board of Trade could be construed as authorising them to enter into agreements without that consent. For these reasons his Lordship thought that this was a case in which the plaintiffs were entitled to the relief claimed.

Lords Justices Farwell and Kennedy also delivered judgments allowing the appeal.

Therefore, the Court declared that the Salford Corporation were not entitled to authorise the defendant company or any other persons or corporations to use the tramways of the plaintiffs, or any part or parts thereof, and granted an injunction to restrain the defendant company, their servants and agents, from running tramcars over and along the lines of tramways belonging to the plaintiffs, unless and until duly authorised by law in that behalf.

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POLE-FACE LOSSES.*

By Comfort A. Adams, A. C. Lanier, C. C. Pope, and C. O. Schooley.

In any dynamo-electric machine with a toothed armature the magnetic flux density at the pole-face opposite a tooth is greater than that opposite a slot, and as the armature rotates, the teeth carry waves of flux across the pole faces; that is, each point on the pole face is subjected to a pulsating flux density which gives rise to eddy currents in the mass of the pole face. Some energy is also dissipated by magnetic hysteresis, but at the ordinarily high tooth-frequencies the eddy-current loss predominates; with solid pole faces the hysteresis loss is negligible. In any case these phenomena are so complex from the standpoint of quantitative analysis that it is practically impossible to separate the two losses.

Were it not for the magnetomotive force of the eddy currents themselves the flux would distribute itself, both outside and inside of the pole shoe, in such a way as to correspond to the minimum total reluctance; that is, the flux pulsations would gradually die out and the flux tend toward uniform density in proceeding from the pole face back into the mass of the pole shoe. But the eddy currents materially hasten this equalisation in their effort to damp out the flux pulsations of which they are the result. This effort to equalise the flux density is maximum at the surface of the pole shoe where the maximum pulsation takes place, and it undoubtedly alters to some extent the flux distribution over this surface.

Within the pole shoe the disturbance is propagated in the familiar manner of electromagnetic waves, the attenuation constant being very large, owing to the high permeability and conductivity of the medium and the relatively high frequency of the pulsation, the penetration wavelength being very short for the same reason.

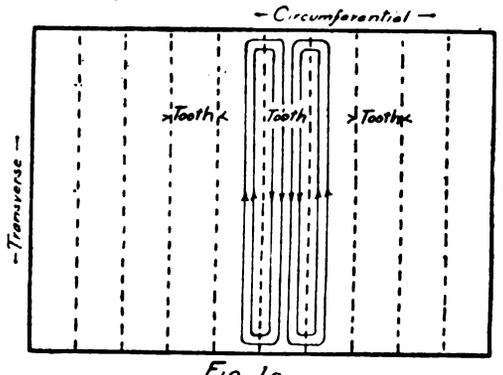

Fig 1a

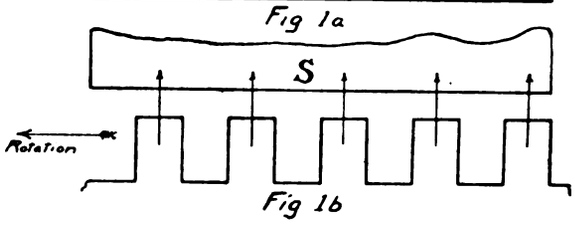

Fig 1b

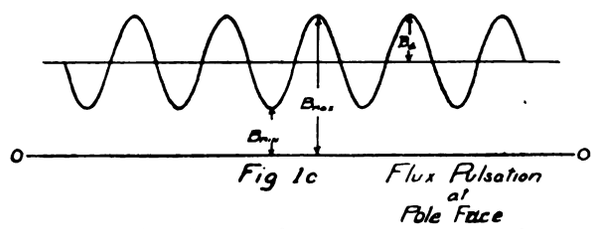

Fig 1c

With solid poles shoes and average constants the wave is practically damped out at a distance back from the pole face equal to about one millimeter, the pulsation being thus confined to a very thin surface layer.

With laminated pole shoes the conditions are quite different. This difference can easily be understood by reference to Figs. 1 and 2. Fig. 1*a* is a plan view and Fig. 1*b* an elevation of a solid pole shoe, together with the teeth. Fig. 1*c* shows an assumed sinusoidal flux variation at the pole face. In Fig. 1*a* approximate eddy-current paths are shown in light lines; the directions as indicated by the arrows correspond to a right-to-left movement of the teeth across the pole face. The transverse portions of the currents are the ones which produce the damping of the flux pulsations and are predominant in the case of solid shoes; they will be referred to as the *damping currents*.

With ordinary proportions of teeth and pole face, those parts of the eddy currents in the circumferential direction are relatively small; their tendency is to screen the centre of the pole from the flux pulsations and to drive the latter to the two circumferential edges; these circumferential portions of the eddy currents will therefore be called the *screening currents*. With solid pole shoes the screening currents may safely be neglected.

Fig. 2*a* is a plan view of a portion of a *laminated* pole shoe showing the approximate eddy-current paths at the pole face, and Fig. 2*b* is an elevation of the pole shoe. Except for the laminations, Figs. 1 and 2 are intended to represent the same conditions.

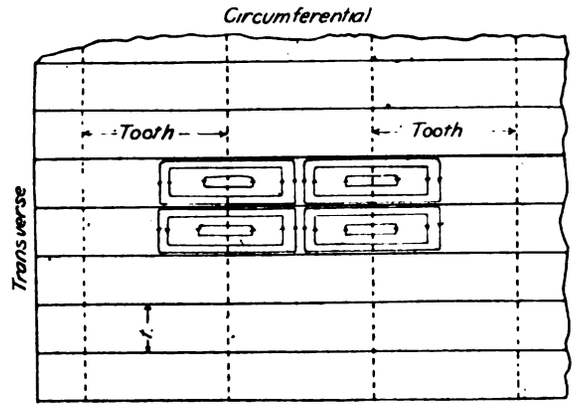

Fig 2a

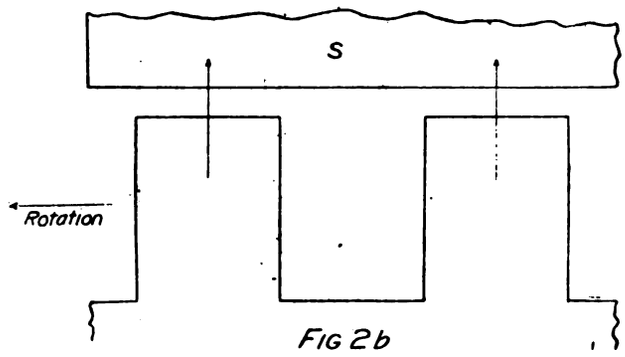

Fig 2b

In the case of laminated pole shoes represented in Figs. 2a and 2b the circumferential or screening currents predominate, and the transverse or damping currents are not only greatly reduced in magnitude but also in effectiveness; that is, the pulsations will penetrate much deeper into the pole shoe and the advantage of the laminations will be considerably neutralised.

Both the damping and the screening currents have the same origin and nature. The damping currents try to check the penetration of the flux pulsations into the pole shoe perpendicular to the face, and the screening currents tend to check the penetration of the flux pulsations into the laminæ from the side surfaces towards the centre. The chief difference is that whereas the damping currents tend to force a more uniform circumferential flux distribution the screening currents tend to disturb an otherwise uniform transverse flux distribution across the section of the laminæ. Both tend to increase the reluctance of the magnetic circuit and to decrease the eddy current loss. The screening currents, however, tend to increase the hysteresis loss, other things being equal.

There is another source of energy loss in the pole face which is in some cases of considerable magnitude. It is that due to the *pulsation of reluctance of the main magnetic circuit* caused by a variation in the number of teeth under a pole. For example, if the pole arc ($l\rho$) is just five and a half times the tooth pitch (λ), and if the air gap be very short, there will be positions of the armature where there

* Abstract of paper presented at the 26th annual convention of the American Institute of Electrical Engineers.

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are six teeth under a pole face and other positions where there are only five, there being a variation of reluctance of about 15% between these two positions (see Figs. 3 and 4). Such a variation would cause a pulsation of flux through the whole magnetic circuit and a consequent loss of energy. Of course, this variation could be largely eliminated by chamfering the corners of the pole shoes.

On the other hand, if the air gap be larger, say about equal to one-quarter of the tooth pitch, the fringing from the pole corners would add about a half tooth pitch to

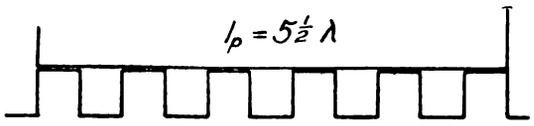

FIG. 3.

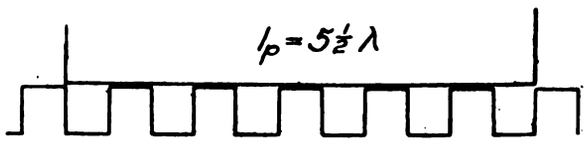

FIG. 4.

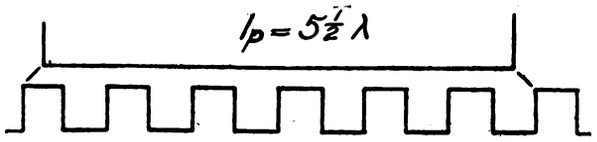

FIG. 5.

the equivalent pole arc, making it just about six times the tooth pitch. In this case there would be practically no reluctance variations, since the number of teeth under the equivalent pole arc is constant (see Fig. 5).

If the actual pole arc is just six times the tooth pitch, the minimum reluctance pulsations occur with a short gap and the maximum with a fairly long gap (see Figs. 6 and 7).

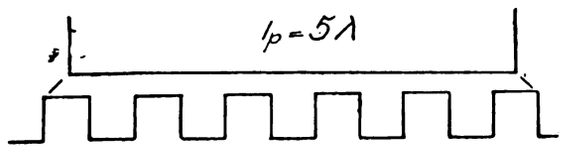

FIG. 6.

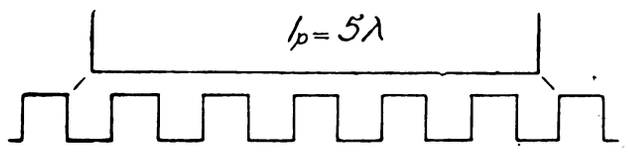

FIG. 7.

As an example, consider the apparatus used by Wall and Smith* for the investigation of pole-face losses. The pole face was solid with square corners, and the actual pole arc was just three and a half times the tooth pitch. Thus with fairly long gaps the reluctance pulsation loss was a minimum, and with very short gaps a maximum. The pulsation was very large at short gaps owing to the large percentage of reluctance variation, probably about 25%. As this part of the loss was not recognised at the time, it made the pole face loss appear to increase with decreasing air gap at least twice as rapidly as it should have done. This entirely masked the phenomena under consideration.

* Institution of Electrical Engineers, London, June, 1908, Vol. 40, p. 577.

This loss was also overlooked in the results of Dexheimer's experiments,* where considerable discrepancies can thus be accounted for.

Returning now to the damping currents and screening currents, these have both been analysed theoretically, but each independently of the other, the former for the case of solid pole shoes by Potier† and Rüdenberg,‡ and the latter for laminated cores by Steinmetz.§

Solid pole shoes. Consider a solid pole shoe subjected to tooth flux waves, and neglect the circumferential or screening currents.

Let λ = the tooth pitch in cm., and
v = the velocity of the armature periphery in cm. per second.

Analyse the circumferential flux distribution curve at the surface of the pole face into its fundamental and harmonics (the wave length of the fundamental being λ), and consider separately the loss due to each.

Let B_1 = the amplitude of the fundamental pulsation, and
B_n = the amplitude of the nth harmonic.
Let μ = the permeability of the pole face, and
ρ = its electrical resistivity in absolute electromagnetic units.

Then it can be shown [3&4] that the pole-face loss in watts per sq. cm., due to the fundamental pulsation wave, is, approximately:

$$P_1 = \frac{B^2_1}{8\pi}\sqrt{\frac{v^3\lambda}{\mu\rho}}\,10^{-7} \qquad (1)$$

and that the corresponding attenuation constant is approximately:

$$\beta_1 = 2\pi\sqrt{\frac{\mu v}{\rho\lambda}} \qquad (2)$$

It is somewhat surprising that in equation 1 the pole-face loss is proportional to the 3/2 power of the velocity (and therefore of the tooth frequency) rather than to the second power. But this is after all only reasonable, since the greater damping action at the higher frequencies reduces the equivalent depth of the active layer; that is, the attenuation constant is larger and the flux wave does not penetrate as deeply into the pole shoe.

In applying equations 1 and 2 to the harmonics of the flux pulsation, it should be remembered that whereas λ, the tooth pitch, is also the circumferential wave length for the fundamental, the circumferential wave length for the nth harmonic is, $\lambda \div n$.

Neglecting the influence of the damping currents and of saturation upon the flux distribution at the pole face, B_1, B_2, B_3, etc., are proportional to the average pole-face density B, and may be written,

$$B_1 = k_1 B, \quad B_2 = k_2 B, \quad B_3 = k_3 B, \text{ etc.}$$

Then from equation (1),

$$P_1 = \frac{10^{-7}}{\quad} k_1^2 B^2 \sqrt{\frac{v^3\lambda}{\mu\rho}} \qquad \frac{10^{-7}}{8\pi} k_n^2 B^2 \sqrt{\frac{v^3\ \lambda}{\mu\rho\ n}} \qquad (3)$$

The ratio of the amplitude of the nth harmonic to that of the fundamental or the per cent. of the nth harmonic is, $kn \div k_1 = a_n$.

Then,

$$P_n = P_1 \frac{a_n^2}{\sqrt{n}} \qquad (4)$$

and the total pole-face loss in watts per sq. cm., is:

$$P = \frac{10^{-7}}{8\pi} k_1^2 B^2 \sqrt{\frac{v^3\lambda}{\mu\rho}}\left(1 + \frac{a_2^2}{\sqrt{2}} + \frac{a_3^2}{\sqrt{3}} + \text{etc.}\right) \qquad (5)$$

or

$$P = \frac{10^{-7}}{8\pi} k^2 B^2 \sqrt{\frac{v^3\lambda}{\mu\rho}} \qquad (6)$$

where

$$k^2 = k_1^2\left(1 + \frac{a_2^2}{\sqrt{2}} + \frac{a_3^2}{\sqrt{3}} + \text{etc.}\right) \qquad (7)$$

The watts per sq. in. of pole face is given by equation (6a), where B = average pole-face density in maxwells

* "Die Gleichstrommaschine," E. Arnold, Vol. 1., second edition, page 649.
† L'Industrie Electrique, 1905, p. 35.
‡ Elektrotechnische Zeitschrift, Vol. 26, 1905, p. 181.
§ "Transient Phenomena," p. 355.

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per sq. in., v = peripheral velocity of the armature in feet per second, λ = tooth pitch in inches, and ρ and μ are the same as before.

$$P'' = 1{\cdot}65 \times 10^{-7}\, k^2 B^2 \sqrt{\frac{v^3 \lambda}{\mu \rho}} \qquad (6a)$$

Thus $k B$ is the amplitude of the *equivalent* sinusoidal pulsation, and the problem resolves itself into the determination of k. The k's and a's are obviously wholly dependent upon the shape of the flux distribution curve, which in turn is wholly dependent upon b, the ratio of slot opening (w') to the tooth pitch (λ), and q, the ratio of slot opening to air gap (δ). Unfortunately the k's and the a's are exceedingly complex functions of these two variables, even under the assumption made above as to neglecting the effect of damping currents and saturation upon the pole-face flux distribution.

Of the two variables involved in k, b ($= w' \div \lambda$) has for open slot machines a fairly narrow range of variation, being rarely found outside of the range from 0·4 to 0·6, with an average of 0·5.

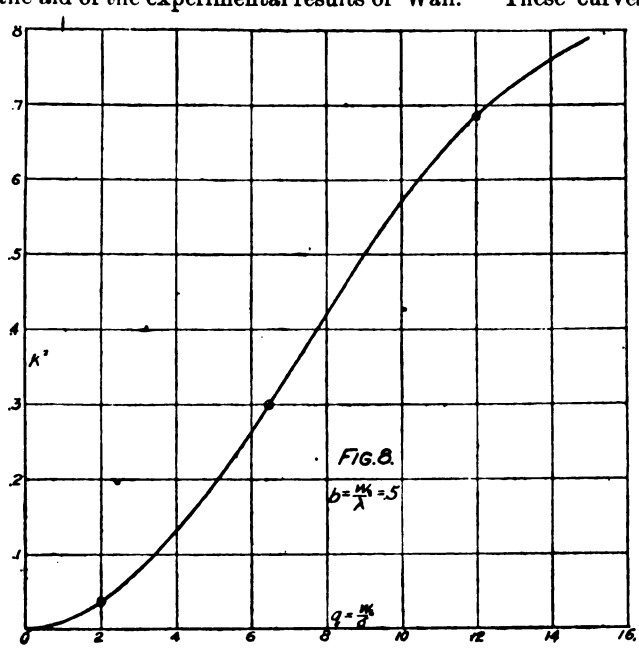
Then if b is fairly constant, k is largely dependent upon the ratio

$$q = w_s \div \delta$$

that is, with a given value of b, k will be a function of q. As a general determination of k appears to be practically impossible, it will be necessary to consider a few special cases in order to get an idea of the nature of its variation.

For very large gaps, q is small and k obviously approaches zero.

For four other points (q = 2, 6, 12 and 24, and b = 0·5), flux distribution curves were carefully worked out with the aid of the experimental results of Wall.* These curves



were then analysed, and k^2 computed according to equation 7. The resulting values of k^2 are plotted in Fig. 8.

For larger values of b, k would be somewhat larger, and smaller for smaller values of b. But within the ordinary range these differences are small.

In using Fig. 8 it should be remembered that even if the flux distributions had been determined accurately from the static standpoint, the eddy currents in the pole shoes tend to alter the static distributions at the surface in the direction of decreasing their variation. The reluctance of saturated teeth also tends in the same direction. Neither of these sources should under ordinary conditions give rise to considerable variations from the results shown in Fig. 8.

Equation (6), together with Fig. 8, thus gives a fair idea of the factors which determine the pole-face losses in the case of solid shoes.

Laminated pole shoes. Although any reasonably complete analytical treatment of this case would be extremely complex and tedious, if not impossible, it is possible, with the aid of equation 6 (for solid poles), to make some roughly quantitative deductions as to the effect of laminations.

Referring to Fig. 9, assume the eddy currents to flow in symmetrical paths as shown, and consider the element $a\,b$ of the damping current. This element experiences exactly the same electromotive force as in the case of the solid pole shoe, but the resistance of its path is $\left[1 + \left(\frac{\lambda}{2\,t}\right)^2\right]$ times as great as for the solid shoe, where t is the thickness of the laminations and λ the tooth pitch. These damping currents will thus have the same effect with respect to those of the solid shoe as if the specific

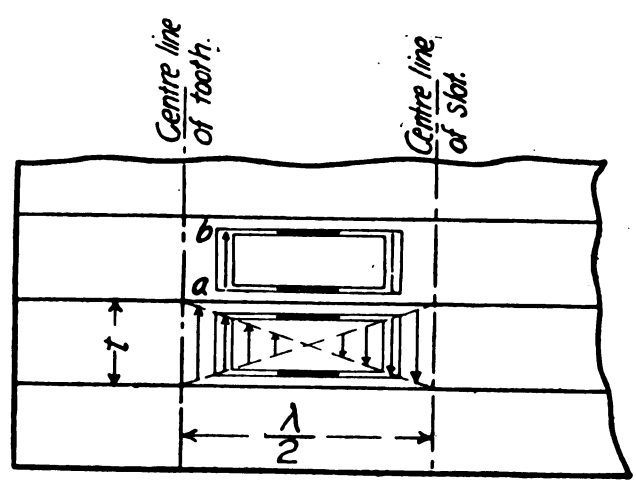


FIG. 9.

resistance were increased in the ratio $1 + \left(\frac{\lambda}{2\,t}\right)^2$ or approximately $\left(\frac{\lambda}{2\,t}\right)^2$. This assumes the same quality of iron in the two cases. It will also be observed that the system of damping currents thus established does not cross the full thickness of the laminæ although the more important longer currents which flow in the longer paths do flow nearly across. The effect of this restriction in length of the damping currents is obviously to reduce the damping effect, to allow the flux to penetrate deeper near the lateral surfaces of the laminæ, and thus to increase the loss slightly.

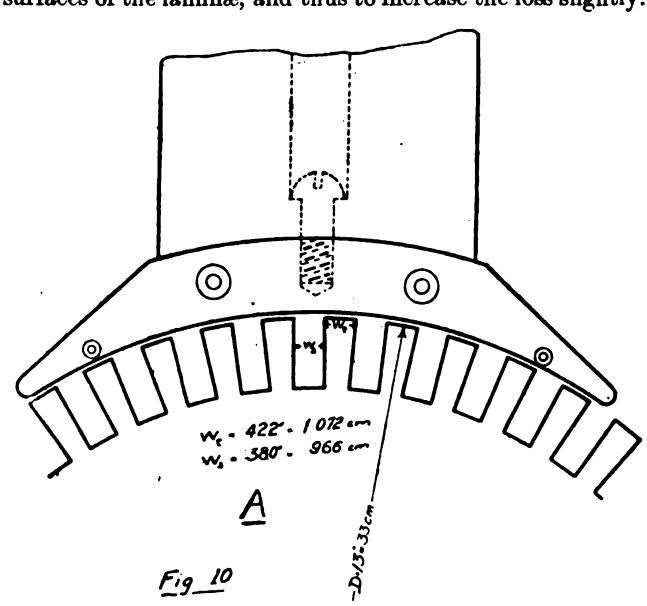


Fig 10

Thus with the same quality of iron as in the solid shoes the principal effect of laminating may be represented by an increase of specific resistance in the ratio $\left(\frac{\lambda}{2\,t}\right)^2$.

By introducing this ratio into equation 6 together with a constant a to take account of the shortened damping-current paths, we obtain for the watts per square centimetre of pole face for laminated pole shoes:

* T. F. Wall. Journal of the Institution of Electrical Engineers, June 1908, Vol. 40, p. 550.

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$$P_l = P\,a\,\frac{2\,t}{\lambda} \qquad (9)$$

or $$P_l = \frac{10^{-7}}{8\pi}\,k^2\,B^2\,a\,\frac{2\,t}{\lambda}\,\sqrt{\frac{v^3\,\lambda}{\mu\,\rho}} \qquad (10)$$

or $$P_l = 7{\cdot}96 \times 10^{-9}\,a\,t\,k^2\,B^2\,\sqrt{\frac{v^3}{\mu\,\rho\,\lambda}} \qquad (11)$$

It is interesting to note that whereas the solid pole-shoe loss is proportional to $\sqrt{\lambda}$, that for the laminated shoes is inversely proportional to $\sqrt{\lambda}$.

Reduced to the same units as for equation 6*a*, the watts per square inch are:

$$P_l'' = 3{\cdot}3 \times 10^{-7}\,a\,t\,k^2\,B^2\,\sqrt{\frac{v^3}{\mu\,\rho\,\lambda}} \qquad (11a)$$

It should be noted that perfect insulation of the laminæ is assumed, otherwise P_l will be larger.

These theoretical equations are crude, not only because of the assumptions and approximations involved in their development but also because no account whatever is included of numerous minor sources of loss, some of which become prominent in certain limiting cases; but they serve very well as a basis for the interpretation of the experimental results. Experimental results without some such interpretation are apt to have a very limited range of usefulness, or in some cases to be worse than useless.

Experimental Results.

Apparatus. The machine employed was provided with detachable poles and pole shoes, and with three armatures, each with a different number of teeth. Three sets of pole shoes were used, one set of solid annealed steel castings, one set of 0·014 in. laminations, and the third set of 0·06 in. laminations.

The laminated pole shoes were held together by insulated bolts and were held on the poles by screws tapped in from behind so as to leave the pole face unbroken. The pole shoes were bored concentric in place; they were then taken down, the tool burrs were removed, and the poles carefully replaced.

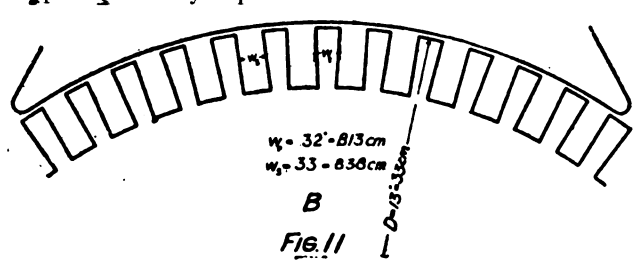


FIG. 11

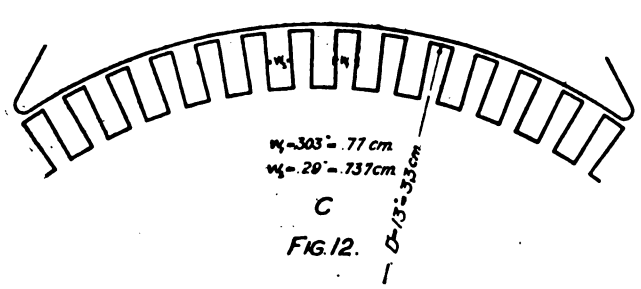


FIG. 12.

The air gap was varied by means of shims placed behind the pole pieces. As the pole face could not be concentric with the armature at all gaps without reboring for each gap, an equivalent corrected gap was computed when necessary.

The dimensions of the pole shoes and armature teeth are given in Figs. 10, 11, and 12.

The losses were measured by running the machine light as a motor, measuring the input and subtracting the other losses as below.

Constant-speed tests.—The field current and armature voltage were varied over a wide range in such a way as to maintain a constant speed of 1246 r.p.m. By plotting a curve of watts lost *versus* volts, the friction loss was determined. This, together with the armature copper and brush losses were then subtracted from the total to get core loss plus pole-face loss. By plotting core loss plus pole-face loss *versus* air gap and extending the curve slightly the core loss was determined. This was then subtracted to get the net pole-face loss.

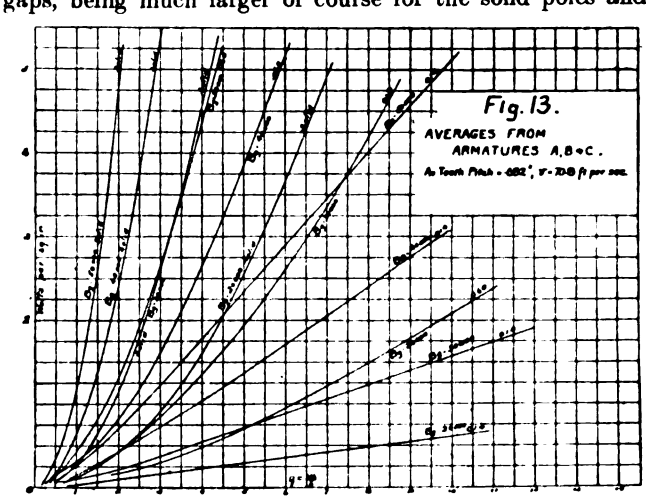
Constant flux tests.—The exciting current was maintained constant and the speed varied over a wide range by varying the armature voltage. The object of these tests was to check the exponent of v in equations 6 and 11.

These two tests were made with numerous combinations of three armatures, three sets of pole shoes and five air gaps.

Errors.—The greatest care was observed in the conduct of the experiments, the measurement of the air gaps and in working up the results; but errors undoubtedly crept in, in addition to those inherent in the method. Of the latter the following are the most obvious; (*a*) errors due to heating of pole shoes and consequent change of specific resistance; (*b*) errors due to distortion of flux under pole-face by armature current; (*c*) variation of the friction loss during the test; (*d*) variation of core loss with air gap.

a. The heating element was largely eliminated by starting the tests cold and not carrying them far enough to cause a troublesome rise of temperature. Within the range of the results given below the maximum temperature variation was less than 20° C., which means about 3% variation in the pole-face loss, since the specific resistance enters equation 6 as the square root.

b. The distortional effect is negligible except for short gaps, being much larger of course for the solid poles and



east for the 0·014 in. laminations. But this error becomes rapidly a serious one when it once begins to count, since it means an increase in armature core loss, which increase—by the method of elimination already outlined—appears in the pole face loss; thus the apparent pole-face loss is doubly increased. This effect results in raising the apparent exponent of v and of q in the loss equation.

c. A large part of the friction being brush friction, this item was subject to an appreciable variation although the greatest care was employed to keep the commutator clean and of uniform polish. All brushes except two, one positive and one negative, were removed from the holders during the tests.

d. The longest gap obtainable was not long enough to eliminate the pole-face loss entirely, hence it was necessary to prolong the curves (*pole-face loss + core loss versus gap*) in order to separate the core loss from the total; but although this prolongation can be made and the core loss determined with a very fair degree of accuracy, the result is the long-gap core loss which is undoubtedly less than that with a very short gap. This error would tend to raise the apparent exponent of q.

The friction error is more or less erratic, but the other three increase with the pole-face loss, the heating error being subtractive and the other two additive. They thus neutralise each other in part, although the heating error is probably less than the other two.

Exponents.—By plotting P *versus* B (for constant speed) on logorithm paper, the exponent of B was determined. By similarly plotting P *versus* v (for constant B) the exponent of v was determined.

The average exponent of B taken from some forty-five sets of observations is—

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2·5 for the solid pole shoes
2·4 for the 0·06 in. laminations, and
2·3 for the 0·014 in. laminations.

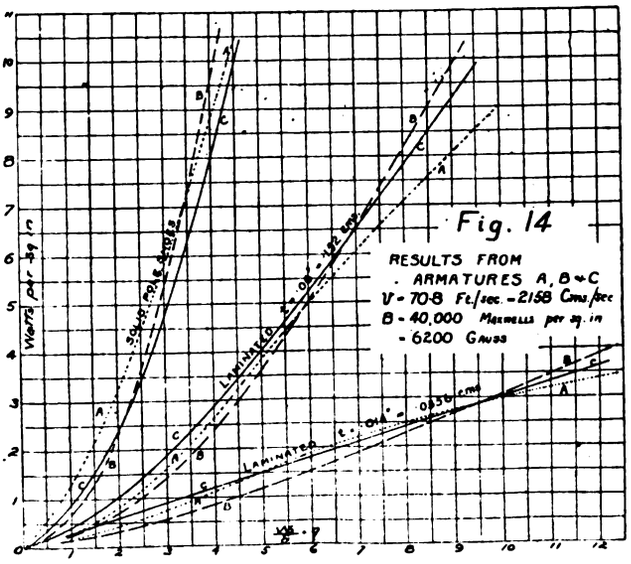
The fact that the exponent is larger than 2, is probably due, partly to the decrease of permeability at high densities and partly to eddy currents in slot conductors and other abnormal localities. These hardly seem sufficient, however, to produce as much increase in the exponent as that observed. In the experiments of Wall and Smith both distortional and core loss errors were practically eliminated and they obtained an exponent for B of 2·1 for solid pole shoes. This should stand as fairly reliable were it not for the predominance of the reluctance pulsation loss in their experiments, and for the fact that only a single set of observations was made.

It is interesting to note that in these experiments the armature core loss itself increased about as the 2·1 power of the flux density; this is doubtless due to the distortional increase.

The average exponent of v was 1·55, a little larger than the theoretical value of equation 6. The apparent excess is probably due to distortional errors.

The variation in λ between the three armatures was not enough to check its exponent, but its effect is quite obvious in the curves of Fig. 14.

An inspection of the computed curve of k^2 in terms of q (Fig. 8) and the curves of P versus q in Fig. 13, will show that while these curves are not all clearly exponential with respect to q, some of them are very close to that form throughout a considerable part of their length. If it were possible thus to express k^2 as a simple exponential function of q even over a moderate range of that variable, it would be possible to formulate the pole-face loss in a comparatively simple manner.



To this end the theoretical and experimental results were plotted on logarithm paper and the exponents of q averaged.

The lower part of the curve of Fig. 8, covering the working range up to $q = 6$, gave an exponent of 1·8. With armatures B and C the reluctance pulsation loss, increasing with decreasing gap, increased the apparent exponent of q, but the reverse was true of armature A, and the average of all three should be fairly reliable; it is, 1·88 for the solid pole shoes, 1·50 for the 0·06 in. laminations, and 1·22 for the 0·014 in. laminations.

The reason for the lower exponents for the laminated shoes is at least partly due to the *screening* effect within the section of each lamina, tending to force the flux and the eddy currents to the lateral surfaces. This screening is not at all negligible at the high tooth-frequencies employed in the experiments here described, even with the 0·014 in. laminations. The effect of the screening is to decrease the eddy currents by contracting the eddy-current paths, and to increase the hysteresis loss by confining the same amount of flux in a reduced cross-section. Both of these effects tend to reduce the exponents of q. Another factor which contributes to a greater extent to these low exponents, is the reluctance pulsation loss which, although small for the long gaps, is large when compared to the small pole-face losses, and thus lifts the lower parts of the P *versus* q curves by a considerable amount; but the experimental exponents are, nevertheless, fairly reliable for practical purposes, since they represent fairly average conditions and include the reluctance pulsation losses.

Comparing Fig. 8 with the experimental curves of Fig. 14, it will be observed that the curves for armatures B and C do not show the inflection of Fig. 8, but that the curves for armature A show even an earlier inflection. The reason for this is that the reluctance pulsation loss which in B and C increase with q, in A decreases with q, hiding the inflection in the first case, and emphasising it in the other. As between B and C the former has the larger reluctance-pulsation loss at very short gaps, partly because of the larger tooth pitch and partly because of the better ratio between the pole arc and tooth pitch. Thus the B curve crosses the others in each case in the upper range of values.

Formulation of experimental results. Disregarding variations in μ and ρ, the results of the experiments described above may be roughly summed up in the following semi-empirical formulæ. In c.g.s. units, as for equations 1, 6, and 11, they are—

For solid pole shoes:

$$P_s = \frac{2{\cdot}65}{10^4}\left(\frac{B}{10^3}\right)^{2\cdot5}\left(\frac{v}{10^3}\right)^{1\cdot55} q^{1\cdot88}\sqrt{\lambda} \qquad (12)$$

For 0·06 in. laminations—

$$P_{\cdot06} = \frac{0{\cdot}985}{10^4}\left(\frac{B}{10^3}\right)^{2\cdot4}\left(\frac{v}{10^3}\right)^{1\cdot55} q^{1\cdot5}\frac{1}{\sqrt{\lambda}} \qquad (13)$$

For 0·014 in. laminations—

$$P_{\cdot014} = \frac{0{\cdot}705}{10^4}\left(\frac{B}{10^3}\right)^{2\cdot3}\left(\frac{v}{10^3}\right)^{1\cdot55} q^{1\cdot22}\frac{1}{\sqrt{\lambda}} \qquad (14)$$

In inch units, the same as for equation 6*a*, these equations become—

For solid pole shoes—

$$P_s'' = \frac{12{\cdot}9}{10^4}\left(\frac{B}{10^4}\right)^{2\cdot5}\left(\frac{v}{10}\right)^{1\cdot55} q^{1\cdot88}\sqrt{\lambda} \qquad (12a)$$

For 0·06 in. laminations—

$$P_{\cdot06}'' = \frac{4{\cdot}62}{10^4}\left(\frac{B}{10^4}\right)^{2\cdot4}\left(\frac{v}{10}\right)^{1\cdot55} q^{1\cdot5}\frac{1}{\sqrt{\lambda}} \qquad (13a)$$

For 0·014 in. laminations—

$$P_{\cdot014}'' = \frac{3{\cdot}15}{10^4}\left(\frac{B}{10^4}\right)^{2\cdot3}\left(\frac{v}{10}\right)^{1\cdot55} q^{1\cdot22}\frac{1}{\sqrt{\lambda}} \qquad (14a)$$

These apply only to the particular conditions of the test as to reluctance pulsation loss, insulation of laminations, μ, ρ, etc., and should be used accordingly. The reluctance pulsation loss was larger in these experiments than with the ordinary chamfered pole tips, but not large enough to give more than a reasonable margin in calculation.

Curves. The most important experimental data, from the practical point of view, are summarised in the curves of Fig. 13, which show the relation of P (the pole-face watts per sq. in.) to q (the ratio of slot opening to air gap.)

Curves for several densities and for the three different sets of pole shoes are shown. Each curve represents an average for the three armatures, and corresponds to a speed of 1,246 r.p.m., or a peripheral velocity of 70·8 ft. per second. = 2,160 cm. per second.

The only apparent reason why the results from the three armatures averaged above should differ, is that the tooth pitches are different; but since λ enters equation 6 as the square root, any moderate difference such as exists between these three armatures does not produce a considerable difference in the pole-face loss. In the present instance this difference was partly masked by the loss due to reluctance pulsation. This will appear from a consideration of Figs. 10, 11 and 12. These figures show that with armature A the reluctance pulsations were a maximum with a fairly long gap and a minimum with a very short gap, while with armatures B and C the reverse is true. Thus the losses in A should be relatively large for long gaps (small q), and relatively small for short gaps (large q). This is what actually occurs.

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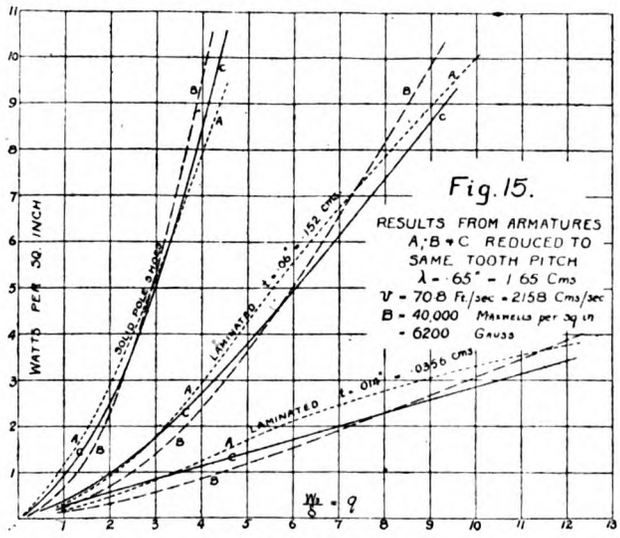
as shown by Fig. 14, where all the curves correspond to the same mean gap density (40,000 per sq. in., or 6,200 per sq. cm.), the three groups of curves correspond to the three sets of pole faces, and the three curves of each group to the three armatures.

While the curves of the three groups are not all perfectly consistent on this point the general tendency is well marked.

Since armature *A* has the largest λ it should have the largest pole-face loss in the case of the solid pole shoes, and the smallest in the case of laminated pole shoes [see equations (6) and (11).] This is borne out roughly by the curves of Fig. 14, if the reluctance pulsation effect be averaged out.


WATTS PER SQ. INCH
SOLID POLE SHOES
LAMINATED
λ = .065" = 1.65 Cms
V = 70.8 Ft./sec. = 2158 Cms/sec
B = 40,000 Maxwells per sq in = 6200 Gauss
Wt/S = q
Fig. 15.

RESULTS FROM ARMATURES A, B & C REDUCED TO SAME TOOTH PITCH

In Fig. 15 the curves of Fig. 14 are reduced to a common value of λ according to equations 6 and 11. This brings out the reluctance pulsation loss still more plainly.

The averaging of the curves of the three armatures, in Fig. 13, averages the effect of reluctance pulsation to a certain extent, since with armature *A* this loss is larger with long gaps, whereas with armature *B* and *C* it is larger with short gaps. But although this averages two armatures against one, in the one the reluctance pulsation comes with long gaps where the true pole-face loss is very small and the per cent effect is thus relatively large; in fact, it probably more than overbalances the other two armatures in the cases of laminated pole shoes, as indicated by the *q* exponents.

Effect of laminating pole shoes. The theoretical ratio of solid pole shoe loss to laminated-pole shoe loss, other things being equal, is (see equation 9), $K = a\,2\,t/\lambda$ where *a* is a constant slightly greater than one, *t* the thickness of the laminations, and λ the tooth pitch. Take 1·25 as an approximate value of *a*; then the ratio is, $1{\cdot}25\,\frac{2\,t}{\lambda}$. Take a value of λ equal to the average for the three armatures; it is λ = 0·67. Then for the two thicknesses of laminations employed $K_{0\cdot014} = 0{\cdot}052$ and $K_{0\cdot06} = 0{\cdot}224$. The observed average values of these ratios taken from the average curves of Fig. 13 are $K_{0\cdot014} = 0{\cdot}11$ and $K_{0\cdot06} = 0{\cdot}278$. The apparent discrepancy is undoubtedy largely due to the imperfect insulation of the laminations; in fact, this was practically demonstrated by the following experiment. After the last regular test with the 0·014 in. laminated pole shoes, the bolts were loosened a little, when it was found that the loss was reduced to 70% of its previous value, which materially closes the gap between the observed and the calculated ratio. This lossening would have been carried further, but owing to the manner of supporting the laminated pole shoes it was not considered advisable. They were still tight enough to hold the shoes together firmly when supported by two half-inch screws tapped directly into the back side of the laminations.

Another factor which contributes considerably to this discrepancy is the reluctance-pulsation loss which adds a much larger percentage effect to the laminated-shoe losses than to those of the solid shoes.

A probable change in μ and ρ from the solid to laminated may also account for a part of the discrepancy.

It is thus reasonable to assume that with perfect insulation between the laminæ and with the reluctance-pulsation loss eliminated, the calculated losses would check very closely with the observed losses. The greater discrepancy in the case of the thin laminations is due to the much greater number of partly insulating surfaces, and to the greater percentage effect of the reluctance pulsation loss.

Additional pole-face losses. There are other losses which sometimes add to those here measured for the laminated pole shoes; they are chiefly due to transverse rivets and to the large heads of flat-head screws sometimes used to hold on the laminated shoes.

Except in the case of reluctance pulsations, the rivets do not contribute much to the total loss, owing to the very slight penetration of the tooth flux waves (about 0·03 in. or 0·04 in.).

The large screw heads do, however, make a considerable addition; for example, the pole shoes which originally accompanied the machine under test had screw heads which occupied 7% of the pole-face area. These pole shoes were of 0·06 in. laminations, so that taking the experimental ratio above, the screw heads would add about 30% to the pole-face loss. With 0·014 in. laminations well insulated the same screw heads would add about 100% to the loss.

Minimum air-gap. Owing to the numerous variables involved, it is impossible to make any general rule as to the smallest allowable air-gap or the largest allowable value of *q*, but a careful study of the curves of Fig. 13 together with equations 6 and 11 should make possible a reasonably intelligent decision for any given case.

Comparison of theoretical with observed results. Although the numerical coefficients and exponents in the wholly theoretical equations cannot be expected to give satisfactory practical results in a problem involving so many complex relations, it may be interesting nevertheless, to see how closely these results compare to those observed. The observed results for comparison are obtained by averaging the three curves in each set of Fig. 15. In making the theoretical computations k^2 is taken from the curve of Fig. 8; μ is taken as 2000 and ρ as $1{\cdot}5 \times 10^3$ in absolute electromagnetic units; *a* in equation 11 is taken as 1·25; λ. = 0·682 in. = 1·73 cm. *v* = 70·8 ft. per sec. = 2160 cm. per sec.

In Fig. 16 are plotted the three averaged observed curves, one for each set of pole shoes and all for the same density, 40,000 per sq. in. The light line curves were computed from equations 6 and 11 and the data assumed above, for the same conditions.

It is thus evident that when the imperfect insulation of the laminations and the reluctance pulsation loss are taken into account, and when it is remembered that μ and ρ are not at all accurately known, the theoretical results compare very well with those observed.

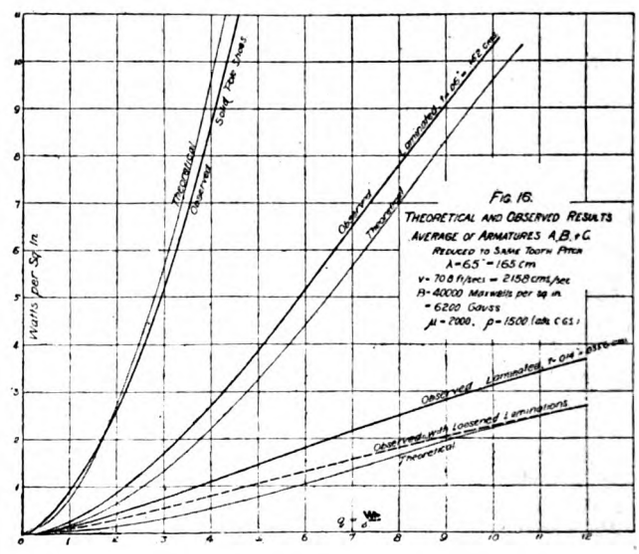


Fig. 16.

THEORETICAL AND OBSERVED RESULTS

AVERAGE OF ARMATURES A, B & C

REDUCED TO SAME TOOTH PITCH

λ = 6.5" = 1.65 cm

v = 70.8 ft./sec. = 2158 cms./sec.

B = 40000 Maxwells per sq. in. = 6200 Gauss

μ = 2000, ρ = 1500 (abt. C.G.S.)

Distortion due to armature reaction. All the results thus far obtained apply only to no-load conditions, but the effect of armature distortion is easily taken into account. Given the dimensions and data of the machine, lay out the full-load flux distribution and compute the *form-factor* (ratio of root mean power to average value) of this curve. Multiply the no-load loss by this *form-factor*.

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Design considerations. It will be interesting now to compare the watts lost per unit of pole-face area with the useful watts developed in the equivalent armature area, as their ratio will give the per cent. pole-face loss.

Let Δ = the peripheral armature current (ampere conductors per inch of periphery).

v = peripheral velocity of armature in ft. per sec.

B = mean pole-face density maxwells per sq. in.

Then the useful watts developed per sq. in. of pole face is

$$P_0'' = 12\, v\, \Delta\, B\, 10^{-8}$$

Taking the pole face watts per sq. in. from equation 12*a* for solid pole shoes:

$$P'' = 12{\cdot}9 \times 10^{-4} \left(\frac{v}{10}\right)^{1{\cdot}55} \left(\frac{B}{10^4}\right)^{2{\cdot}5} q^{1{\cdot}88} \sqrt{\lambda}$$

$$q_{p/} = \frac{P''}{P_0''} = \frac{1{\cdot}07}{10^3} \left(\frac{v}{10}\right)^{{\cdot}55} \left(\frac{B}{10^4}\right)^{1{\cdot}5} \left(\frac{\Delta}{100}\right)^{-1} q^{1{\cdot}88} \sqrt{\lambda}$$

This shows clearly what factors determine the per cent. of pole-face loss, and makes it possible to consider intelligently the question of pole-face lamination as a rational part of design.

For example, take $v = 50$, $B = 40{,}000$, $\Delta = 400$, and $\lambda = 0{\cdot}7''$, then in order to keep $q_{p/}$ within 1% it is necessary to keep q below 1·6 for solid pole shoes. For 0·06 in. laminated pole shoes q could be increased to 3·1, and for 0·014 in. laminated pole shoes q could be as large as 5·9 without raising $q_{p/}$ above 1%. For other values of B, v, Δ, and λ these percentages would change somewhat.

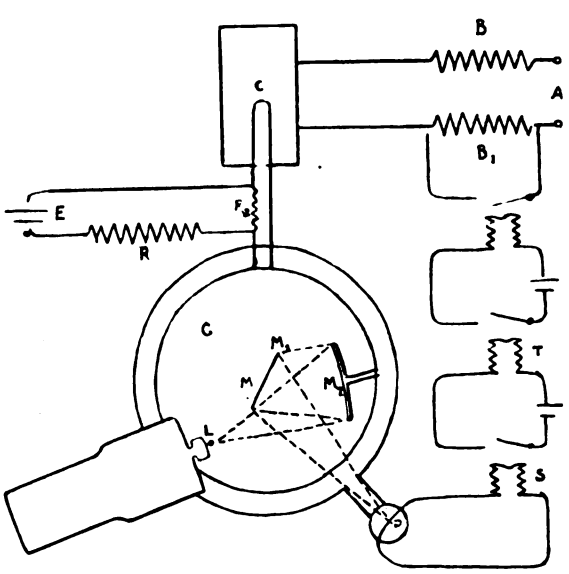
It is obvious from the above results that it is quite possible to get values of $q_{p/}$ considerably above 1% without exceeding ordinary proportions.

Although there are other considerations than that of pole face loss which frequently control the choice of the air gap and of the pole shoe type, it is hoped that the experimental results and analysis above presented may help toward a more rational consideration of these questions.

AUTOMATIC REGULATION OF ELECTRIC FURNACES.

L. Kolowrat, in the course of some researches in Mme. Curies laboratory, was confronted with the problem of keeping an electric furnace at a constant temperature for several days, in spite of the fact that it was heated by alternating current varying frequently in voltage to the extent of several per cent.

The diagram shows the arrangement by which the problem was solved. F is the furnace and C a Chatelier thermo electric element connected with the galvanometer G. The movable galvanometer frame carries a concave mirror M which shows the deflections on the scale D, and also a



plane mirror of thin glass M, measuring 4 × 5 cm. L is the vertical filament of a Nernot lamp, M_2 a spherical mirror gilt on its front surface and P a battery of 20 copper constantan thermo electric cells.

The position of the mirrors is so regulated that the rays of the lamp fall upon the junctions of the battery. When the deviation of the galvanometer and therefore the temperature of the furnace reaches a fixed point they cause a current in the battery which acts on a system of three relays, S, T, V, whereby a resistance B_2 is switched into furnace current and the temperature falls, whereupon the deflection of the galvanometer decreases, the rays of the lamp leave the thermo electric junction and the relays short circuit B_2 so that the current again increases to the fixed intensity and so on. L M_2 and P being fixed to the rotatable wheel H_1 the fixed point can be chosen at will, and the temperature can be read off on the scale D. It is best, however, to arrange the apparatus as a potentiometer, *i.e.*, to combine C with an accumulator in such a way that the galvanometer deflection is always very small. The temperature of the furnace is then determined as a function of the resistance R (and of the same E.M.F. of E itself measured by comparison with a standard cell), making a small correction for the mean deflection of the galvanometer. In this case then the same galvanometer both measures and regulates the temperature.

By these means a temperature of 1,000° C. has been maintained for days together with a maximum variation of 3°. The apparatus must, however, be adjusted occasionally to compensate for example for spontaneous changes in the temperature of the battery junctions. As small changes in the sensitiveness of the galvanometer are without effect in a compensation method the action of the apparatus is not influenced by a rise in temperature of several degrees, such as is produced by the lamp. The thermo electric vortices caused by lighting the lamp soon disappear when the temperature becomes uniform.

LEGAL.

Injury by Electric Wire.

In the King's Bench Division, before Mr. Justice Grantham and a special jury, the case of Wheeler *v.* the St. Marylebone Borough Council was heard. The plaintiff, a builder and contractor, was, in April, 1909 engaged in rebuilding a house in Devonshire-place. In the course of his work he cut with a chisel into a piece of lead piping in a cellar, which was, according to his evidence, hanging down from the ceiling and which he took to be a gas or water pipe. It was, in fact, a pipe containing a live electric light wire, which had been left by the defendants when they had disconnected the consumer's installation some time previously. The result was a severe shock and burning owing to the fusing of the chisel and cable, and it was alleged that the plaintiff was completely incapacitated for over six months, and permanent injury had been caused. The defendants maintained that the cable had been properly disconnected by withdrawing the fuses of the cut-outs and removing the leads connecting the cut-outs with the installation, the cut-outs being left properly sealed up and insulated and the pipe attached by wall-hooks to the wall. They claimed that the pipe was their own property, with which the plaintiff had no business to tamper; but it was maintained for the plaintiff that, having received orders to disconnect the service, the defendants had no right to keep a live wire on the premises. The defendants alleged negligence on the plaintiff's part, as the presence of the cable and sealed cut-outs should have given him warning of possible danger, but the plaintiff said that he did not see the sealed cut-outs, as they were hidden under some rubbish. It appeared that the plaintiff's foreman had told the defendants' engineer, before the disconnection took place, that, though the house was coming down, the cellar was not going to be touched, and that it was in consequence of this that the live wire was left on the premises.

The jury found a verdict for the plaintiff and assessed the damages at £450 for loss of business, £75 for pain and suffering, and £56 for special damages.

Judgment was entered accordingly, a stay of execution being refused.

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PHOTOGRAPHS BY "WIRELESS."

Remarkable Achievement by an Australian Electrician.

(From our Sydney Correspondent).

Exceptional interest has been aroused in electrical circles here by the successful outcome of a long series of experiments undertaken by Mr. Reginald Wilkinson with the object of demonstrating the possibility of transmitting photographs by wireless telegraphy. A practical demonstration of this achievement is given in the *Sydney Daily Telegraph*, which prints a photograph of the late Sir Frederick Darley, and side by side prints the same picture as transmitted by wireless telegraphy. The likeness is extremely striking, even minute gradations of tone and facial individualities being reproduced with remarkable faithfulness.

The principle on which Mr. Wilkinson's invention is based is simply a matter of getting the picture on a specially prepared thin plate, whereby the lines and dots of the picture are exposed as bare metal, the remainder being covered with an insulating varnish. The slate thus prepared is placed on a cylinder similar to that of a phonograph, and revolves under a fine contact wheel until a fine needle point has completely covered the surface of the photograph, just as a phonograph needle traverses a phonograph record. The receiving apparatus is somewhat similar to the transmitter, but on this a piece of ordinary white paper is placed, which is covered with a piece of typewriting carbon. An electro-magnetic needle is brought in contact with the covered surface, pressing on the paper an accurate reproduction of the photograph on the cylinder at the other station.

The experiment was conducted in the editorial offices of the *Telegraph*, and the demonstration was only from one end of the room to the other, but it was proved that the same efficiency can be secured between two points many miles apart. The receiver at the further end of the room was placed on a table, which was examined to make sure that there were no communicating wires. To see the instrument dotting out the lineaments of the portrait without any manual assistance is described as imparting quite an uncanny feeling.

The process is exceedingly simple, and presents unlimited possibilities both from a commercial and military point of view, in the latter respect furnishing a means of swift transmission of sketch plans, written orders, and photographs. The photographs sent by wireless are exceptionally interesting, the gradation of tones being achieved by a series of minute dots caused by the pressure of an electro-magnetic needle at the receiver, excited by similar movements at the transmitter.

NAVAL ELECTRICAL ENGINEERS.

New Admiralty Regulations have been issued relating to the appointment of electrical engineers and of first and second assistant electrical engineers at the Admiralty and in the Royal Dockyards.

Vacancies for electrical engineers will be filled by selection from the grade of first assistant electrical engineer. Vacancies for first assistant electrical engineers will be filled by selection from one or other of the following classes: Assistant electrical engineers; Dockyard employés who have held the Admiralty scholarship; outside candidates, who will be required to produce evidence of having passed through a course of engineering study in a University technical college, or other educational establishment, to the satisfaction of the Admiralty, and of having been engaged in practical engineering work for at least five years, part of which time must have been spent in a responsible position as electrical engineer. An admirable provision for the introduction of new blood is the general rule that every second vacancy will be filled by the appointment of an outside candidate.

Appointments in vacancies for second assistant electrical engineers will be made by means of a competitive examination at which inspectors or electrical fitters and first-class draughtsmen of three years' seniority and persons qualified by Admiralty scholarship will be eligible to compete, provided they are under the age prescribed by the Home Dockyard Regulations at the date of the examination.

As a trial measure an Admiralty scholarship in electrical engineering will be instituted for a period not exceeding six years. It is to be awarded to a specially able and deserving electrical fitter apprentice who has completed his four years' course of study in a dockyard school. The holder of the scholarship will be placed on the establishment as electrical fitter, and will proceed to the Royal Naval College, Greenwich, for a year's study in electrical engineering, at the end of which he shall, at the discretion of the Admiralty, continue to hold the scholarship for a second year. On passing satisfactorily at the conclusion of a two years' course at Greenwich he will return to service in a yard or at the Admiralty as supernumerary electrical draughtsman, and after one year's service will be eligible to compete for appointment as first-class draughtsman or inspector or second assistant electrical engineer in the event of a vacancy. He will further be eligible for selection as first assistant electrical engineer after not less than three years' service subsequent to his Greenwich training. The Admiralty scholarship will be of the value of £40 per year, in addition to the *minimum* rate of pay of an established electrical fitter. The first award will be made after the Dockyard School examination in June, 1910, to the electrical fitter apprentice who has distinguished himself most highly in that examination or in the examination of the previous year.

ELECTRICAL ENGINEERS' SPORTS.

The second annual Athletic Sports of the Electrical Engineers' Territorials (London Division) took place on May 25 at the London County Athletic Grounds, Herne Hill. Major A. E. Le Rossignol acted as referee. By the way, the gallant Major has presented a handsome Inter-Company Challenge Cup for the best Company aggregate, and this was won by "C" Company with 28 points. In the hundred yards level race the holder, Sapper E. A. Abbott-Young, again proved the victor, carrying off the prize from Sapper G. M. Drake, the winner of the second heat. Time, eleven and two-fifths seconds, and won by two yards. In the 880 yards level running race, Sapper J. A. Mitchell won in fifteen and three-fifths seconds, by six yards. In the 440 yards level running race, Sapper L. G. Bennett won in fifty-seven and two-fifths seconds. The one mile running level race gave excellent sport, Sapper J. A. Mitchell winning by two yards in 5 min. 25 sec. In the 120 yards hurdles level race, Sapper E. C. Abbott-Young won the first heat; time, 20 sec., and Sapper Wimberley the second heat in twenty and two-fifths seconds, the final win falling to Abbott-Young, who romped in with two yards to spare in nineteen and two-fifths seconds. Again Sapper Abbott-Young proved victor in the long jump, his record being 16 ft. 6 in. The quarter-mile cycling level race was won by Sapper W. E. Cox by a wheel in 36 sec., while the one mile cycling level race also fell to him, the ground being covered in 2 min. 47⅘ secs. The Inter-Company Tug-o'-War proved exciting. Company "B," the holders, defeated Company "C," but being pitted against Company "A," who proved victors over Company "D," were hauled over the mark. Mrs. Le Rossignol brought a pleasant event to an end by gracefully presenting the prizes.

VALUATION OF UNDERGROUND CONDUITS.

A Sub-Committee of the Glasgow Corporation, after mature deliberation, have resolved: "That it be remitted to the Parliamentary Bills Committee to endeavour to get the Government, or a member of Parliament, to introduce a bill amending the law as to the method of the valuation of gas, water, tramway, and electric light undertakings, and giving effect to the recommendations of the Royal Commission, which reported in 1902, viz., that in rural areas underground gas and water piping, and underground works connected with such undertakings, should only be assessed on one-fourth of the annual value thereof; and, further, that tramway lines and the underground works of electric light undertakings be similarly treated," and in endeavouring to get legislation passed in regard to the matter.

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THE

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IMPORTANT NOTICE TO ADVERTISERS.

Displayed Advertisements intended for insertion in the current week's issue, and alterations for standing advertisements, must reach the offices by 9 a.m. on Monday if proofs are required.

Contracts, Patents and Small Advertisements by 9 a.m. on Wednesday.

Terms for displayed advertisements may be had on application.

Second-hand Plant and Machinery Advertisements, 24 words 1s. per insertion, three insertions for 2s. 6d., each additional line of eight words 4d.

Situations Vacant, 24 words 1s., three insertions 2s. 6d.

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Municipal Central-Station Engineers and Tramway Managers are invited to send advance notes of new work being undertaken by them, and of successful results obtained from the undertakings under their charge..

Secretaries and Managers of Companies are asked to furnish Notices of Meetings, Issues of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers.

Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

Contractors can make use of our columns to obtain the names of the makers of any specialities they require in their business.

TO SUBSCRIBERS.

THE ELECTRICAL ENGINEER *can be had by order from any Newsagent in Town or Country, and at the various Railway Stations; or it can, if preferred, be supplied direct from the Office on the following terms:*

	3 months.	6 months.	12 months.
United Kingdom ..	3s. 3d. ..	6s. 6d. ..	13s. 0d.
Other Places	5s. 6d. ..	10s. 6d. ..	21s. 0d.

(Post Free, Payable in Advance.)

Cheques, Post Office and Postal Orders for Subscription and Advertisements should be made payable to "THE ELECTRICAL ENGINEER," LIMITED, 149, *Fleet Street, London, and be crossed.*

Bound volumes of THE ELECTRICAL ENGINEER, *containing half year's copies, bound in Dark-Blue Cloth, Gold Lettered, price* 8s. 6d.

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ACCIDENTS.

M. d'Arsonval has been giving the results of his experience as regards accidents caused by electricity before the International Society of Electricians at Paris. While, necessarily, much of what he had to say is common knowledge among experts, his remarks are worthy of consideration, on account of novel points and suggestions. Not that we can expect the battle between high and low tension for mining and quarry work to be settled at one conference. This side of the subject is certainly hotly enough contested over here. It is rather remarkable that under a bureaucratic system of administration, such as prevails in France, accurate details of accidents are not recorded. We are better off as regards that in Great Britain, with our double line of investigation—reports to the Government Inspectors of Mines, and our coroners' inquests in cases of fatality. In Austria, however, investigation and systematic recording goes much further. There, all accidents attributed to electricity have to be reported to a special clinical laboratory attached to the Ministry of the Interior, and presided over by Dr. Gellineck. This laboratory was established by the Emperor, and is maintained out of his Privy Purse. Here all particulars are studied, and, ultimately, technical and physiological reports are published. Such systematic records will soon prove of great value, and may lead to practical results. As regards M. d'Arsonval, he agrees that, as a rule, a voltage of under 100 is not dangerous. However, he cited two cases: one of a man who was killed by a charge of under 100 volts, and the other of a girl killed by a charge of under 65 volts. He pointed out that touching two conductors was more dangerous than touching one, though the problems of earthing and insulation modify the general rule. He found prolonged contact more dangerous in the case of continuous than in that of the alternating current. As regards resistance of the human skin, this varied immensely. It may be placed at between

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70,000 and 100,000 ohms for the working man and as low as 5,000 ohms for the professional or clerical class. He attributed great importance to two points: the condition of the skin and the mental attitude. In some cases, the current seemed to glance off the skin, without causing any internal injury. Therefore, where there was no manifest injury, persevering artificial respiration exercises were incumbent. If a person received a shock, terror might paralyse the vital functions. He had killed rabbits with 1,500 volts; and, on the other hand, he had brought back to life others to which he had administered dangerous doses of chloroform, the same charge being used He cited a case where two men went to sleep on a coil of wire, and when a strong current was sent through the wire by inadvertence, the men were simply startled into wakefulness by burns on their backs. Artificial respiration is the sheet anchor in most cases, but, under medical supervision, a slight electrification of the larynx may produce good results. When a patient recovers and shows intense excitement, extreme danger exists of fatal epilepsy, resulting from degeneration of the nervous system. Bleeding is sometimes useful; but, when this is done, attempts at artificial respiration must be abandoned. A most encouraging aspect of the discussion was the statement that in Austria, as the result of work at the Electrical Clinic, education of workers has been undertaken, by means of lectures and pictorial posters. These deal both with prevention of accidents and first aid. Since that course was undertaken the average of from 110 to 140 electrical accidents per annum was reduced to eight last year. Surely this is an achievement of which our Austrian colleagues may well be proud, and which we should endeavour to emulate.

CORRESPONDENCE.

All communications intended for the Editor should be addressed "The Editor, 149, Fleet Street, London, E.C." Anonymous communications will not be noticed. Letters should reach the Editor not later than Tuesday afternoon to be included in that week's issue of the Journal.

The Editor is not responsible for, nor does he necessarily endorse opinions advanced by correspondents.

BRUSSELS EXHIBITION.

Sir,—A Mr. Max Kaiser, describing himself as "Commissioner for England and Great Britain," is soliciting manufacturers and traders in respect of an exhibition at Brussels, which may be mistaken for the Exposition Internationale et Universelle now in being. The forms of application for space are headed "International Exhibition, Brussels, 1910."

It is, therefore, necessary to say that Mr. Max Kaiser has no connection with the International Exhibition in which the British Government and the Governments of other nations participate; and to appeal to your esteemed courtesy for publicity in the matter.

I am, Sir, your obedient servant,

F. Mander Burd.

Exposition de Bruxelles 1910 Société Anonyme.
Direction Générale.
Bruxelles, le
Mai 26, 1910.
Electrical Engineer, Londres, E.C.

TECHNICAL PROBLEMS, WITH SOLUTIONS BY PRACTICAL MEN.

RULES.

Under the above heading we insert questions of a practical character relating to power stations, electrical railways and tramways, mining installations, electric power in workshops, electro-metallurgical plant, and electrical engineering work generally.

Questions.—For each suitable question we offer one shilling. Questions of a practical character stand a better chance of acceptance than those of a theoretical nature. Questions may be sent in at any time.

Answers.—A fee of 10s. will be paid for the best answer, and 5s. for every other published. Replies should reach the office within 14 days of the appearance of the questions.

QUESTIONS.

Question 1217.—What would be a reasonable assumption for the overall efficiency of an electric railway (short distance) reckoned from the generating busbars to the locomotive road wheels? How would the losses be distributed over the intervening transmissions, conversions, etc.? Quote actual results where possible.—"L. C."

Question 1218.—What is the best practice to follow in the construction of electro-magnets so as to overcome the tardiness of action arising from self-induction, and enable them to acquire and lose their full strength, or the full strength required, practically instantaneously? Give an example of a magnet taking a current of about 1 amp. at a pressure of 110 volts, and state the time that would be required (a) to acquire and (b) to lose the required strength, and specially comment on the practice of winding a few turns of large wire upon a laminated magnet having a plain resistance in series with the coil. References also to the practice followed with regard to the construction of the field magnets of a generator through which the direction of rolling mill or planer motors are quickly reversed, to quick acting reversible electro-magnetic clutches, or to the field magnets of series wound alternating current commutator motors *working in a high-pressure circuit* would be useful.

Does differential winding or do condensers conduce to rapidity of action as well as suppress sparking at break, and in the case of condensers what is the best way to connect (1) across the break, (2) across the magnet terminals, or (3) in shunt with a plain resistance in series with the magnet. Explain the contradiction or apparent contradiction between Dr. G. P. Thompson and Professor Fleming, the former stating in the "Electro-magnet," page 328, that "a condenser placed as a shunt to the magnet does not prevent the retarding action in the coil itself"; whilst the latter states at page 389 of his work on the Alternating Current Transformer, that if the terminals of the relay are joined to the poles of a suitable condenser, the effective self-induction of the relay is thereby lessened.—"Mica."

SWEDISH RAILWAY ELECTRIFICATION.

News comes from Stockholm that a proposal is shortly to be laid before the Swedish Diet for the electrification of the State frontier railway in the north of Sweden. It is proposed to harness the Porjus waterfall, near the Gellivare iron district, in order to obtain the necessary power.

The Porjus falls can furnish 50,000 h.p., about twice as much power as will be necessary under normal conditions, and 16,000 h.p. more than will be needed for the railway when working at full pressure. The harnessing of Satisjaure, whereby the minimum quantity of water could be increased from 24 to 45 or 50 cubic metres per second, is reckoned to cost 600,000 kronor (£33,300). The harnessing of the entire river system, increasing the quantity of water to 125 cubic metres per second, would cost 5,000,000 kronor (£278,000), and would affect not only Porjus, but also the several important falls lower down, Harspranget, Liggaforsen, Porsiforsen, and Edeforsen.

Great hopes are entertained that a large industry will arise in the regions affected. Among other things it would be possible to treat the low grade iron ore (waste ore), of which a great many thousand tons are available in the Gellivare district, and which hitherto has been useless. Mr. Sterling is informed that large quantities of this waste ore have recently been exported to Bavaria and other parts of Germany to be made into briquettes and treated in smelting furnaces.

A later despatch from the British Acting Consul states that the majority of the Committee have agreed to the Government proposal to grant the sum of 21,500,000 kronor (£1,194,000) for the establishment of an electrical power station at the Porjus Falls on the Stora Lule river.

Electrical Contractors' Section.

A Survey of New Things and Business Prospects.

NOTICE.

Contract and Miscellaneous Advertisements should reach this Office by Mid-day on Wednesday. For rates apply to the Manager, 149, Fleet Street, London, E.C.

CONTRACTS.

CITY AND COUNTY OF KINGSTON-UPON-HULL.

ELECTRICITY DEPARTMENT.

TO CABLE MANUFACTURERS AND OTHERS.

CONTRACT No. 68—MAINS.

The ELECTRIC LIGHTING COMMITTEE of the HULL CORPORATION are prepared to receive TENDERS for the SUPPLY AND LAYING OF ELECTRIC MAINS, &c., required in connection with the extensions of the Electric Lighting Mains during the period ending March 31, 1911.

Forms of Tender and Specification for this contract may be obtained on depositing the sum of ONE GUINEA with the City Treasurer, T. G. Milner, Esq., Town Hall, Hull, for each copy required, such deposit being returnable on receipt of a *bona fide* Tender.

Tenders, endorsed "Mains, Electricity Department," are to be addressed and delivered under seal to the Chairman of the Electric Lighting Committee, Town Hall, Hull, by not later than noon on Monday, June 20, 1910.

The Corporation do not bind themselves to accept the lowest or any tender.

By order,

H. BELL,
City Electrical Engineer.

Sculcoates-lane Works, Hull.
May 28, 1910.

CORPORATION OF LEICESTER.

ELECTRIC TRAMWAYS.

EXTENSION OF POWER STATION.

Tenders are invited for the supply and erection of Steel Roof Trusses and other work for an extension of the Engine Room at the Tramway's Power Station.

Plans may be seen and copies of the general conditions, specification and bill of quantities obtained at the Borough Surveyor's Office, on and after Wednesday, June 1, on payment of the sum of £1, which will be returned on receipt of a *bona-fide* Tender.

Cheques, etc., should be crossed and made payable to the Leicester Corporation.

Sealed Tenders on the forms supplied, addressed to "The Chairman of the Tramway's Committee, Town Hall, Leicester," are to be delivered not later than 12 noon on Thursday, June 9, endorsed "Tender for Steelwork, Power Station Extension."

The Committee do not bind themselves to accept the lowest or any tender.

E. GEORGE MAWBEY, M.Inst.C.E.,
Borough Engineer.

Town Hall, Leicester.
May 23, 1910.

THE PENRIKYBER NAVIGATION COLLIERY CO. (LIMITED), PENRHIWCEIBER R.S.O., GLAM.

The Directors of this Company are prepared to receive Tenders for the following during a period of 12 months from July 1, 1910. Tenders to be in not later than Wednesday, June 8, 1910. Forms of Tender may be obtained on application to the Secretary.

No. 1. Iron and Steel.
No. 2. Castings.
No. 3. Bolts, Nuts, Rivets, Iron Washers, and Nails.
No. 4. Electrical Fittings.
No. 5. Rubber, Leather, Waste, Wick, Brattice Felt Packing, Yarn and Leather Belting.
No. 6. Steam, Water and Gun-metal Fittings, etc.
No. 7. Ironmongery, Files, Saws, Gauges, Colliers' Tools Helves, Shovels, and Sundry Stores.
No. 8. Paints, Drysalteries, Brushes, Brooms, Glass, etc.
No. 9. Pitch Pine Deals, Red Pine, best quality American Birch Boards and Deals, Poplar and Elm Curbs, Elm, G. and T., Match, and Flooring Boards.
No. 10. Wires Ropes.
No. 11. Lime and Cement.
No. 12. Oils, Tallow, and Grease.
No. 13. Steel Rails and Sleepers.

COUNTY BOROUGH OF DEVONPORT.

The DEVONPORT CORPORATION ELECTRICITY COMMITTEE invites TENDERS for the supply of the undermentioned for a period of 12 months ended June 30, 1911:

Contract No. 1.—Direct-Current Meters.
Contract No. 2.—Paper-Insulated Cables, Rubber-Covered Wires, and Cut-outs.
Contract No. 3.—Lubricating Oils.

Particulars and form of Tender may be obtained on application to J. W. Spark, Borough Electrical Engineer, Newport-street, East Stonehouse, Devon, on deposit for each form of contract of one guinea, which will be returned on receipt of a *bona fide* Tender.

Tenders must be delivered not later than noon June 15, 1910.

R. J. FITTALL,
Town Clerk.

Municipal Offices, Devonport.
May 30, 1910.

ERITH URBAN DISTRICT COUNCIL.

EXTENSION PLANT—ELECTRICITY WORKS.

The Council invite Tenders for the supply, delivery and erection at their Electricity Works, Erith, of the following plant:—

Section A.

1. Lancashire Boiler complete with mechanical stokers, superheater, and all necessary fittings and pipe-work, to couple up to existing steam range.

Section B.

1. 750 kw. Impulse type Turbo 3-phase Alternator and Exciter, complete with surface condenser, air and circulating pumps, and necessary pipe-work in connection therewith.

Contractors may tender for one or both sections, but not for a part of a section.

Early delivery is the essence of the contract, and Tenders will only be considered from firms who are able to guarantee completion of the work in time for the Council's Winter Loads.

General conditions and specification, with form of Tender, may be obtained from the Electrical Engineer, Mr. A. Coveney, Offices, Walnut Tree-road, Erith, upon depositing a cheque for two guineas, which will be returned upon receipt of a *bona-fide* Tender, but not otherwise.

Additional copies of the specification may be obtained upon payment of 10s. 6d., which is not returnable.

Tenders, sealed and endorsed "Tender for Electricity Plant," must be delivered at my Office not later than 12 o'clock noon, on Modnay, June 20.

The Council do not bind themselves to accept the lowest or any Tender.

J. KENNEDY ALLERTON,
Clerk of the Council.

Council Offices, Erith.
May 30, 1910.

COUNTY OF SOUTHAMPTON.

CONTRACT No. 2.
COUNTY ASYLUM, KNOWLE, FAREHAM.
ELECTRIC LIGHT AND POWER PLANT AND HEATING, ETC., INSTALLATION.

TO CONTRACTORS.

Persons desirous of tendering for the supply and erection of Electric Light and Power Plant, wiring for Electric Light and the installation of Steam and Hot Water Heating to additions to the Asylum, may obtain copies of the specifications, conditions of contract and plans, and procure all other necessary information on application at the office of Mr. W. J. Taylor, County Surveyor, The Castle, Winchester, on and after Monday, June 13 next, between the hours of 9 a.m. and 5 p.m. (Saturdays 9 a.m. and 1 p.m.).

A deposit of five guineas will be required for a copy of plans, etc. Deposits must be made by cheque payable to the HANTS COUNTY COUNCIL and crossed BANK OF ENGLAND, or the particulars and information will not be sent. The deposit will be refunded on receipt of a *bona-fide* tender, and the return of the documents sent.

Tenders must be on forms supplied by the County Surveyor, and endorsed "Electric Plant, etc.," and must be delivered to me on or before 5 p.m. on Tuesday, June 28 next.

The Committee of Visitors do not bind themselves to accept the lowest or any tender.

J. RAILTON WYATT,
Clerk to the Committee of Visitors.

Knowle.
June 1, 1910.

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CONTRACTS—continued.

COUNTY BOROUGH OF BELFAST.

TO ELECTRICAL CONTRACTORS.

The Committee of Management of the Belfast District Asylum invite TENDERS for ELECTRIC LIGHTING INSTALLATIONS in new Asylum buildings on the Purdysburn Estate.

Specifications can be obtained, and drawings seen, at the offices of Messrs. Watt, Tulloch & Fitzsimons, 77a, Victoria-street, Belfast, on payment of a sum of 10s. (which will be returned on receipt of a *bona-fide* tender).

Sealed Tenders, endorsed "Tenders for Electric Installations," addressed to the Chairman, Belfast Asylum Committee, must be delivered in my Office not later than 12 noon on Monday, June 13.

The lowest or any Tender not necessarily accepted.

R. MEYER,
Town Clerk.

CHORLTON UNION.

The GUARDIANS of the POOR of the Chorlton Union are prepared to RECEIVE TENDERS for the WIRING, etc., for Electric Light at the "G and L" Blocks at the Union Workhouse, West Didsbury.

Specifications and drawings may be obtained at the offices of Messrs. Charles Clegg & Sons, architects, 21, Spring-gardens, Manchester, upon payment of 10s., which sum will be returned on receipt of a *bona-fide* tender.

Sealed tenders, endorsed "Tender for Electric Wiring, etc.," must be delivered to the undersigned at the Union Offices, All Saints', Manchester, not later than Tuesday, the 7th proximo.

The Guardians do not bind themselves to accept the lowest or any tender.

By order,
DAVID S. BLOOMFIELD,
Clerk to the Guardians.

Union Offices, All Saints', Manchester.
May 25, 1910.

CORPORATION OF LEICESTER.

ELECTRIC TRAMWAYS.

EXTENSION OF POWER STATION.

Tenders are invited for an extension of the Engine Room, Offices, etc., at the Tramways Power Station.

Plans may be seen and copies of the general conditions, specification and bill of quantities obtained at the Borough Surveyor's Office, on and after Wednesday, June 1, on payment of the sum of £2, which will be returned on receipt of a *bona-fide* Tender.

Cheques, etc., should be crossed and made payable to the Leicester Corporation.

Sealed Tenders on the forms supplied, addressed to "The Chairman of the Tramways Committee, Town Hall, Leicester," are to be delivered not later than 12 noon on Thursday, June 9, endorsed "Tender for Power Station Extension."

The Committee do not bind themselves to accept the lowest or any tender.

E. GEORGE MAWBEY, M.Inst.C.E.,
Borough Engineer.

Town Hall, Leicester.
May 23, 1910.

PATENTS.

S. SOKAL, Chartered Patent Agent,
AND
Certified Austrian Patent Attorney (Patentanwalt), Specialist for German Patents and Patent Litigation.

55, CHANCERY LANE, LONDON, W.C.

PATENTS AND DESIGNS ACT, 1907.

TURNER'S PATENT 13311 of 1906, Kelley Monroe Turner (W. G. Heys) for "Improvements in Telephone Dictating Machine or Apparatus."

The owner of the above patent desires to grant a licence or licences or to enter into other arrangements to be agreed upon to ensure that the above patented apparatus is manufactured to an adequate extent in the United Kingdom.

Apply in the first instance to W. E. HEYS & SON, Chartered Patent Agents, Deansgate Arcade 51, Manchester.

THE PROPRIETOR of LETTERS PATENT No. 12210. of 1901, relating to "Electrostatic Separators," desires to dispose of the Patent or to grant licences to interested parties on reasonable terms with a view to the adequate working of the Patent in this country. Enquiries to be addressed to CRUIKSHANK & FAIRWEATHER, Ltd., International Patent Agency, 65-66, Chancery-lane, London, W.C.

CONTRACTS OPEN.

HOME.

BELFAST.—Committee of Management of the Belfast District Asylum invite tenders for electric lighting installations in the new asylum buildings on the Purdysburn Estate. Particulars from Messrs. Watt, Tulloch & Fitzsimons, 77a, Victoria-street, Belfast. June 13.

BIRMINGHAM.—Corporation Tramways.—2,100 tons grooved steel girder tramway rails, together with fishplates, bolts, nuts, and tiebars. (Specification, £3 3s., General Manager, 147, Corporation-street). June 20.

CHORLTON.—The Guardians invite tenders for wiring, etc., for electric light at the "G" and "L" blocks of the Union Workhouse, West Didsbury. Particulars (10s.) from Messrs. Charles Clegg & Sons, architects, 21, Spring-gardens, Manchester. June 7.

DEVONPORT.—Corporation invite tenders for supplies for year ending June 30, 1911, as under: (1) Direct current meters, (2) paper insulated cables, rubber covered wires and cut-outs, (3) lubricants and oils. Particulars from Borough Electrical Engineer. June 15.

EALING.—Borough Council invite tenders for surface condensing plant. Specification (£2) from Borough Electrical Engineer. July 4.

ERITH.—Urban Council invite tenders for supply and erection of (1) Lancashire boiler complete with mechanical stokers, superheaters and all necessary fittings to couple up to existing steam range. (2) 750 kw. impulse turbo 3-phase alternator and exciter, complete with surface condenser, air and circulating pumps, etc. Particulars from Mr. A. Coveney, Electrical Engineer, Erith. June 20.

GLAMORGAN.—Standing Joint Committee of Glamorgan Quarter Sessions and County Council invite tenders for (2) wiring and fitting the new police court for electrical lighting. Specifications from Bargoed Police Station. June 11.

GLOUCESTER.—Electricity Department invite tenders for supply of rough small slack coal, for nine months from July 1. Particulars from Engineer. June 6.

ILFORD.—Urban Council invite tenders for 1,600 yards of conduit. Particulars from Mr. A. H. Shaw, Electricity Works, Ilford. June 14.

LEICESTER.—Corporation invite tenders for extension of engine room, offices, etc., at the Tramway Power Station. Specifications (£2) from Mr. E. G. Mawbey, Borough Engineer. June 9.

LEICESTER.—Corporation invite tenders for supply and erection of steel roof trusses at Tramway Power Station. Specifications (£2) as above. June 9.

LIVERPOOL.—Liverpool Overhead Railway Co. invite tenders for following stores for year ending June 30, 1911: (1) bolts and nuts, (2) electric fittings, etc., (6) India-rubber material, (9) iron and grease, (10) engine packing, (13) insulating tapes, (15) waste and sponge cloths. Particulars on application to General Manager, 31, James-street, Liverpool. June 7.

MANCHESTER.—Corporation invite tenders for supply of stores to June 30, 1911, as under: Asbestos goods, brasswork and iron castings, carbons, cement, coal, cotton waste and rags, dynamo brushes, iron and steel, limestone, rubber goods, oils, paraffin, pitch, team labour, timber, etc. Particulars from Town Clerk. June 7.

MORTLAKE.—Barnes Urban District Council.—Triple concentric, paper insulated, lead sheathed and jute scroll cable, 660 v., B.E.S., (4.000 yds., 25 ft. by 25 ft. 125 sq. in.). (Particulars, Engineer and Manager.) June 14.

PENRHIWCEIBER, GLAMORGAN.—The Directors of the Penrikyber Navigation Colliery Co., Ltd., invite tenders for: (2) castings, (3) bolts, nuts, rivets, iron washers and nails; (4) electrical fittings; (5) rubber, leather, waste, wick, brattice felt, yarn and leather belting; (6) steam, water and gun metal fittings; (10) wire ropes; (12) oils, tallow and grease; (13) steel rails and sleepers. Particulars from Secretary, The Colliery, Penrhiwcliber, R.S.O., Glamorgan. June 8.

SOUTHAMPTON.—County Council invite tenders for supply and erection of electric light plant, wiring for electric light, and installation of steam and hot water heating for the County Asylum, Knowle, Fareham. Specifications and plans (£5 5s.) from Mr. J. R. Wyatt, Clerk to the Committee of Visitors, Knowle. June 28.

WEST HAM.—Borough Council invite tenders for electric light installation at three schools. Specification (20s.) from W. Jacques, 2, Fen-court, Fenchurch-street, E.C. June 20.

OVERSEAS.

ADELAIDE.—Tenders will be received at the office of the Deputy Postmaster-General, Adelaide, up to noon on July 6, for the supply of cordless switchboards, in accordance with specification No. 338. A deposit will be required with each tender. Local representation is necessary. Copies of the specifications, etc., may be obtained, and preliminary deposits paid, at the offices of the High Commissioner in London for the Commonwealth of Australia, 72, Victoria-street, S.W. A copy of the specification may be seen by British firms at the Commercial

(*Continued on Page* 726).

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EIGHTY MOTORS AND DYNAMOS for sale or hire.—MARTIN, 320, Witton-road, Birmingham.

FOR SALE, 20 h.p. Suction Gas Plant and 14 b.h.p. Engine; also 10 h.p. Vertical Boiler and 6 h.p. Vertical Steam Engine.—BOX C.E., c/o THE ELECTRICAL ENGINEER, 149, Fleet-street, London, E.C.

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MISCELLANEOUS.

ENGLISH Metal and Carbon Lamp Manufacturers, at present able to produce 300,000 lamps per annum, and capable of extension, desire to arrange with a Wholesale Factor House to take practically exclusive output.—Address "LAMPS," c/o CLARKE, SON & PLATT, LTD., 317, High Holborn, W.C.

ELECTRICAL CONTRACTOR'S BUSINESS for Sale on South Coast; price, £150; owner returning abroad.—Box No. 44, THE ELECTRICAL ENGINEER, 149 Fleet-street, E.C.

SITUATIONS WANTED.

FOREMAN WANTS SITUATION with Arc Lamp firm; well up in Theory and Practice of Mechanics and Electricity; 32 years of age, and 17 years' practical experience.—Box W. E., c/o THE ELECTRICAL ENGINEER, 149, Fleet-street, E.C.

ELECTRICAL ENGINEER desires berth in Central Station, or charge of private installation.—Box C., c/o THE ELECTRICAL ENGINEER, 149, Fleet-street, London, E.C.

WANTED, SITUATION as DEPOT SUPERINTENDENT, or take charge of Private Installation.—Box 43, c/o, THE ELECTRICAL ENGINEER, 149, Fleet-street, London, E.C.

WIREMAN WANTS WORK, 12 years' experience; screwed conduit.—G. H., 14, Sterndale-road, West Kensington.

WIREMAN wants sit. or job power lighting telephones, bells.—E. C., 65, St. John's-hill, Clapham Junction, S.W.

ENGINEER seeks CHARGE ELECTRIC PLANT; gas or petrol engines, or Engineer in factory; lathe experience, all branches engineering; married.—ENGINEER, 28, Adelaide Road, Chislehurst.

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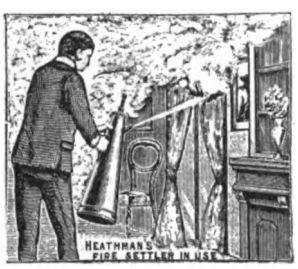

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Intelligence Branch of the Board of Trade, 73, Basinghall-street, London, E.C.

ADELAIDE, S.A.—Postmaster-General.—Cordless switchboards (Specification No. 3,381.) July 6.

ADELAIDE, S.A.—Deputy-Postmaster-General.—120 common battery switchboards, cordless, for pripate branch exchanges, four (4) line, equipped for two (2) extension and one (1) main line only; 70 common battery switchboards, cordless, for private branch exchanges, six (6) lines, fully equipped; 30 common battery switchboards, cordless, for private branch exchanges, ten (10) lines, fully equipped. (Specification No. 338.) July 6.

ANTWERP.—Lower Scheldt Works.—Electric lift for vehicles on floating pier. Dep., £320. Specification No. 19, 2d., plans 1s. 5d., Direction du Service Spécial de l'Escaut Maritime. June 16.

BELGRADE.—Monopolies Administration.—One five-ton electric crane. (Dep. 20%.) (Particulars, Administration Autonome des Monopoles.) June 25.

BUDAPEST.—H.M. Consul-General at Budapest (Mr. Esme Howard, C.V.O., C.M.G.) reports that tenders are invited by the Municipality of Pécs for the building and working of an electric railway in that town. Tenders will be received up to noon on June 6, by the "Pécs varos gazdasagi tanacsnokanak, Varosi Székhaz," Pécs, Hungary, from whom also detailed conditions and forms of tender may be obtained at a cost of 2 kronen (1s. 8d.). The plans and other documents can be examined on personal application at the Engineering Office of the town of Pécs.

MELBOURNE.—Postmaster-General.—4,00 telephones, wall sets, magneto, complete (specification No. 220 and pattern C. No. 11); and 200 telephones, bridging table (specification No. 221, and pattern N.S.W. 339, schedule 321.) July 9.

ROME.—Italian State Railways invite tenders for supply of: 19.600 glass shades for electric lights in railway carriages; tenders will be received up to June 14. Tenders should be addressed to the "Direzione Generale delle Ferrovie dello Stato, 16, Via Ludovisi," Rome. Only those firms (Italian and foreign) on the special list kept by the Italian State Railways Administration are generally allowed to tender.

TENDERS ACCEPTED.

ASHBURTON.—The Borough Council have accepted the tender of Messrs. Craddock & Co., Ltd., for electric lighting.

BRISTOL.—The City Council have signed the following contracts: Sykes & Sugden, Ltd., March 31, 1910, joint and junction boxes, 1910-1911 contract, £213 13s. 1d.; General Electric Co., Ltd., April 12, 1910, meters, 1910-1911 contract, £546 4s.; Bruce, Peebles & Co., Ltd., April 13, 500 kw. converter for Underfall-yard sub-station, £1,230. The committee have also entered into contracts with the Union Electric Co., Ltd., Ship Carbons, Ltd., and the Oliver Arc Lamp, Ltd., for the supply of the various kinds of arc lamp carbons required during the year ending April 30, 1911, at schedule prices, estimated to amount in the aggregate to £655 5s. 1d.

HESTON AND ISLEWORTH.—The following tenders have been accepted by the Urban Council for its electric power station extensions: W. Lacey, Hounslow, buildings; Browett, Lindley & Co., 250 kw. generating set with Westinghouse dynamo and British Thomson-Houston switch panel; Babcock & Wilcox, steam piping and G. & J. Weir pump; Korting Bros., condensing plant: Selson Engineering Co., machine tools.

LONDON, WOOLWICH.—The Borough Council have accepted the tender of Messrs. F. Sage & Co. for fitting up the Powis-street electricity showroom and shop front in accordance with the design submitted, for the sum of £619 10s., subject to their agreeing to the final specification to be prepared by the Borough Electrical Engineer.

JOURNAL OF THE INSTITUTION OF ELECTRICAL ENGINEERS

Edited by P. F. ROWELL, Secretary.

Part 201. Price 5/-

"THE WORK OF LORD KELVIN IN TELEGRAPHY AND NAVIGATION." By Professor J. A. Ewing, C.B., F.R.S.

"EQUITABLE CHARGES FOR TRAMWAY SUPPLY" (*With discussion*). By H. E. Yerbury.

"AN ELECTRICAL SAFETY SYSTEM FOR MINES" (*With discussion*). By H. J. Fisher.

"AN INVESTIGATION AS TO THE MOST ECONOMICAL VACUUM IN ELECTRIC POWER STATIONS EMPLOYING STEAM TURBINES AND COOLING TOWERS" (*With discussion*). By R. M. Neilson.

"THE TESTING OF RUBBER FOR ELECTRICAL WORK" (*With discussion*). By Professor A. Schwartz.

"THE INFLUENCE OF COOLING MEDIA UPON THE RISE IN TEMPERATURE OF SOFT IRON STAPMINGS" (*With discussion*). By R. D. Gifford, M.Sc.

"THE PRESENT ASPECT OF ELECTRIC LIGHTING" (*Discussion at Manchester*). By H. W. Handcock and A. H. Dykes.

"OVERHEAD LINE CONSTRUCTION" (*With discussion*). By W. B. Woodhouse.

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The Company has always encouraged the development of Electricity, and the well-known "Phœnix Fire Office" Rules for Electrical Installations are in use throughout the world. Copies will be supplied free on application to the Head Office.

G. H. RYAN, General Manager.

TECHNICAL CLASSES.

ENGINEERING AND CHEMISTRY.

CITY AND GUILDS OF LONDON INSTITUTE.

There are two City and Guilds Colleges providing Courses of Instruction in Engineering and Chemistry. The **City and Guilds Central Technical College** (Exhibition Road), and the **City and Guilds Technical College, Finsbury** (Leonard Street, E.C.). The Entrance Examinations to both Colleges are held in September, and the Sessions commence in October. Particulars of the Entrance Examinations, Scholarships and Courses of Study, may be obtained from the respective Colleges, or from the Head Office of the Institute, Gresham College, Basinghall Street, E.C.

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(EXHIBITION ROAD, S.W.)

A College for higher Technical Instruction for Day Students not under 16 preparing to become Civil, Mechanical, or Electrical Engineers, Chemical and other Manufacturers, and Teachers. The College is a "*School of the University of London*," and also forms the *Engineering Section of the Imperial College of Science and Technology*. The Entrance Examination includes the subjects of Mathematics, Mechanical Drawing, Physics, Chemistry, English Composition, and French or German Translation, and the Courses of Study for the Associateship of the Institute cover a period of three years. Fees, £36 per Session. Professors:—

Civil and Mechanical Engineering ..	W. E. DALBY, M.A., B.Sc., M.Inst.C.E., (Dean for the Session).
Electrical Engineering	T. MATHER, Wh. Sch., F.R.S.
Chemistry	H. E. ARMSTRONG, Ph.D., LL.D., F.R.S.
Mechanics and Mathematics	O. HENRICI, Ph.D., LL.D., F.R.S.

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A College for Day Students preparing to enter Engineering and Chemical Industries, and for those who have already served an apprenticeship, and also for Evening Students. The subjects of the Entrance Examination are Mathematics, and English Composition and Precis Writing. The Day Courses in Mechanical or Electrical Engineering cover a period of two years, and those in Chemistry three years. Fees, £20 per Session. Professors:—

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Mechanical Engineering and Mathematics ..	E. G. COKER, M.A., D.Sc. F.R.S.E., M.Inst.M.E.
Chemistry	R. MELDOLA, F.R.S., F.I.C.

City and Guilds of London Institute,
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NOTES.

Tantalum Lamps.

An important step has been taken by Messrs. Siemens Bros. Dynamo Works, Ltd., which should help to stimulate trade. While they have been busy improving the quality and quantity of output of "Tantalum" lamps, they have now decided to reduce prices. They are now supplying 5, 10, 16 and 25 c.p. lamps of 20-40 volts in standard bulbs at 1s. 6d., and spherical bulbs at 1s. 9d.; 10 c.p. lamps at 50-80 and 100-120 volts at the same prices; 16 c.p. of 50-80, 100-120, and 130-160 volts; 25 c.p. lamps at 50-130, 140-160 and 200-250 volts, and 32 c.p. lamps at 60-130, 140-160 and 200-250 volts at 2s. and 2s. 3d. respectively. 50 c.p. lamps of 100-130 volts will be charged 2s. and 2s. 3d. respectively, at 140-160 volts 2s. 6d. and 2s. 9d., and at 205-250 volts at 3s. and 3s. 3d. All these lamps are kept in stock with bayonet, Edison screw and centre contact caps. It is good policy to bring these facts prominently before customers, as these very considerable reductions may hasten the decision to change from carbons to metallic filaments, and impel a more lavish use of lamps.

British Prometheus.

The British Prometheus Ltd., of Birmingham, have removed their London showrooms to very convenient premises at 9, Newman-street, Oxford-street, W. This will be found a central position for this class of trade, and we understand that a very comprehensive stock of the company's domestic specialities are being kept on view.

Water Purifying Plant.

Among the many orders recently received for Paterson Water Purifiers are the following: H.M. Dockyard Pembroke, a repeat order for the Generating Station; India Office, two orders; Hull Corporation, repeat order for the Tramway Power Station; General Post Office Generating Station, Blackfriars, to the order of Messrs. Aiton & Co.; Messrs. J. G. White & Co., repeat order for the Lacroze Electric Tramways, Buenos Aires; Messrs. J. G. White & Co., repeat order for Para Electric Light & Tramways Co.; Messrs. Rowntree & Co., York; J. Lysaght Ltd., Scunthorpe, near Doncaster; Midland Electric Corporation for Power Distribution, Ltd., for Ocker Hill, Tipton. Besides these the firm have completed a number of plants for export and have in hand at the present time plant for a number of industrial firms in this country.

Artistic Metal Work.

Messrs. Jesson, Birkett & Co., Ltd., designers and workers in metals at St. Dunstan Works, Salop-street, Highgate, Birmingham, notify us that for the greater convenience of the trade, they have removed their London offices and showrooms from 27, Ely-place to a more central position for the electrical trade, at No. 9, Newman-street, Oxford-street, W., where they extend a cordial invitation to the trade to visit these new showrooms and inspect a large selection of their manufactures.

Rail Grinding Equipment.

Messrs. Thermit, Ltd., have received orders for two electrical rail grinding equipments ((Mattinson's Patent Grinder), one being destined for Sydney, Australia, and the other for the Paisley District tramways.

CONTRACTS WORTH WATCHING:—

Below is a list of contracts recently given or tenders invited. Although we have no means of ascertaining whether in all these cases electricity is to be used, it is to be presumed, from the nature of the cases that this will be so.

Aberdeen.—Mr. G. B. Mitchell, architect, 148, Union-street, Aberdeen. New offices for Royal Insurance Co.

Belfast.—Messrs. Young & Mackenzie, Scottish Provident-building. Manse at Woodvale Park.

Bishop Auckland.—Baptist Church in Cocleton-hill, at cost of £3,500.

Bradford.—Prospect Mission Hall, to seat 1,000; cost, £7,000.

Blackburn.—A. R. Gradwell & Son, architects, 28, Victoria-street, Blackburn. St. Jude's Church, Accrington-road.

Deal.—Rev. M. Allen, Gilford-road, Deal. Alterations and additions to Wesleyan Day Schools.

Dublin.—Mr. G. T. Moore, 1 and 2, Foster-place, Dublin. Tenders invited for (1) shop fittings, (2) electric installations for premises, in Sackville-street.

Exeter.—Mr. J. A. Lucas, Guildhall-chambers. Garage.

Folkestone.—Harvey Grammar School to be erected, accommodation 150 scholars, at cost of £6,000.

Gloucester.—Mr. P. B. Cooke, Berkeley-street, Gloucester. New school in Deacon-street.

Grimsby.—Mr. D. Chandler, clerk to the Education Authority. New Council School.

Halifax.—C. Williams & Sons, architects, Post Office-buildings, Commercial-road, Halifax. Two shops for Halifax Industrial Society, Ltd.

Holmes Chapel.—Mr. R. P. Ward, Director of Education, Chester. Alterations and additions to Agricultural College.

Kendal.—Mr. J. F. Curwen, architect, 26, Highgate, Kendal. Garage and power station at Hawesmead.

Maidstone.—A proposal is being considered to erect new County Council offices on site of Session House.

Pengam, Wales.—Mr. E. T. James, clerk, Council offices, Hengoed. Infectious Diseases Hospital.

Penzance.—Mr. Frank Latham, Borough Engineer. Alterations to Library.

Pontypridd.—Messrs. T. E. Richards & Kaye, architects, Pontypridd. Conversion of premises into cinematograph theatre. Tenders by June 6.

Rugby.—Mr. Frank Langley is about to build a thearte, to seat 1,000, in Railway-terrace.

Ryde, I.W.—Mr. P. M. Du Feu, architect, Ventnor. Alterations and additions to Artillery Drill Hall.

Stanwix (Carlisle).—Mr. J. Slack, architect 18, Bank-street, Carlisle. Erection of Memorial Hall.

Warwick.—Mr. W. Hardisty, Secretary, 46, High-street, Warwick. Alterations to premises at Aston Lower Ground, for Warwickshire Territorial Forces. Tenders by June 7.

Woodstock.—Mr. A. G. Higgs, clerk to the Guardians Alterations at Workhouse.

CAPE TOWN CONSOLIDATED TRAMWAYS AND LAND.

The report for the year ended December 31 last states that after charging London administration expenses and trustees' fees, and after crediting accrued interest and transfer fees, a balance of £941 is shown to the debit of profit and loss account for the current year, which, added to the balance brought forward from 1908 of £1,228, makes the total to the debit of profit and loss account of £2,169. Neither the Estate Companies nor the Camps Bay Tramway Co. have been able to declare any dividends during the past year. Although a slight improvement in general business conditions in Capetown has made itself manifest during 1909, that improvement has not been of such a decisive character as materially to influence the results of the operations of the tramways during the past year, or to create any public demand for land investments which might benefit the Estate Companies.

ELECTRICAL ENGINEERS TERRITORIALS (London Division).—Orders for week ending, June 11, 1910: Monday, June 6, "A" Company, Recruits' Infantry Drill, 6 to 6.45 p.m.; Technical Drill, 7 to 9.30 p.m. Tuesday, June 7, "B" Company, Technical Drill, 7 to 9.30 p.m. Wednesday, June 8, Gymnasium, 6 to 9.30 p.m. Thursday, June 9, "C" Company, Recruits' Infantry Drill, 6 to 6.45 p.m.; Technical Drill, 7 to 9.30 p.m. Friday, June 10, "D" Company, Recruits' Infantry Drill, 6 to 6.45 p.m.; Technical Drill, 7 to 9.30 p.m. Saturday, June 11, Musketry at Runemede. This course is now compulsory; please send name in as soon as possible for this shoot. Next shoot after this, July 30.—(Signed) P. H. Campbell, R. E. Adjt.

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PUBLICITY.

In this Section of "The Electrical Engineer" we give Publicity to New Inventions and Specialities.

Two-Rate Continuous Current Meters.

A practical solution of the two-rate electric meter has been found in the Ferranti-Hamilton appliance here illustrated. This meter has two sets of dials, each recording the consumption of current in B.O.T. units, but not simultaneously. As a rule, the lower dials are used for indicating the consumption during the low-priced day load, while the upper set are used for the later, usually lighting, and higher priced current. This is managed by using an automatic time switch, making and breaking with a quick action at the beginning and ending at the end of a high-rate period.

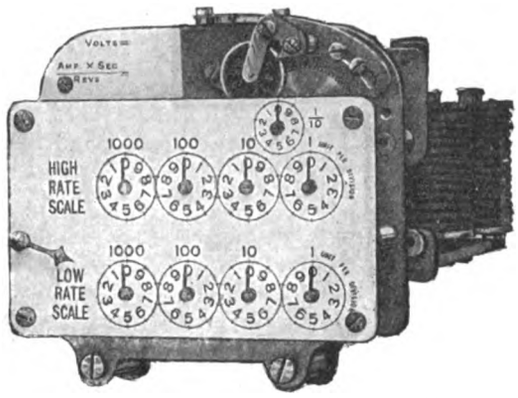

FIG. 1. FRONT VIEW, SHOWING ELECTRO-MAGNET.

The dials, which are of the ordinary clock type, register up to 9999 units. The small top dial shown in Fig. 1 is for testing purposes. Now let us consider the working of these appliances, which can be followed by referring to Figs. 1 and 2. The two-rate train consists of two sets of recording dials, and an intermediate change over gear (Fig. 2) of novel construction. The meter spindle drives the one-hundredth unit and one-tenth unit spindles in the usual manner, which facilitates testing. While the one-tenth unit spindle drives the first wheel of the inter-

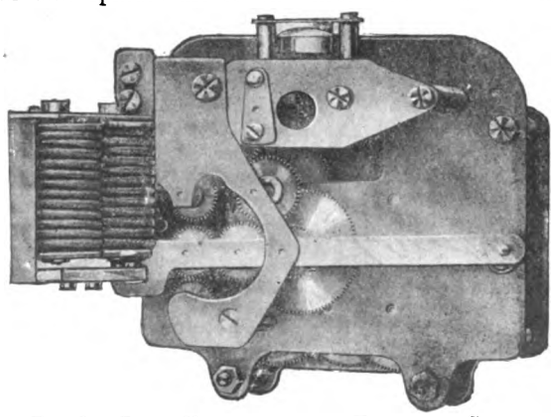

FIG. 2. BACK VIEW, SHOWING EPICYCLIC GEAR.

mediate change-over gear wheels, wheel 1 drives wheel 2, 2 drives 3, and 3 may gear with the wheel on the unit spindle of the lower recording dials, or with the wheel on the unit spindle of the higher recording dials, according as the lever is on the low-rate position or the high-rate position. As we have said, the intermediate change-over gear is a new type, it being of an epicyclic character. By this arrangement a rotation of the lever about the centre of wheel 1, does not transmit rotation to wheel 3, when wheels 1 and 3 are of the same diameter. So, in the act of changing from registering on the one dial, to registering on the other dial, no rotary motion is given to the dials, for wheel 3 enters and leaves gearing with wheels behind the lower or upper unit dials with no rotational movement whatever.

It is self-evident that even a slight rotation transmitted to the dials due to the act of changing becomes very serious, for the wheels affected are usually on the unit spindle, and one revolution of these equals 10 units. The change-over occurs once each way per day, and it must be borne in mind that an indifferent contact in automatic time switch may possibly cause the armature of operating electro magnet to "tremble," thereby causing incorrect dial readings. The electro magnet consists of two coils of fine copper wire wound on cores. These coils are placed in series with a fine wire resistance and form a shunt circuit. The current passing through the shunt circuit when energised is about one-sixtieth of an ampere. The armature is spring supported, and thereby a very certain action is obtained. A projection at bottom of armature engages with a slot in arm of change-over gear. The pointer operated by this lever indicates which of the two dials is in operation at any time. A time switch is required of a type which

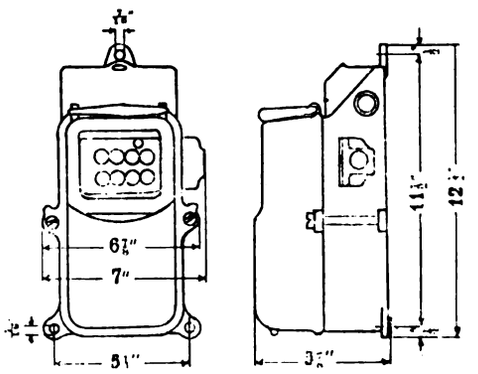

FIG. 3. DIAGRAM NO 4. 3 TO 150 AMPERE METER.

makes circuit for the whole of the high-rate period and opens circuit for the whole of the low-rate period. Where a hand-wound time switch is employed, it should run for about 40 days with one winding. It should be mentioned that one time switch can operate simultaneously a number of two-rate meters.

In operation, a shunt circuit consisting of the electro-magnet resistance and the automatic time switch all in series, and taking about one-sixtieth of an ampere, provides the energy to operate the change-over from low rate to high rate. The automatic time switch 'makes" the shunt circuit at the beginning of the high-rate period, this energising the electro-magnet attracts the armature and brings wheel 3 out of gear with the wheel of lower unit and into gear with wheel of upper unit. The shunt circuit is "made" during the whole of the high-rate period, and the meter registration is on the higher dials for this period. At the end of the high-rate period the automatic time switch "breaks" the shunt circuit, and allows the armature to fall away and bring wheel 3 out of gear with the upper unit wheel and into gear with the lower unit wheel. The shunt circuit is "broken" during the whole of the low-rate period, and the meter registration is on the lower dials for this period.

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Electrical Progress at Home & Abroad.

A Review by our Special Correspondents.

TYNESIDE.

NEWCASTLE-ON-TYNE.

There is a probability that a wireless telegraph station may shortly be established on the north-east coast in conjunction with the Post Office organisation. As readers of THE ELECTRICAL ENGINEER know, a Poulsen station has for some time been located at Cullercoats, but during the past week Commander Loring, the Inspector of Wireless Telegraphy attached to the General Post Office, attended a meeting at the Guildhall, Newcastle-on-Tyne, at which representatives from local bodies such as the North of England Steamship Owners' Association, the Tyne Shipbuilding Association, etc., were present. After explaining that the Post Office authorities had acquired the shore wireless stations of the Marconi Co., Commander Loring stated that in view of the necessity of giving shipping, commercial and travelling interests, proper facilities and organisation in wireless telegraphy, and that there was a certain demand for a wireless station on the north-east coast, the Postmaster-General would probably be able, under certain guarantees, to advise the equipment of such a telegraph station. These guarantees were financial, as the Post Office could not bear loss in the matter, and such guarantees should be against any loss by the Post Office for a period of ten years. The Post Office did not desire to make a profit on such a venture, but to ensure against loss. The representatives present discussed the question and are putting it before their various associations.

The Institution of Electrical Engineers.

The annual general meeting of the Institution of Electrical Engineers, Newcastle Local Section, was held on Monday, closing the present session, when Mr. C. Faraday Proctor, of Messrs. Edison, Swan, Ltd., was elected chairman, and Mr. C. S. Vesey-Brown, of Milburn House, the vice-chairman. The new members of the committee are: Mr. J. M. Robb, M.I.E.E., Mr. C. Vernier (of the Newcastle-upon-Tyne Electric Supply Co., Ltd.), Mr. H. J. Fisher, who is also the local secretary of the Institution of Mining Electrical Engineers, and Mr. W. W. Wood, whose recent paper on mining work, read both here and in London, has attracted so much attention. The Hon. Secretary is now Mr. H. W. Clothier, of Messrs. A. Reyrolle & Co., Ltd., while Mr. W. A. Clatworthy, of Messrs. J. H. Holmes & Co., Ltd., is the Hon. Treasurer. After the meeting Mr Clothier gave an informal discussion of switch-gear design and constructions, which was copiously illustrated by lantern slides of interesting apparatus.

Electric Traction.

One or two interesting developments in electric traction in this area claim attention. One of these is the beneficial results which have attended the adoption of car meters on the system of the South Shields Corporation. A remarkable profit of over £1,650 has been made during the past year in the undertaking, an increase of over £1,226 on last year's profits. The percentage of gross profits to capital expenditure is 6·33, the average revenue per car mile being 8·67d. The current expenditure per car mile before car meters were used was 1·36, while since their installation the figures for two succeeding months have been 1·196 and 1·188. It also appears from Mr. L. E. Harvey's annual report that the use of such meters also enables him to locate feeder losses. In Sunderland, in spite of bad trade, tramway matters also appear satisfactory. During the past year nearly £3,600 profit has been made, which is put to the reserve and renewals fund. Two new experiments are being tried on the traction systems in the Newcastle area. One is virtually the adoption of a half-penny-per-mile through rate from Newcastle city to Tynemouth, as the authorities concerned have fixed a return fare of 9d. for this distance for through traffic. This may be taken as the latest phase of the struggle going on in various parts of the country between electric tram service and local railway service. The other experiment is the adoption of terminal half-penny fares on the routes of the Newcastle Corporation Tramways, these fares being only applicable on cars travelling towards the outer termini. The object of this is to pick up a short-distance load at the ends of the car runs, and thus improve the total load-factor per car.

Local Engineering Developments.

Two or three local engineering developments of interest may be noted. One is the floating of the Whitley Bay Pier Co., Ltd. If the public responds to the appeal for capital now being made, a pier having a length of 850 ft., 40 ft. wide on the promenade and 120 ft. maximum width, will be placed on the sea front of Whitley Bay, and will have a pavilion for theatrical work, concerts, etc., which, with the pier itself will be lavishly lighted. It is reported that the Consett Iron Co., Ltd., are arranging important works extensions in which electricity will be used, and there is also a rumour that Messrs. Merz & McLellan, the prominent electrical consultants of this city and London, have been appointed consulting electrical engineers to the Salt Union.

THE MIDLANDS.

BIRMINGHAM.

Electric supply occupies a prominent place in the Provisional Order just issued by the Local Government Board for the Greater Birmingham Scheme. This scheme, which embodies practically all that the Birmingham Corporation proposed, will, if carried through Parliament in its entirety (as is generally believed will be the case), extend the boundary of the existing city so as to include in addition to that area the borough of Aston Manor, the Erdington district, the Handsworth district, a large portion of King's Norton and Northfield, and the whole of the large district of Yardley. At the inquiry, held at the beginning of the year, a great point was made of the neglect of certain outside districts to deal with the matter of electric supply. In the case of Yardley, it was stated that the authorities had repeatedly postponed the putting into effect of its powers in the matter and was in danger of having its orders lapse. With regard to the King's Norton authority some remarkable correspondence was put in showing that firms in that district had applied for power and had jointly guaranteed a minimum demand of 4,000,000 units. Failing a response from the King's Norton District Council these firms had approached the Birmingham Corporation Supply Department, and the latter had offered to supply these firms provisionally, say, for a term of ten years, and to hand over the whole business to the District Council as soon as that body should be in a position to deal with it. To this offer Birmingham had received no reply beyond the formal acknowledgment of the letter. With regard to Yardley it was stated that the Corporation had been approached by firms who were willing to guarantee a consumption of 1,500,000 units a year.

Electrical Provisions.

The Provisional Order lays it down that the electricity undertakings of the Aston Manor Corporation (which includes Erdington in its electric supply), and of the Handsworth Council are to be amalgamated with that of Birmingham. In accordance with an understanding arrived at at the inquiry, the prices to be charged in Aston and Erdington are not to exceed those charged on March 31, 1910. The most significant provision, however, is one that the Corporation shall, within a period of two years from the commencement of the Order, lay down suitable and sufficient distributing mains for the purposes of a general supply of electricity throughout every street or part of a street within the area of the King's Norton and Northfield districts, and within the area of the Yardley district.

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The tramway undertakings in the added districts are also to be amalgamated with the Birmingham Municipal tramways.

Extension of Plant will be Necessary.

The requirements of the extended city will render necessary a considerable extension of the Birmingham generating plant beyond even that approved by the City Council last week. Mr. Chattock at the inquiry suggested that provision must be made with a view to an ultimate capacity of 100,000 kw. The Electric Supply Committee of the city, it is well-known, have in view the erection of another large station, and the site suggested is part of the land of the Birmingham Tame and Rea Drainage Board. Negotiations have been going on for some time with regard to this and other sites, but it is not likely that any final decision will be arrived at till the passage of the Greater Birmingham Scheme through Parliament has been assured.

Standardisation of Fuses.

The discussion at the meeting of the Birmingham Local Section of the Institution of Electrical Engineers showed that the subject of Mr. Kefford's paper, "The Standardisation of Fuses," was one in which general interest was felt. The prevailing feeling, however, seemed to be one of doubt whether the time had arrived for laying down absolute standards. Mr. J. F. Crowley agreed that something ought to be done soon to put the matter on a definite basis so that they should no longer have such a thing as fuses of the wrong type being put in circuit, as was too often the case where incompetent persons were in charge. Often fuses were inserted in such a way as to make them a part of the circuit, so that what was nominally a protective device became really a source of danger. Fuses certainly ought to be non-interchangeable. He thought the lecturer's time of four hours for the fuse to blow with a minimum limiting current was scarcely sufficient for practical purposes. Many of the fuses in the market were subject to oxidation, and he had known fuses which actually went six hours. The whole matter of fuses was in a chaotic condition. One of the difficulties in the way of standardisation was the fact that cut-outs were now so largely employed. In fact, a cut-out for rapid or large currents was the proper thing, though for small currents they ought to have fuses.

Asbestos-Covered Wires.

The use of asbestos-covered wire was referred to by Mr. Lindsay Foster as having done away in certain cases with the difficulties illustrated in Mr. Kefford's paper. While he agreed that standardisation would be of great value, he thought the day had scarcely arrived for it. The liability of precise specifications to handicap the development of electrical industry was dwelt upon by Dr. Kloss. In many departments it was customary to repeat old directions and so handicap the engineer. Requirements should be specified and not means. The paper was described by Mr. A. E. Gott as probably the most practical one they had had. If it did not add much to the scientific value of fuse design it certainly put them on the right track for a solution of the question of the perfect fuse. Mr. Gott did not agree with Mr. Kefford's statement that fuse election was often decided on considerations of ornamentation. He believed there were reasons for every variation found in practice. Many of these were sound reasons, though no doubt others were bad. He thought the author expected too much of fuses, but he agreed that there was no difficulty in manufacturers working to narrower limits in the way of accuracy and uniformity. The real difficulty that the small values of the proportion of its rated current which a fuse should carry for at least four hours without fusing (denominated in the paper, $a - a$) suggested by the author were impracticable and rendered supply internally unreliable.

Difficulties.

In illustration of this statement, Mr. Gott mentioned a brisk correspondence he had with the supply company with regard to a 15-gauge wire which was continually melting. The supply company assumed the load diagram of the motor to be flat. Actually it has peaks in it sufficient to melt the fuse although the mean load did not overheat the motor. A fourteen S.W.G. was eventually substituted and the trouble ended. In another case a supply company laid on power mains to a large newspaper office. The main fuse margin was totally inadequate, with the result that on the first occasion on which the proprietors printed the entire edition by electric power, the supply company's man had to mop the fuses and terminals with waste and water for several hours until the edition could be run off. No fuse, said Mr. Gott, should be expected to save plants from overload, which if continued would injure them. The proper function of a fuse was to save plant, wiring and appliances under very abnormal conditions, and if a fuse performed this function even at the cost of its own destruction it had carried out its purpose. Where small values of $a - a$ were required the obvious method was to use a circuit breaker which could be set for any desired overload or time limit. Short fuses under certain circuit conditions of induction failed to cut off the current and many a switchboard panel was ruined by their use. For this and other reasons, supply authorities have insisted on definite lengths for certain currents and voltages and the power dissipation loss over such fuses was the price of real safety to other apparatus. The economic fuse of the future would probably be a fraction of an inch in length, but with mechanical means for increasing the gap at the moment of fusion.

Rushes of Current.

The possibility of rushes of current, where a fuse was in a circuit connected up to powerful bus-bars, was referred to by Mr. A. M. Taylor, who expressed the opinion that in such a case the power liberated was probably far beyond anything of which they had any record. The chairman, in summing up the discussion, said that the danger of allowing authorities to make regulations was that they usually made them as inconvenient as possible. They had an example of that in the case of motor cars. Fuses might be cut too fine. For instance, in a South African tramway station he found a lot of automatics all tied up, while in a Continental hotel the lights were continually going out, with the result that all the fuses were tied up with two-franc pieces.

New Wiring Rules and Mine Practice.

Mr. Kefford gave a demonstration. The first experiments were to illustrate the new wiring rules. These rules allow a larger overload for fuses, namely, 300% instead of 200%, the reason being that metal filament lamps have a large current rush and a larger temperature co-efficient. Therefore, it was said that to sustain the rush of switching on, the fuses should carry a 300% overload. That to his mind, was ridiculous, because the time of the rush was so exceedingly small that a fuse of even the smallest time length was not affected. He had there a bank of 20 lamps. When all were switched on, the fuse would blow. If he put a few on and switched them on and off rapidly the fuse did not blow. By putting on more lamps it would be seen that while the fuse stood the switching on and off, he had only to put on one or two more lamps and the fuse would blow with a steady current. It was evident that the rush in its effect was not equal to those two lamps. Therefore, he saw no object in increasing the overload to 300%. The second experiment, the lecturer said, bore on the use of fuses in explosive atmospheres, as in coal mines. It was essential in a coal mine that they should get an apparatus as little likely as possible to initiate an explosion. He had there a small gasometer filled with a mixture of coal gas and air at the critical explosion point. Inside were two fuses, through which he would pass the current and each of them would blow. The lecturer then passed the current through a "Zed" cartridge fuse and though the fall of the ammeter showed that the fuse had blown, there was no explosion. He then tried the experiment with a common type of bar fuse and the gas exploded, lifting the gasometer from the tank and scattering the water over the spectators.

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LANCASHIRE.

MANCHESTER.

Judging from the reports of local manufacturers there is no doubt that a really substantial improvement is taking place in the electrical trade. There is an increasing demand for all kinds of material, and there is promise that the demand will continue to increase for some time. It is to be hoped that with the revival in trade generally, strenuous efforts will be made to push forward the application of electricity to every class of work, and to increase the domestic use of electricity for heating, cooking, and light motor work. The more widespread the use of electricity becomes, the less the effect of bad trade on the electrical industry will be, for there will then always be a fairly constant amount of supplies required for renewals and repairs, quite apart from the amount needed for new work, which must depend on the prosperity or otherwise of business in general. To be successful it is always necessary to organise to meet possible reverses, not simply to cope with the tide of orders that pour in in prosperous days.

A Suggestion for Bad Trade.

There is no doubt that the work resulting out of the supply of current for household purposes is the least likely to be effected by bad trade, provided, of course, the cost of energy is reasonable compared with other means. Such a steady constant basis of business could in time be made to at least cover the general expenses of running the works, so relieving the manufacturing firms of a most worrying item and enabling them to handle such additional work as they may be lucky enough to get, at something nearer to a profit, than is now usually made in bad times. Thus something like a minimum amount of work would be assured; and a certain minimum is a much more satisfactory thing to deal with in a works than an uncertain maximum. It all depends on forcing supply authorities to seriously work with the turn of trade for the development of the domestic load. It would be well worth the while of manufacturers and contractors to help the stations in this matter, since it would be to their own ultimate benefit equally as much as to the supply authority's.

Publicity.

Sound commercial publicity is required—a thing there is very little of anywhere in the electrical ranks. The sticking up of expensive fine colour posters is of no use at all unless it is helped by a very vigorous canvass. Without this it is not likely to give anything like a satisfactory return, even of its own outlay. The enclosing with the quarter's lighting bill of neat little booklets showing how to use more current seems to be deliberately choosing the most inopportune moment possible for extending the supply; getting the meter readers to leave them round would be a much more effective way, and would pave the way for the canvasser—who alone can be relied on to bring returns with certainty—to get the order before the account is sent in. Municipal ownership and the control of the so-called electricity committees over the undertakings are the two great curses of the electrical business in this country. The best men are elected on the Gas Committee, and the incompetents are distributed. The result is that in most cases whatever development takes place in the supply, takes place in spite of their "control" (hindrance) and not through any help. It cannot be denied that to have the engineer responsible to the whole council as a body, and only as a body, would be a much better arrangement than the present one of electing a little set of fussy old tradesmen to continually hamper and hinder him in the carrying out of matters on which they are wholly ignorant. While the supply is in such hands it is hopeless to expect anything like the developments which might be expected and ought to be taking place. Under the circumstances, the simplest way seems to be for the contractors and manufacturers to join in educating the public, and leave the stations out of it; making them pay higher prices for machines to cope with the resulting increased loads—if this can be done.

How Cotton Fares.

The vote of the Masters' Federation shows about 92% in favour of the 5% reduction in the wages of cotton operatives, but in view of the approach of the new crop it has been decided to postpone the reduction for further consideration in 3 months' time. Thus a very serious strike has been avoided. It is interesting to note that the Bleachers' Association have this year made larger profits than ever before, although it is the worst cotton year of any. The reasons given are the advantages of co-operation among the works (for this company is an association of many works) and the good return which money invested in bringing the works up to date, has given in the way of cheaper production. The Fine Spinners Association have also had a record year and have paid their usual 8%, but also carried to reserve a sum which would have paid another 9½%. In this case the result is attributed mainly to good buying. It must be noted that several of this Association's mills are entirely driven electrically, while it is practically a settled policy with them to replace the old engines by motors, current being taken from the mains or from a plant in the mills. The report, therefore, is gratifying to electrical engineers as an eloquent testimony to the value of their drive.

SCOTLAND.

GLASGOW.

The preparations for the Glasgow Convention of the Incorporated Municipal Electrical Association are now practically completed. The indications so far are that the attendance of members and visitors will be large, judging from the bookings at the various hotels. The *Windsor Hotel*, which will be the headquarters of the Convention, was fully booked up early in the day. It would seem that no stone is being left unturned at the Glasgow end to make the various items of the programme quite up to the high standard of these annual gatherings. It is well known that even in progressive Glasgow the electricity and tramways are the most energetic and up-to-date departments of a corporation which has never allowed the grass to grow under its feet in any of the many branches of its manifold activities.

Tungsten Filament Lamps for Street Lighting.

The experiment in street lighting with tungsten filament lamps, tried by the Watching and Lighting Department of the Glasgow Corporation, is likely to prove so successful as to warrant early extensions of this form of street lighting. The scene of the experiment is Queen-street, which is some 350 yards long. Thirteen lanterns have been fitted with 100 c.p. lamps, and 11 lanterns with two 50 c.p. lamps each. The inclusive annual charge made by the Electricity Department for each of these lanterns is 40/4 for the 100 c.p. lamp, and 55/9 for two 50 c.p. lamps. It is understood that the difference in price between gas and electricity for this form of lighting is a matter of coppers only.

Lowering Gear.

As the magazine flame arc lamp grows in popularity for street lighting, the question of easy and economical trimming becomes more clamant. So it is not surprising to find that experiments are proceeding in various directions with collapsible ladders and lowering gear. The Glasgow Corporation Electricity Department have recently installed six sets of lowering gear in George-square, the makers being the North-Western Appliances Co., of Cathcart. This has resulted, so far, in very considerable saving. The lamps were formerly trimmed with the aid of a tower ladder, requiring two men to handle it, and entailing considerable loss of time taking it from one point to another. With the lowering gear the lamps can be trimmed with one man in one fifth of the time formerly taken by two men. The flame arc is more difficult to trim than the ordinary arc, owing to the greater complexity of its mechanism, and when it is brought to the ground level it can be more conveniently handled than at the top of a ladder.

Collapsible Ladder.

Although lowering gear has obvious advantages over any form of ladder, there are certain cases where the lowering gear is not suitable, as, for instance, with centre posts in a busy thoroughfare. A Glasgow man has recently devised a collapsible ladder, and this is being tried on an arc lamp-post in Mitchell-street, Glasgow. The rungs of the ladder are hinged direct on to the post on the one side, and hinged to a U-shaped beam on the other. The ladder collapses in

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an upward longitudinal direction. It is, of course, an improvement on the older cumbersome forms of portable ladder, but in its down position it projects on to the roadway, and in a busy thoroughfare might be carried away by passing traffic when the man was at the top of it. It still also fails to obviate the need for a second man, as it does not provide anything in the way of facilities for the trimmer having his tools handy, nor does it enable the trimmer to handle the mechanism of the lamp with the same ease as is the case with lowering gear. For centre posts and places where the lowering gear is too complex and otherwise unsuitable, the ladder will no doubt be still further improved, and prove very useful.

New Generating Station for Glasgow.

The site which the Glasgow Corporation acquired the other day for a new generating station is as near as may be an ideal site for such a purpose. It abuts on the river Clyde, thus furnishing an abundant and continuous supply of water for condensing purposes; it is in close proximity to a railway siding which ensures a cheap and easy supply of coal; it is within a few yards of the existing network, and will therefore be easily joined up; and it was purchased at a remarkably low price, viz., 8s. a square yard. There will be nothing further done, however, as regards getting out schedules and specifications for buildings and plant for the new station for a year at least.

Glasgow Local Section of the Institution.

At the last meeting of the Glasgow Local Section of the Institution of Electrical Engineers, instead of the usual lengthy paper, two short papers were read. This plan has much to recommend it. Once in a while, at least, what is wanted at such meetings is not so much some members to give an exhaustive account of any particular subject with diagrams and formulæ resulting from elaborate investigation and experiment, but a crisp, interesting statement of the facts with regard to some technical subject of contemporary or local interest, with a view to starting or introducing a discussion. This would not only give the whole of the members an opportunity to join in the discussions, but it would encourage the younger members to send in short papers which might very well take the form of stating difficulties encountered in connection with any given matter instead of seeking to elucidate it. By the way, the members of the Local Section are to join in with the Iron and Steel Institute in a sail down the Clyde on June 9, when it is anticipated that over 200 will be present. This trip was so successful last year that it is likely to become an annual thing.

GERMANY.

BERLIN.

The Vienna Ministry of Public Works has put 20 milligrammes of radium-barium-chloride at the disposal of the Deutsches Museum for demonstrations. This amount of the salt is worth about £250. It has never been given out before by the Austrian Government except for scientific purposes to Mme. Curie & Prof. Ramsay, and then only on loan.

Aluminium Cells as Safety Conductors.

The A.E.G. has devised a new form of aluminium cell to prevent loss of current from a system due to discharge of over voltages by a horn lightning conductor. It acts as an inductionless resistance. The aluminium is piled in the cell in the form of concave plates, and kept in position and at a little distance apart by means of vertical insulating tubes. The cell stands on a cost iron support mounted on insulating legs, which serves as a conducting medium between the forming switch and the earth. The stand and the aluminium plates are suspended from the cast iron cover of the cell.

Alternating Motors in the Coal Industry.

Kleesath has written an interesting article on this subject in *Braunkohle*. He calls attention to the fact that many of the machines used in this industry require careful regulation in speed. This fact is very unfavourable for rotary current motors because the change of speed requires the use of resistances which entails much loss of power. The single-phase collector-motor, with Deri shunt, built by Brown, Boveri & Co., avoids the difficulty completely. Its action depends on the repulsion principle, and merely substitutes movable for fixed brushes. If the movable brushes are moved from the null position, the motor runs one way or the other according to the direction in which the brushes are moved. Hence a strong torque is obtained with a comparatively small starting current.

Multiphase Motors.

It is well known that an asynchronous machine is either a dynamo or a motor according to whether the rotating field or the armature goes the faster. If the change is from a motor to a dynamo there is a sudden change in the useful effect. Dr. Benischke attributes this fact to the transference of the demagnetisation at the time when the machine becomes a dynamo instead of a motor. The torque caused by the remanent magnetism operates in different senses according to the change from synchronisation. It diminishes with the slip, and when the actual change takes place its value is zero.

Regulations.

In our happy country, everything has to be done by police regulation, and we have recently been favoured with several yards of red tape in the form of stringent rules governing telegraphy, telephony, and all other sorts of tele, except telepathy. These rules must be the result of profound cogitation, and quite a long article in the *Zeitschrift fur Schwachstromteknik*, numbered 8, being the second issue for April, 1910, is devoted to them.

Electric Pumping.

The water supply of Groz, formerly worked by steam driven pumps, is now obtained by electric motors made by the Siemens Schuckert Werke. The current is brought from a distance of about 12 miles from the power station at Peggau, which is able to supply 8,000 h.p. A rotary current of 42 periods and 20,000 volts in the overhead wires is converted at the outskirts of the city into a 5,000 volt current, which supplies the pumps by means of an underground cable. The economy thus attained is considerable, and the action of the centrifugal pumps admits of better regulation than when they were driven by steam engines.

Steam Turbines for Driving Dynamos.

The A.E.G. Zeitung has collected some extremely interesting statistics with reference to the comparative cost of turbines and ordinary steam engines, as respects coal consumption. They are the results of extensive experiments made at the electrical stations of Oberspres, Moabit and Rummelsburg. Since the year 1904–5, when steam turbines were first laid down, up to the end of the year 1908–9, the output was 164·8 million kw. hours per annum, as against 868 million per annum previously, while the coal consumption fell from 180,596 to 102,446 tons. Thus the power was increased by 89·81%, and at the same time the coal consumption was lowered by 76·28%. The heat coefficient was also increased by 13%, as 1,000 W.E. now give 141·8 watt hours as against 125·4.

Nitric Acid from the Air.

The Salpeter Säure Industrie Gesellschaft at Patsch, near Innsbruck, are working the Pauling process in which the arc is made between bent iron electrodes shaped like the wires in the horn lightning conductor. The electrodes are about an inch and a half apart, but the arc is spread out to a length of a yard or more by the electrodynamic action and by the stream of air that sweeps round them. The electrodes, although cooled only last about 200 working hours. At the Patsch works there are 24 electric furnaces, working at 4,000 volts, and operating by means of two arcs on about 10,000 cubic feet of air per hour, with an expenditure of energy equivalent to 400 kw. These furnaces are to be replaced by others using four times as much electric power. The production of nitric acid will thereby be raised from 60 to 80 grammes per kw. hour. The heat of the gases escaping from the furnaces is used partly to heat up the entering air, and partly for concentrating the solutions obtained.

Sea Wireless.

Three or four years ago we had only 16 ships fitted with wireless telegraphy at a time when America had 62 and England 26. To-day we have between 70 and 80 steamers with wireless apparatus. Shipowners are beginning to

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appreciate the enormous advantages obtained. Working with the new Telefunken system, the German mail steamer *Kleist*, belonging to the Nordeutsche Lloyd, has sent messages between the North Sea and the Mediterranean which have passed over the Alps. The Roland line steamer *Holger* has sent messages from the Pacific at Valparaiso to Buenos Ayres, a distance of 1,600 miles, the waves having to cross the Andes. The distinctness of the messages was perfect. The *Cap Blanco*, a steamer belonging to the Hamburg-Sudamerikanische Dampschifffahrtsgesellschaft has exchanged messages over 1,500 miles with the steamer *Ypiranga*, of the Hamburg America line. These results far surpass any that have been reached before by any of the older systems. They are the more remarkable when we consider that the energy used in bridging over the distances above quoted have never exceeded 3 h.p. It may fairly be claimed for Germany that we stand just now before all nations in regard to wireless telegraphy. Roughly, two-thirds of the wireless stations of the world are of German origin.

Company Notices.

The Akkumulatoren Fabrik Aktien Gesellschaft, Berlin Hagen, is paying 12½% for 1909–10, as for 1908–9, but the statistics of the trade of the respective years are somewhat curious. The gross profit fell from 6,370,000 to 5,700,000 marks, and the turnover from 19,230,000 to 17,420,000 marks, and yet the net profit increased from 1,500,000 to 1,580,000 marks.

UNITED STATES.

NEW YORK.

An unusually large number of papers of high average merit were read at the annual meeting of the American Electro-chemical Society, which has been in session at Pittsburg for four days. A very wide range of subjects was covered and much valuable information placed on record. Great interest was aroused by a paper read by Dr. C. G. Fink, of the Schenectady Research Laboratory, on ductile tungsten. He showed that though the tungsten filaments of to-day were so improved that under the most searching chemical tests no impurities could be discovered, they were, nevertheless, exceedingly brittle, and showed no traces of ductility or even of pliability. He went on to show that the result of the work at Schenectady had been the production of tungsten in a form in which it is ductile, and which, it is stated, would seem to be a new substance from the point of view of the physical chemist. The material is a bright, tough, steel-coloured metal, which can be drawn into the finest wire, much below one-thousandth of an inch. The tensile strength of the wire increases as the drawing proceeds, or, in other words, the more the metal is mechanically worked the tougher it gets. A table included in the paper gave a tensile strength varying from 490,000 lb. per sq. in. for a wire 0·005 in. in diameter, to 610,000 lb. for a diameter of 0·0012 in. The tensile strengths found for molybdenum wire varied from 260,000 lb. per sq. in. for a wire 0·005 in. in diameter, to 310,000 lb. for a wire 0·0015 in. in diameter. A piece of hard-drawn piano wire, tested with the same apparatus, registered, on the average, 507,000 lb. per sq. in., the diameter of the wire being 0·003 in. The density or specific gravity of ductile tungsten increases similarly with the amount of working, varying from a value of 18·81 before drawing to 20·19 for for a wire 0·0015 in. in diameter. The corresponding values for molybdenum are 10·02 and 10·32. A table in the paper gives the electrical resistance and the temperature co-efficient of the two metals, which were obtained by the Wheatstone bridge method, the resistance being measured at room temperature and at 170°, employing two oil thermostats. The resistivity for tungsten was found to be 6·12 for hard-drawn wire and 5 for annealed wire, the corresponding figures for molybdenum being 5·6 and 4·8. The resistivity of copper is 1·59. The temperature co-efficient of the former is between 0° and 170°, 0·0091, and of the latter, 0·0050. The co-efficient for copper is 0·0045.

The Dry Cell.

A paper on the evolution of the dry cell, which was read by Mr. D. L. Ordway, also aroused considerable interest. In this paper special attention was given to methods of testing cells, and a table of results was given showing that the short-circuit test was not a reliable index of the value of the cell or of its service capacity (in ampere-hours). Tests were made by discharging the cells through a constant resistance, the value of which was different in different tests. It was found that the greatest watt-hours of discharge were obtained on the highest resistance; that is, at a low rate of discharge. As intermittent service is usually the practical condition, comparative curves were shown for three different kinds of discharge: (*a*) continuous discharge; (*b*) discharge of five minutes per hour; (*c*) discharge of five minutes per hour for eight hours per day. In the early stages the voltage curve for (*b*) was higher than for (*a*), but the curves crossed at a later period, and the crossing occurs sooner the higher the resistance in the discharge circuit. Curve (*c*) was lower than curve (*b*), showing very plainly that with intermittent service better results are obtained by a more regular discharge than by an irregular one. The writer pointed out that in selecting a battery it is better to increase the number of cells in parallel for heavier service, but on light service it is a positive disadvantage to have too many cells in parallel. The temperature of the test is a very important feature, and results should be compared only when the temperatures are the same.

Furnace Electrodes.

An important contribution to the technical literature of Furnace Electrodes was made by Dr. Carl Hering, whose recent researches into this question have on more than one occasion recently formed a subject of comment in these Notes. The experiments described in Dr. Hering's paper consisted in imbedding a rod of the material to be tested in a heat-insulating material, allowing the two ends to project sufficiently for terminals. A steady current is then passed through it which will heat it; it becomes hottest midway between the ends. The temperatures at the middle and at the ends, the voltage at the two ends, and the current, are then measured. From these data all the necessary physical constants are calculated. The mean resistance is the quotient of the volts and the amperes; from this and the size of the rod, the mean resistivity is calculated. The product of the volts and amperes gives the heat flow in watts, which flows out at the two ends, and from this and the dimensions the heat conductivity is calculated. The rod is equivalent to two electrodes butting together at their hot ends, the interior of the furnace itself being omitted; hence the entire flow of heat is that due to the resistance of the electrodes, which is the condition under which a well-proportioned electrode should operate. The rod is assumed to be perfectly heat-insulated; this is nearly accomplished by surrounding it with a cage of similar rods, through each of which the same current passes. A stable state of temperature is, of course, essential, and the calculated constants are the correct mean values under electrode conditions; these mean values represent those which an equivalent electrode would have whose conductivities are the same from end to end. The high temperatures were measured with a platinum-platinum-rhodium thermo-couple made especially for this test with long wires, the electromotive forces being measured with a potentiometer, thereby avoiding the error due to a current. The use of a potentiometer with this thermo-couple also enabled widely different temperatures and small changes in them to be measured with very great accuracy. Dr. Hering said it had been already shown that neither thermal nor electrical conductivity alone is a true measure of the good or bad qualities of electrode materials, but that the product and the quotient of these two quantities are the important values. The loss of power is determined by the quotient of these, that is, by the product of thermal conductivity k and electrical resistivity r; while the proportions of the electrode are determined by the value of the quotient r/k. Even these quantities may, in the author's method, be displaced in practice by two others depending upon them, thus simplifying the calculations. One of these quantities is the drop of potential in volts between the two ends of an electrode operating normally under the specified conditions, or $E = \sqrt{2krT}$, where T is the drop in temperature between the two ends of the electrode. The other quantity is the section per ampere per inch length, represented by $S^1 = \sqrt{r/2kT}$. The total cross-section is therefore $S = S^1 IL$.

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The Electric Furnace.

In the course of an editorial on electricity in the steel industry, the *Western Electrician* observes that more than 30 years have passed since Siemens patented his electric furnace for melting iron and steel, and for 10 years Héroult has been using the electric method of producing special ferro-alloys. It was but a step from this to the production of alloy-steels and high-grade carbon-steels in the electric furnace, and the smelting of iron ore has also been successfully accomplished, and can be operated to advantage under certain conditions of power cost, etc. "The electric-furnace method of making high-grade steel," proceeds the writer, "seems destined to drive the expensive crucible process out of the field. Several of these furnaces have been in operation in the United States long enough to demonstrate not only their practicability in operation, but their complete commercial success. At last the Pittsburg field, with its cheap fuel, has also been invaded, and a Héroult furnace has been operated by the Firth-Sterling Company with entire satisfaction. The cost of this process is but little greater than the open-hearth method, but a grade of steel can be produced equal to the best crucible-steel. In using an arc furnace, any impurities can be burnt out, although with the other forms of furnace, the quality of the product will depend largely upon the quality of the raw material. It is easy, however, to produce alloy-steels of any desired composition, and it is hard to see how the crucible process is to hold its own against the new competitor. In a few years we may well expect to see around Pittsburg, not one but a host of electric furnaces, and in sizes larger than have yet been attempted."

A Problem for Electricians.

Mr. Robert C. Finch, president of the Colonial Illuminating Company of New York, announces in a page advertisement in the technical press, and in terms which suggest something of cometary influences, that he has succeeded "in Perfecting a Line of Invention (not Tungsten Lamps—not Storage Batteries) that will Increase the Net Earning Power of Electric Light Plants at Least Fifty Per Cent., and, in most cases, One Hundred to Two Hundred Per Cent. Annually. (Unless you are in a Position to Successfully contradict this statement, do not do it—it has Taken Eight Years to Develop—Cost Exceeds $20,000.00.) I invite the highest authority—all lines Electrical to-day, to make all experiments possible—Mechanical, Technical, Chemical. If this invention, controlled by one corporation, perhaps Two, with their great Earning Power (well known), ten years from to-day the United States Steel Company could be considered an Infant Industry, if Commercialized and Products Sold At One Hundred Per Cent. Net Profit Over Manufacturers' Cost. United States Rights (Local) Will be Given to all Electric Light Plants. Machinery delivered at actual Cost. No profit to us except on the basis Net Earning Power. Settlements annually or semi-annually. Royalty or Contract. No Stock or Bond Sales. Nothing but a strictly clean, legitimate business proposition. Will say that this invention Will Not be Commercialized in any manner. This invention not for sale until such time as we have Proved Absolute Commercial Worth to One Thousand Electric Light Plants (Municipal and Private) in the United States. All that the inventor is seeking to-day is the Honour, holding the personal right to Anticipate, but not to Equal—What Mr. Edison and Dr. Isadore Kitsee is to Electricity, Mr. Carnegie to Steel, Mr. Rockefeller to Oil, Mr. Morgan to Finance, Mr. Clark and Mr. Lawson to Copper, Mr. T. P. Shonts to Railroads and Subways, Mr. Paul Morton to Life Insurance, United States and Abroad, Inventor will be entitled to, at least, the Honour of Shedding Light on One of the Best Electrical Opportunities, plus more light in reading the Bible, by those that Need to Most (Hypocrites Excepted). One Month From To-Day Every Newspaper in the United States will possibly 'Head Line' this invention. (My name will not be mentioned if I can prevent.) Every Man, Woman and Child in the United States will be Benefited Directly by this Invention. It is made by Electricity, Air and Water, purified by Electricity. Two to Four Hours 'Off Peak Load Daily' Electric Light Plants all that is necessary. $2,000 to $10,000 is the actual Cost of additional equipment. Your Electric Plant Can be Made the Attraction of Your City. Consumers Happy." Here is evidently something which the world has long been waiting for.

A Colossal Power System.

Mr. Paul M. Downing read at the recent meeting at San Francisco of the American Institute of Electrical Engineers a highly interesting paper on the great power system of the Pacific Gas and Electric Company. The full text of the paper is printed in the current issue of the San Francisco *Journal of Electricity*, which electricians would do well to secure and file for reference. In an editorial on this paper the *Journal* compares the four-horse chariot of the Roman, the ancient acme of power control, with the 200,000 and more horse-power controlled by the load-despatcher described by Mr. Downing, and observes "That one man should have such tremendous energy under his dominion surpasses the most extravagant conceptions of the Arabian Nights. Yet we have become so gradually accustomed to such wonders that it ceases to arouse more than passing comment." The various power houses of the Pacific Gas & Electric Company generate over 100,000 h.p., and connected to their transmission lines are other power companies, the Great Western, the Sierra and San Francisco, the Northern California and the Snow Mountain, with an aggregate installed capacity nearly as great. Most of this power is water-generated, steam and gas engines furnishing an auxiliary reserve. The transmission lines tied together in these systems are nearly 2,000 miles in length, the mileage of this combination network of high tension wires being greater than that of any other system in the world. The 350-mile stretch from the Kilare station of the Northern California Power Company in Shasta County to San Francisco is also the longest continuous transmission system in the world. As all of the generators in all these power houses are paralleled, or run in synchronism, the details of their control become of absorbing interest. The heart of the system, to which all these arteries lead, is the office of the load dispatcher, who has even more responsibility than the chief dispatcher of a railroad. His telephonic approval governs every operation on the system, and it is he that apportions the load to each power house and regulates the voltage. In case of accident or any interruption to service he must at once make such adjustments as will insure continuous power and light to the consumer. Every generating plant, transmission line and sub-station is shown in miniature on a board in this office, together with dummy switches which are set open or closed, as may be the condition of the real switches they represent. Experience has shown that the great size of the system facilitates voltage regulation, just as it is easier to maintain a given water level in a large lake than in a small pond. The inductance and resistance of the lines act as a cushion in case of line troubles, so that a local disturbance but slightly affects the rest of the system. Practically the entire regulation is left to one power house, having great enough capacity to handle all the load fluctuations. The large wattless current due to the inductive drop seems to be best handled by one station, preferably a steam turbine installation, which is also available as a reserve. Simple and obvious as these facts may appear on paper, they represent the patient solution of many vexed problems, requiring years in their unravelling, and representing hard work for the pioneers in this great development.

Current Items.

The triple moving platform railway recently described in this column will soon be an accomplished fact, the Mayor of New York having signed the bill giving authority to the Public Service Commission to authorise the installation, and the Continuous Securities Transit Company is ready to instal the platform as soon as the Commission asks for bids for construction and operation. It is to be built under Thirty-fourth-street, and if successful, another will be built under Broadway from Tenth to Forty-second-streets.

Dr. Frederick H. Millener, experimental engineer of the Union Pacific Railroad, has received orders to begin immediately the installation of a wireless telegraph system on the Union Pacific Railroad. A station has been already equipped at Omaha, capable of communicating with smaller ones along the entire line.

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Business Notes and News.

LIGHTING AND GENERAL—Home.

BARROW-IN-FURNESS.—The accounts of the Corporation Electricity Works for the past year are excellent. The total revenue has increased from £12,902 to £13,265, while the cost has been reduced from £6,286 to £5,882. The net surplus, after paying £3,196 interest and £3,937 sinking fund, amounts to £249.

BELFAST.—The surplus on the past year's trading of the Corporation Electricity Works is £11,040, after paying interest on capital and sinking fund, comparing with £8,282 in 1908-1909, and this in spite of a reduction of 8½% on the charge to the Tramways Department, a reduction amounting to £1,522.

BOLTON.—Mr. A. A. Day's annual report of the Borough Electricity Department shows that the total revenue was £60,527, the expenditure £26,749. The gross profit was £34,941 and the net £8,119, of which £6,000 has been paid in aid of rates.

DUNDEE.—In the Electricity Department the revenue for current sold was £39,901, as against £36,974 17s. 3d. for the previous year. The tramways, which consumed 2,402,282 units at 1¼d., produced £11,260 14s. 1d., and private lighting, 1,148,251 units at 3½d., produced £16,745 6s. 6d. The expenditure side of the revenue account shows a total of £21,478 11s. 5d., leaving a balance to be carried to net revenue of £18,429 8s. 11d., as against £12,046 19s. 7d. last year. After meeting interest, expenses of loans, sinking fund, and depreciation and claim account the balance carried to next year is £1,259 17s. 9d., as against £1,256 6s. 10d. In the expenditure the generation of energy absorbed £11,510 8s. 7d., distribution £2,975 10s. 6d., rates and taxes £5,128 9s. 11d., and administration £1,864 2s. 5d.

GRIMSBY.—The ninth annual report of the Corporation Electricity Department is very satisfactory, showing a profit of £3,867. For the first three years there was a loss, but the private lamps connected nine years ago were 13,061; now they are 84,705.

HEBDEN BRIDGE.—The Electricity Department have been requested to supply electricity for power purposes during the work of construction at Heptonstall new burial ground. Permission is being sought from the Todmorden Rural Council to carry a temporary cable across their district for this purpose.

HECKMONDWIKE.—A new condenser is being installed, at a cost of £3,000. It is expected that this will lead to further savings, and so increase profits, which are already assisting materially in keeping down the general rates.

PRESSALL, LANCS.—There has been a suggestion that a Provisional Order under the Electric Lighting Acts should be applied for, but on the motion of Mr. F. Swarbrick, of Leigh, it was decided to postpone this and to take into consideration a proposal to be put forward by an unauthorised electric light undertaking.

SOUTH SHIELDS.—The old staithes at Bullock Spouts, West Holborn, are to be reconstructed by the Harton Coal Co.; an endless electrical conveying belt is to be erected for loading the coal.

SUNDERLAND.—It is proposed to convert 266 gas lamps along the line of the electric mains for electric lighting. The Borough Electrical Engineer estimates the cost of conversion at £465.

SUNDERLAND.—The Corporation Electrical undertaking's annual return shows that there was, during the year ending March, a net loss of £112, the revenue being £49,361, of which £28,351 was gross profit, from which had to be paid £12,524 for interest, £15,518 to the sinking fund, and £421 for renewals and special expenditure. The net losses on the undertaking since it was inaugurated in 1895, now amount to £9,006, but against that are net gains amounting to £6,803. The cost of production has been reduced from 1·82d. to 1·53d.

WHITCHURCH.—The Streets Committee have been instructed to consider reports sent in by an electrical consulting engineer on the proposed adoption of electricity. The report is based on the hypothesis that the loans would be repaid in 15 years out of profits. The Streets Committee are to report to the Council in July.

LIGHTING AND GENERAL—Overseas.

BARCELONA.—The General Directorate of Public Works in Madrid, granting to the Compañia General de Tranvias de Barcelona a concession for the construction and working of an electric tramway from Sans to Coll-Blanch (Barcelona).

MIDDELBURG, HOLLAND.—The communal authorities of Middelburg have voted a credit of 1,250 gulden (£104) for the purpose of considering the question as to the practicability of erecting a central electric generating station for the requirements of the town.

OLAVARRIA, ARGENTINE.—A company with a capital of two hundred thousand dollars has been formed to take over a concession granted to Mr. A. Brumana for an electric light station.

POTCHEFSTROOM.—The Municipality propose laying down an electric lighting station of their own and efforts are being made to induce the authorities to take over the existing company, which was started rather as a public benefit than as a means of making profits.

PRETORIA.—The Electric Power Bill has been reported and read a third time in the Transvaal Legislative Council. During the discussion it was pointed out that the total Debentures in the Victoria Falls Co. amounted to £3,000,000, and that there were £1,250,000 for assets, which were more or less intangible.

TRACTION—Home.

BOLTON.—The revenue of the Borough tramways for the year ending March 3, was £122,528 and the operating cost £72,436. Out of the surplus, £7,866 was paid in aid of rates.

LONDON, SOUTHFIELDS.—Residents in Southfields are petitioning the London County Council to extend the tramway from Wandsworth, *via* Merton-road, to the county boundary. The district has a population of 72,000.

SOUTH SHIELDS.—The surplus on the year's working of the Corporation tramways amounts at £1,650 and has been placed to reserve, which fund now amounts to £7,674. Since meters have been placed on the cars, and motormen have been taught to economise current, the consumption has fallen from 1·363 units per car mile to 1·188 units. It is expected that the reduction will be got down to as low as 1·2 unit per car mile. This careful driving has also resulted in less wear and tear.

TORQUAY.—The Board of Trade has given notice that it will not renew licence for the Dolter stud system tramway, now run by a company, after its expiry in May. The company may either abandon its property, or, with the approval of the Corporation, convert the track into an overhead trolley or a conduit system. There is also a suggestion that the company should be bought out by the Corporation.

TRACTION—Overseas.

COPENHAGEN.—The Danish State Railways are considering tenders for the installation of an electric light plant at the New Central Station in Copenhagen.

PUBLICATIONS.

"Journal of the Institution of Electrical Engineers," No. 201, Vol. 44, May. Price, 5s.

Among the contents are Professor J. A. Ewing's address on the work of Lord Kelvin in Telegraphy and Navigation, and papers by Mr. Yerbury on "Equitable Charges for Tramway Supply," by Mr. H. J. Fisher on "An Electric Safety System for Mines," Mr. W. B. Woodhouse on "Overhead Line Construction," etc.

"Rapid Transit in the Future," By E. W. C. Kearney. Price, 3d.

In this illustrated pamphlet Mr. Kearney gives particulars of his special system of high speed underground and overhead railway. An effective sketch shows how the now overcongested Strand would benefit by the adoption of this form of elevated railway.

"Brassworkers of Berlin and of Birmingham: A Comparison." (London: P. S. King & Son. Price 6d. net. Fifth Edition.)

This purports to be an independent report by three investigators. It amounts, in effect, to a powerful plea for social reform and better technical education.

"Aero Manual." (Temple Press, Ltd. Price 1s. 6d. net.)

This is a second edition of a most carefully compiled and comprehensive *vade mecum* on all that appertains to the art of flying as attempted by man. It contains 208 pages and over 200 illustrations, many of these valuable diagrams. The book is well up-to-date, containing particulars of the latest mechanical devices and flying triumphs. The special section on aerial motors is full of most useful information.

"Vibrations of Systems Having One Degree of Freedom." By B. Hopkinson, M.A., Professor of Mechanism and Applied Mechanics. (Cambridge University Press. Price 2s. 6d. net.)

This is No. 1 of a new series of Cambridge Engineering Tracts issued under the general editorship of Professor Hopkinson. This initial issue promises well, for after general considerations, we are quickly taken to practical applications.

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"The Ideal Home" is a neat little souvenir of Electra House, 111, Bromley-road, Catford, E., and includes both illustrations and descriptions of this elaborately equipped electrical villa, together with comments by the technical and non-technical press.

"Reduction of Working Costs on the Rand." (London Investors' Guardian, Ltd. Price 1s.)

In these reprints of contributions to the *Investors' Guardian*, the information is chiefly of interest to financial readers, but in the course of discussing the policy of management valuable hints to mining engineers crop up. As regards electricity we are told, "In a modest way also the increased use of electricity on the Rand in substitution of, or as an auxiliary to the usual steam power, has not been without its beneficial influence on working costs of recent years, but it is anticipated that the greatly extended use of electricity will tend still further to lower working costs in the immediate future." The increasing orders for electrical machinery is evidence that the mining magnates realise this to the full.

EDUCATIONAL.

LONDON.

Particulars will be found in another column of the two schools of the City and Guilds of London Institute—the City and Guilds Central Technical College, South Kensington, the engineering side of which forms the Engineering Section of the Imperial College of Science and Technology; and the City and Guilds Technical College, Finsbury. The fees for the Session at the two Colleges are respectively £36 and £20. Examination for entrance to both Colleges for the October Sessions are held in September.

OXFORD.

The delegates of the Common University Fund have ordered an additional payment of £200 a year to the Wykeham Professor of Physics for the general purposes of his department, and in consideration of the increased expenditure which will become necessary on the opening of the new electrical laboratory. The laboratory, which is the gift of the Drapers' Co., is now almost completed.

FINANCIAL NOTES.

We learn from Brussels that a joint stock company has been constituted with the object of supplying electric power and light to the city of Rosario, really to take over the concern bought from the British shareholders. The capital of the new venture is 17,500,000 f., in which the Tramways Co. of Rosario is interested to the amount of 4,000,000 f. This latter concern will in future get its supply of electric current from the new company.

* * *

At the ninth ordinary general meeting of members of the Typewriting Telegraph Corporation, Ltd., held on the 27th ult., Mr. Arthur J. Parker, presiding, moved an extraordinary resolution that, by reason of its liabilities, the company should be wound up, said they had a machine which was an exceedingly good one, but the Government had unfortunately refused to take it up. They had now no customers to go to either in England or abroad, and the bulk of their foreign patents had run out. Although they had tried every source, they were unable to sell their machines, and it was, of course, impossible for them, as a going concern, to sell these at scrap prices. The Debenture holders were claiming their share in the concern, and in the circumstances the best thing was to wind up the business. The resolution was carried unanimously.

* * *

The Calgary Power and Transmission Co., Ltd., have issued at 92% of £256,800 5% First Mortgage 30-year gold bonds to bearer, in bonds of £100 each. The principal of the bonds will be payable on January 1, 1940.

* * *

In the matter of Robertson Electric Lamps (Limited and Reduced) notice has been given that a petition for confirming a resolution reducing the capital of the above-named company from £100,000, divided into 10,000 shares of £10 each, to £35,000, divided into 10,000 shares of £3 10s. each, was on May 6, 1910, presented to the High Court of Justice, and is now pending, and that the list of creditors of the company is to be made out as for July 4, 1910.

PERSONAL.

Mr. L. B. Humphrys having resigned the post of assistant borough electrical engineer, Sunderland, Mr. J. A. Crowther, shift engineer, has been promoted to the post at a salary of £156 per annum.

Mr. S. Whitehouse, senior shift engineer at Smethwick Power Station (Birmingham and Midland Tramways Joint Committee), has been appointed Superintendent of sub-stations to the Walsall Corporation.

On the strong recommendation of Mr. Christie, Chief Borough Electrical Engineer, Brighton, Mr. G. Cloughton, power-house superintendent at the Southwick Works, has had his salary increased from £250 to £300 a year.

ONTARIO HYDRO-ELECTRIC LIGHT.

The Minister of Justice has announced the Dominion Government's attitude in reference to the Hydro-Electric legislation of the Province of Ontario.

The Government has definitely decided not to disallow this legislation.

Application for disallowance was made during the summer of 1909 by a number of companies interested in electrical development at Niagara, and the matter has caused considerable comment at various periods since.

The electrical companies took the ground that the provincial legislation was an unfair and a constitutional infringement of vested rights, and, since this involved millions of dollars, it was considered that the Dominion should take cognisance of the conditions. The Hon. A. B. Aylesworth, Minister of Justice, in recommending to the Canadian Government that the legislation should not be disallowed, took the ground, viz., that this was a matter which affected the Province only, and was one which the voters of the Province should decide for themselves, and that, therefore, it was not a matter for Federal interference.

ASSOCIATION OF ELECTRICAL ENGINEERING STUDENTS.

L.C.C. School of Engineering, Poplar, E.

The second meeting of the above Association was held on Wednesday the 25th inst., when a paper was read by Mr. W. S. Ibbetson, B.Sc., A.M.I.E.E., on "Hydro-Electric Power Plants," before a large audience. The relative advantages of steam and hydro power were first discussed, followed by a general description of the construction of different types of power plants on the Continent and in America. In conclusion, three of the largest water power plants of the world were described and illustrated by a very large number of excellent slides. The next meeting of the Association will be held on June 22, 1910, when a debate on "Gas *versus* Electricity" will take place.

PATENTS.

Apparatus for Lighting, Ventilating and Heating Railway Carriages.

7425—1909. J. Stone & Co., Ltd., Deptford. The variably driven dynamo is provided with means for effecting specific alterations in its excitation, either by varying a resistance in its shunt circuit or by varying the number of sections of demagnetising field windings. The governor is provided with graduated arms for enabling predetermined adjustments of its weights corresponding with the adjustments of excitation. The dynamo can thus be regulated to suit the different conditions of speed of the vehicle.

Electrically Propelled Vehicle Brakes.

9494—1909. J. F. Simpson, Fulwood. The brake is held in the on position by springs, moved to the off position by a solenoid and held in the full off position when the solenoid is de-energised by a spring actuated detent device engaging with a notch in the core of the solenoid. The electric switch has contacts whereby when the switch arm is moved to either of the full on or full off positions the electrical circuit to the solenoid is broken.

Controlling Electric Arc Lamp Carbons.

14674—1909. H. D. Weaver, Wednesbury. This controlling mechanism for converging carbons consists of a screw engaged by a nut connected by cords with both the positive and negative carbons.

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Electric Controller Contact Fingers.

9829—1909. F. Jackson, W. L. Hurst, Ashton-under-Lyne. The object is to enable the wearing portion of electric controller contact fingers to be renewed without requiring the whole of the finger to be replaced. The wearing portion is formed separately and joined to a phophor bronze spring by means of a brass connection The upper outer end of the connection is grooved to receive the lower inner end of the copper wearing portion of the finger and is secured by a set screw.

Vapour Electric Apparatus.

10409—1909. The Brush Electrical Engineering Co., Ltd., Loughborough. This apparatus is adapted to work at high temperature. The positive electrode surface is formed of a solid material, anchored in position within an exhausted enclosing envelope formed of quartz. In order to maintain the electrode at an incandescent temperature during working a column of mercury is interposed, extending from a point clear of and below the electrode surface to the sealing-in point of the positive leading in conductor. A path for the current of smaller heat conductivity is provided across the space left between the mercury and the positive electrode.

Commutators of Dynamo Electric Machines.

10588—1909. C. A. Parsons, A. H. Law and J. P. Stockbridge, Newcastle. The invention consists in the provision of means for holding the segments of commutators of dynamo electric machines in place. These comprise longitudinal tee-shaped or dovetailed projections upon a central hub and engage with corresponding recesses in the commutator segments. The length of commutator is considerably reduced and the bars are held in place with a much smaller amount of material than would be the case in a construction where the supporting medium is external to the commutator.

Electric Arc Lamps.

11282—1909. E. R. Grote, Wimbledon. This is an improvement in lamps of the converging carbon type. The electrode consists of a short hollow cylinder of large diameter—at least half the length of the cylinder. The electrodes are mounted on inclined axes and are geared together so as to rotate together. The cylinders are arranged to be automatically rotated so as to bring another pair of cores into engagement when one pair has burned a predetermined short distance. The axis of one cylinder can be moved to strike and control the arc.

Electric Distribution Systems.

11285—1909. British Thomson-Houston Co., Ltd., London E.C. In order to prevent the paralleling of systems of different frequencies in systems in which current of more than one frequency is generated at a single station, locking devices are provided on the switch gear which are either locked by difference in phase and frequency or unlocked by coincidence of phase and frequency.

Electric Switch Operating Mechanism.

12395—1909. Electric Control, Ltd., Bridgeton. This switch operating mechanism in which rocking motion is imparted to a member in opposite directions through the medium of a spring, comprises a carrier to which one end of the spring is attached and a rocking arm to which the opposite end of the spring is attached. The carrier is pivoted at a distance from the centre about which the rocking member is pivoted. The carrier and rocking arm are similarly directed, the parts being so arranged that the points of connection of the spring and the pivot of the member to be rocked are brought into alignment in the action of operation.

Trolley Heads for Electric Cars.

12609—1909. W. L. Smith and W. Watson, Colwick. This is an improvement in trolley heads in which the harp spindle is made separate from the harp and in the form of a bolt. According to the improved construction a bolt takes the place of the harp spindle. The bolt is held in position by a key and does not rotate. The harp itself rotates on ball bearings.

Electric Locks.

14164—1909. J. Zabski, Tarnapol, Austria-Hungary. A lining having a number of apertures is arranged in the keyhole of the lock. Two contacts are provided, one on each side, each behind one of the apertures. The key has two spring arms which, when inserted in the lock, connect the two contacts behind each aperture in the keyhole lining.

Electric Arc Lamps.

16292.—1909. P. A. Messenie and W. E. Slaughter, Chicago, U.S.A. The lamp comprises a rotary carrier rotated by a spring, a number of pairs of electrodes, one pair of which is connected into the circuit after consumption of the preceding pair; and an electromagnet, which releases the rotary carrier when the pair of electrodes is consumed to a sufficient extent.

Metal Filament Electric Lamps.

17960.—1909. Felten & Guilleaume, Lahmeyer-Werke, A.G., Frankfort. The invention relates to lamps having a non-gaseous compound containing nitrogen, such as a compound of nitrogen, with phosphorus, placed in bulbs. According to the invention, the compounds used are entirely free from hydrogen, whereby disintegration of the metal filaments is present in as efficacious a manner as when compounds containing hydrogen and nitrogen are used. The compounds are applied to solid interior portions of the lamp.

Apparatus for Electrolytic Production of Salt Solutions.

20192.—1909. T. Girtin, Highbury, N. In this apparatus, for the production of metallic salts in solution by electrolysis, the cathode liquid is circulated from the sealed vessels to the cooling apparatus and back by means of the gas evolved during electrolysis.

Metal Filament Incandescent Electric Lamps.

21285—1909. H. Zschocke, Dresden. This is an improvement in lamps of the kind in which bifurcated metal filaments are resiliently supported. According to the invention, the filaments are held by rigid supports at their bend, and only their free ends are attached to resilient support within the electric circuit.

Braking Electrically Propelled Vehicles.

21669.—1909. G. Rizzo, Brussels. In vehicles wherein series of motors act as generators when applying the brake, an arrangement is made whereby the motors are excited when commencing to apply the brakes by an additional branch current taken off the main line, after which the circuit of the armatures in parallel is closed on the field windings in series, and the winding of the solenoid becomes closed.

Trolley Clips for Electric Conductors.

22904.—1909. J. C. Michaelson, Charlestown, U.S.A. Besides the wedge pin, the clip comprises only two parts, *i.e.*, two grooved jaws provided with interengaging flanges, forming hinges. The hinges have grooved extensions for receiving the wedge. The grooves in the body of the jaw hold the conductors.

Electric Light Fixtures.

24599.—1909. G. F. Rush, Chicago, U.S.A. The fixture is made from an insulating and reflecting material, such as porcelain, provided with simply means for attaching electric light bulbs, and applying current thereto. The surface of the fixture not adapted to reflect the light is of such material that it will take calcimine, or the like, whereby it will be possible to change the decorations of the room, and at the same time change the colour of the fixture.

Production of Ductile Electrolytic Iron.

24841.—1909. Langbein-Pfanhauser-Werke, A.G., Leipzig, Sellerhausen. In this process for producing ductile electrolytic iron of any thickness, hot iron salt solutions of temperature above 70° C. are employed. Hygroscopic substances, such as chloride of calcium, may be added, in order to improve the ductility of the deposit.

Detection of Thermal or Electric Energy.

27689.—1909. O. von Bronk, Berlin. The detector consists of a thermo-couple connected in parallel with an external source of electric current. One of the elements of the thermo couple is composed of tellurium, while the other element consists of a fragment of a metallic ore in its native state. Means are provided for enabling an auxiliary electric current, under an electromotive force of less than 1 volt, to pass across the elements of the thermo-couple connected in series parallel with an indicator of variations in electrical potential.

Apparatus for Lighting, Heating and Ventilating Vehicles.

7468 7470 and 7471.—1910. J. Stone & Co., Ltd., Deptford. The first-named patent dealing with the lighting, heating, and ventilating of vehicles consists of a combined governor and main switch, comprising an axially slidable sleeve, carrying switch contacts for connecting up the main and other circuits—a governor spring-operated sleeve. The second sleeve engages with the first, and moves it in the direction for opening the main switch as the speed falls. Patent 7470—1910 provides an arrangement whereby the electromagnet switch diverts the whole or part of the charging current from the battery into demagnetising field windings, as occasion requires. According to Patent 7471—1910, an auxiliary resistance is connected in parallel with a resistance connected between one of two secondary batteries and the dynamo whenever the dynamo is put out of circuit.

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TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns per week.			Increase or decrease.		Miles of track open.		Accounts for past year.							Cost per car mile.
	Ending	1909-10.	1908-9.	Week.	Current year.	1909.	1908.	Ending	Total receipts.	Passengers carried.	Car miles run.	Receipts per Passenger.	Receipts per Car mile.	Receipts per Mile of track.	
		£	£	£	£				£						
Aberdeen Corporation	May 25	1,439	1,381	+ 57	— 567	27½	27½	May 31	71,930	17,517,304	1,566,119	·98	11·02	4,940,	5·93
Ayr Corporation	Sept. 18	671	562	+ 108	—	8	8	—	—	—	—	—	—	—	—
Baker Street and Waterloo Ry.	Nov.	8,141	6,070	+2,071	—	4·25	—	—	—	—	—	—	—	—	—
Birkenhead Corporation	May 22	1,222	1,022	+ 200	— 29	24·003	13·52	—	—	—	—	—	—	—	—
Birmingham Corporation	May 21	7,706	6,479	+ 1,227	—	56·792	58·52	—	—	—	—	—	—	—	—
Blackburn Corporation	Oct. 6	1,100	1,293	— 173	— 1,036	24·53	28·3	—	—	—	—	—	—	—	—
Blackpool Corporation	Aug. 26	2,152	2,050	+ 102	+ 732	—	—	—	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams	„ 8	2,304	2,309	— 24	—	—	—	—	—	—	—	—	—	—	—
Bolton Corporation	Oct 10	2,416	2,337	+ 79	— 259	42	42	Mar. 31	117,799	25,492,902	2,492,147	1·1	11·34	2,804	6·50
Bournemouth Corporation	July 21	1,681	1,723	— 42	— 23	29½	29½	„ 31	86,225	18,991,328	1,766,068	1·47	11·71	2,912	7·22
Bradford Corporation	May 7	4,937	4,733	+ 204	— 1,504	98	54·81	„ 31	235,258	47,839,569	5,331,007	1·17	10·59	2,378	—
Brighton Corporation	May 29	915	974	— 59	— 341	9·5	—	—	—	—	—	—	—	—	—
Bristol Tramway Company	May 27	6,129	5,494	+ 635	—	57	51½	Dec. 31	265,362	46,652,389	5,756,842	—	—	—	—
Burnley Corporation	May 28	1,208	1,254	— 46	—	19½	19½	Mar. 31	64,261	12,355,958	1,202,330	1·23	12·88	5,971	7·92
Burton Corporation	May 29	248	280	— 32	— 10	6½	6½	„ 31	14,918	3,221,595	430,913	1·04	8·30	1,460	5·85
Cardiff Corporation	April 3	2,000	1,957	+ 43	—	—	—	„ 31	109,979	25,058,146	2,497,169	—	10·57	—	—
Carlisle Tramways Company	June 19	170	175	— 5	— 89	—	—	—	—	—	—	—	—	—	—
Central London Railway	May 28	6,052	5,783	+ 275	+ 2,220	6·32	6·32	Dec. 31	350,150	41,898,373	1,456,781	2·01	5·769	55,404	30·27a
Charing X, Euston, & Hamp. Ry.	Nov.	6,822	6,092	+ 730	—	7·75	—	—	—	—	—	—	—	—	—
City and South London Railway	May 29	2,959	3,162	— 203	— 157	7·26	7·26	—	—	—	—	—	—	—	—
Colchester Corporation	July 14	200	219	— 39	—	8	—	Mar. 31	10,983	2,308,721	349,539	1·09	7·74	1,477	6·56
Cork E. T. and L. Company	May 26	611	497	+ 114	+ 1,602	9·89	9·89	Dec. 31	24,044	5,737,478	896,945	—	6·43	—	4·43
Croydon Corporation	May 6	1,612	1,401	+ 211	+ 42	11½	—	Mar. 31	74,132	16,277,418	1,884,137	1·06	9·56	3,703	7·109
Darwen Corporation	Oct. 1	239	256	— 17	— 201	7·23	7·23	„ 31	13,899	2,557,654	245,584	1·30	13·68	1,922	9·40
Dover Corporation	Sept. 18	230	252	— 22	— 395	7	—	„ 31	11,593	2,697,672	316,754	·98	8·78	—	—
Dublin and Lucan Electric Ry.	May 27	153	137	+ 16	+ 92	7	7	—	—	—	—	—	—	—	—
Dublin U.T.	May 27	6,242	5,709	+ 532	+ 4,555	54½	54½	—	—	—	—	—	—	—	—
Dundee City Tramways	Oct. 6	1,332	1,305	— 27	— 569	—	26½	May 15	60,573	16,367,911	1,281,552	·875	1·9	2,371	7·46
East Ham Corporation	May 28	1,024	1,034	— 10	+ 170	14	15	Mar. 31	47,430	15,355,703	1,091,586	·73	10·26	—	6·96
Glasgow Corporation	May 21	19,499	18,315	+ 1,184	+ 5,389	194½	189	May 31	907,494	226,948,290	20,766,722	·96	10·49	5,060	5·85
Gloucester Corporation	Oct. 6	395	425	— 30	+ 535	15	—	—	—	—	—	—	—	—	—
G.N., Piccadilly and Brompton	Nov.	13,429	9,354	+ 4,075	—	9·25	—	—	—	—	—	—	—	—	—
Halifax Corporation	—	—	—	—	—	52·574	37	Mar. 31	81,872	20,378,672	1,786,390	11·40	11·13	1,528	8·40
Huddersfield Corporation	Dec. 4	1,613	1,357	+ 256	+ 2,663	28	28½	„ 31	84,704	16,200,020	1,960,329	1·29	10·37	2,421	5·10
Hull Corporation	May 28	2,587	2,573	+ 14	+ 1,034	29	26	„ 31	128,722	30,964,254	3,022,844	1·	10·22	—	6·04
Ilford Corporation	Feb. 12	451	391	+ 60	+ 1,969	10	10½	„ 31	25,328	6,385,466	634,446	·87	9·58	2,066	6·42
Ilkeston Corporation	May 26	138	135	+ 3	— 39	4	4	„ 31	7,214	1,968,850	198,415	9·1	7·9	1,803	7·04
Kirkcaldy Corporation	Sept. 8	259	266	— 7	—	7½	7½	May 15	14,993	4,874,199	459,066	·711	7·838	1,856	5·26
Lancashire United Tramways	May 25	1,773	1,307	+ 466	+ 463	39	39	Dec. 31	68,904	12,554,593	2,244,344	—	—	—	—
Leeds Corporation	Sept. 18	6,896	6,624	+ 272	+ 3,662	108	96½	Mar. 31	340,368	75,734,083	7,694,989	1·06	10·62	3,527	5·51
Leicester Corporation	Sept. 11	2,162	2,130	+ 32	—	—	—	—	—	—	—	—	—	—	—
Liverpool Corporation	Nov. 19	10,803	10,687	+ 116	— 1 977	109	104	Dec. 31	572,822	124,043,239	12,231,799	1·108	11·24	5,508	7·94
Liverpool Overhead Railway	May 22	1,627	1,324	+ 303	+ 735	6·65	2·40	June 30	79,004	11,171,515	1,106,386	—	—	—	—
London County Council	May 7	40,802	35,395	+ 5,407	+ 23,837	132½	123½	Mar. 31	1,274,660	279,166,461	25,591,028	1·08	11·74	—	6·79
Lowestoft Corporation	Dec. 11	155	150	+ 5	+ 30	3½	—	Sept. 30	11,399	2,645,206	370,320	1·03	7·36	2,279	6·12
Maidstone Corporation	Mar. 6	157	100	+ 57	—	7·4	—	—	—	—	—	—	—	—	—
Manchester Corporation	Sept. 11	15,631	15,297	+ 334	— 2,871	183	181	—	—	—	—	—	—	—	—
Metropolitan District Railway	May 28	10,767	10,310	+ 457	+ 22,977	24	24	—	—	—	—	—	—	—	—
Metropolitan Railway	May 29	16,923	16,815	+ 108	+ 12,597	24½	24½	June 30	680,357	99,846,735	—	1·46	—	—	—
Nelson Corporation	Oct. 16	151	131	+ 20	+ 7	2½	2½	Mar. 31	7,362	2,060,712	204,740	·85	8·63	1,907	—
Newcastle-on-Tyne Corporation	May 21	3,980	3,790	+ 190	— 1,452	60½	59½	„ 31	211,085	46,203,164	4,411,745	1·10	11·48	3,504	6·36
Newport (Mon.) Corporation	Oct. 9	663	638	+ 25	— 311	14½	14½	„ 31	35,531	8,174,003	798,029	1·04	9·89	2,450	7·21
Oldham Corporation	Jan. 24	1,778	1,516	+ 262	— 386	—	—	—	—	—	—	—	—	—	—
Portsmouth Corporation	Oct. 10	2,046	1,809	+ 237	—	28½	28½	Mar. 31	97,741	21,247,048	2,309,439	1·10	10·15	—	—
Reading Corporation	May 19	764	558	+ 206	— 5	13½	13½	„ 31	32,769	7,933,572	915,481	—	8·93	—	4·65
Rochdale Corporation	Dec. 26	1,240	1,126	+ 114	+ 746	20·9	20·93	„ 31	56,558	10,196,148	1,252,925	1·32	10·88	2,693	6·47
Rotherham Corporation	Feb. 4	555	587	— 32	—	—	—	—	—	—	—	—	—	—	—
Salford Corporation	Sept. 27	4,096	4,662	— 66	— 3,326	78	74½	Mar. 31	244,065	45,771,611	5,486,150	1·25	10·67	3,185	—
Scarborough Tramways Co.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Sheffield Corporation	May 22	6,731	5,627	+ 1,104	+ 3,510	39½	37½	Mar. 25	289,745	17,568,686	7,065,380	·896	9·842	4,225	5·04
Southampton Corporation	May 18	1,446	955	+ 490	+ 338	18	18	„ 25	52,647	10,121,887	1,157,451	1·25	11·33	—	7·30
Southend-on-Sea Corporation	Aug 21	995	557	+ 438	+ 1,483	—	—	—	—	—	—	—	—	—	—
Stockport Corporation	—	—	—	—	—	25	25	Mar. 31	52,004	9,155,172	1,335,911	1·34	9·342	1,830	4·75
Sunderland Corporation	Jan. 27	1,310	1,336	— 26	— 7,984	—	—	—	—	—	—	—	—	—	—
Swindon Corporation	May 18	170	119	+ 51	—	—	—	—	—	—	—	—	—	—	—
Torquay Tramways	Aug. 26	630	647	— 30	—	8·41	—	Dec. 31	15,065	2,880,420	353,297	1·40	1·023	—	—
Wallasey U.D.C.	May 28	905	925	— 20	— 349	12·68	12·45	Mar. 31	43,823	8,331,038	891,540	1·2	11·79	3,453	7·72
Warrington Corporation	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
West Ham Corporation	May 19	3,085	2,248	+ 837	— 436	27	14·7	Mar. 31	122,881	35,502,886	2,556,854	·789	10·95	4,417	6·79
Wolverhampton Corporation	Nov. 3	841	823	+ 18	— 206	21½	—	„ 31	44,432	9,440,369	975,714	—	10·929	2,190	6·509

a Train Miles. h Half-year's figures.

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THE
Electrical Engineer.
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WITH WHICH IS INCORPORATED "ELECTRIC LIGHT."

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NOTES.

Corrosion Committee.

All who have anything to do with the non-ferreous metals owe a debt of thanks to the Institute of Metals for their constituting an adequately equipped Corrosion Committee to investigate the action of sea-water, acids, and chemical and electrolytic action on non-ferreous metals. Sir Gerard Muntz, President of the Institute, is acting as chairman, and the first efforts of the Committee are to be turned to the corrosion of condenser tubes and marine engines, and all stationary engines influenced by sea or foul water, or subjected to violent electrolytic action. Thus the machinery of electric power generating and transformer stations will come under the investigation. Much undoubtedly remains to be done in this matter. Careful investigations over a sufficiently wide area and varying circumstances should lead to valuable information being tabulated, from which deductions may be drawn and remedies suggested. The loss both from shortening the life of apparatus corroded by the above means and the loss of efficiency during working, is enormous. As electrical engineers know, acid and electrolytic corrosion of non-ferreous metals are often responsible for very serious breakdowns. Every assistance should be afforded the Committee.

Electric Furnaces in Sheffield.

It is good news to hear from so unimpeachable an authority as the Borough Electrical Engineer, that Sheffield is really awakening to the benefits of the electric furnace. Just a little over £78,200 is required for further extensions at the Neepsend Works, and this, it appears, is to meet not so much the increasing demand for more and better light, but for cheap, easily controllable power. In the East-end Works electricity is being much more largely used for smelting furnaces. From special information in the possession of the municipal authorities, it is quite clear that this movement is soon to have a big and rapid acceleration, and so measures are to be taken to meet the demand. Half-a-dozen or so smelting furnaces in a busy centre like Sheffield is not much, but it shows that serious attention is being given to the matter; it is only the beginning of a reform necessary if our steel is to maintain its position on the markets of the world. Although we cannot say that Sheffield leads in thus going in for electricity, it is to be hoped that once having tested, it will go boldly ahead and finally introduce modifications or methods which will compensate for the delay.

The Human Body's Resistance.

Last week we gave some results of Professor d'Arsonval's experiments on the resistance of the human skin and body to electricity. Professor W. W. Haldane Gee has been delivering himself of remarkable utterances before the Manchester Literary and Philosophical Society as the results of his experiments at the Municipal School of Technology. He placed the resistance of the human body to continuous current under ordinary circumstances at 1,500 ohms, but when the alternating current was used the resistance fell to between 800 and 700 ohms. Yet it is to currents of high frequency that the medical world is now turning its attention with the greatest hopes for curative and restorative purposes. Professor Gee found that the muscular contraction is much greater on touching the cathode than on touching the anode. Upon this discovery he has invented a new method of telegraphy, which may conceivably have a distinct place in emergency makeshifts, even if not developed on commercial lines. By connecting two bowls containing a saline solution, in which the receiver dips his hands, by energising the cathode or anode, it is easy to transmit a message by the Morse dot and dash code. The demonstration of this method, with a human receiver, answered very well.

Charging Tramway Current.

The question of what is the fair method of charging for current required by a tramways undertaking has cropped up once more, this time at Derby, and in rather an acute form. The Tramways Committee wrote to the Electricity Committee asking if the charge for current could not be reduced from 1½d. to 1¼d. per unit, a request which could not be acceded to. Thereupon what almost amounted to an attack on the Electricity Committee was made in open Council, and it was alleged to be unfair that manufacturers could obtain current for power purposes on the day load at 1d. per unit, when exactly 50% more was charged to the Tramways Committee. Rather unwisely, we think, the Chairman of the Electricity Committee declined to discuss details. It could, however, have been made quite clear that an extra charge was not only legitimate but necessary from the ordinary business point of view, owing to the extra plant and attendance required to meet the erratic demands of the tramway undertaking. Of course, the obvious way out of the difficulty is for the tramways to reduce the peak load, and take a steady supply, which is quite possible where accumulators are used for the express purpose of storage with a view to equalisation of demand from the generating station. Tramway men ought to have more frequent recourse to accumulators, which would reduce their own expenses and make the task of the central station staff all the easier and more remunerative on a lower rate.

Electrical Towing.

In our last week's Notes we had occasion to refer to the advisability of making greater use of electricity for haulage purposes on our canals. The Berlin correspondent of the *Times* now gives some interesting details of the towing arrangements installed by the City of Bremen, at the mouth of the Weser, where electricity is also used for opening the sluices, lighting, etc. The work was carried out by the A. E. G., who had to resort to quite an ingenious plan owing to the lack of space and other difficulties. The ordinary towing locomotive had to be abandoned, because there was no room for two rails on the top of the wall dividing the sluices, this top being used for control apparatus. So a single line of rails was laid close to each of the outer edges of the wall, where its strength was a *maximum*, leaving the remainder of the wall crest free. The tractor used is in the form of a gantry of sufficient height to pass over the controlling devices, operators' cabins, conductor poles, etc. The necessity of passing under a passenger bridge which is to be erected had also to be taken into account. The motor, which is arranged on the top, at the level of the cross-arm, is of the three-phase type, and drives the tractor by intermediate gearing. The two wheels on each side of the engine are coupled together so as fully to utilise the adhesive force. The tractive force amounts to over 1,500 kilos. The engine is manipulated by reversing controllers placed on both sides immediately beside the controllers for the winches that operate the towing cable. These two winches, which are placed in the upper cross-arm, enable the towing cable to be let out to a length of upwards of 100 metres.

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Engineering Manufacturers Overseas.

Recently we had occasion—in connection with Australian telephone and telegraph contracts—to point out the difficulty of setting up efficient and economical engineering enterprises in localities unsuited for the purposes, whether owing to the paucity of population or other causes. Now, Mr. F. W. Harbord's report to the Transvaal Government on the possibility of building up a remunerative local iron and steel industry teaches the same lesson. To begin with, the ores are not of the best description, being titaniferous they are scarcely suitable for the blast furnace, the limestone is of inferior quality, and the local coal gives only a poor coke. But apart from that altogether, there is the question of demand. Now, the total consumption of pig iron for foundry purposes for the whole of South Africa is placed at 2,000 tons a year as a maximum, while the total consumption of finished iron and steel for the same region is only 100,000 tons a year. This, of course, is not enough to sustain the expense of equipment and management. Electrical smelting would scarcely alter this argument, especially as electric power is sold locally at a very high rate. According to Mr. Harbord, the only chance of a success as regards smelting is in the matter of treating waste scrap, which amounts to only 10,000 tons a year, and scarcely enough to keep a big plant remuneratively at work. If this is the case as regards iron and steel, the argument applies all the more strongly to attempts to set up factories of elaborate machinery of appliances, or parts. This can only be done occasionally by branch firms of bigger European or American concerns, which have the advantage of uniform patterns, and even imported parts, to be assembled locally and fitted in with the heavier sections made on the spot. This latter method is often a success not only in the colonies, but in certain countries on the Continent, where this form of international co-operation finds favour.

Weston Cell as a Standard.

In a short paper, before the Physical Society, Mr. S. W. J. Smith dealt with the limitations of the Weston cell as a standard of electromotive force. To some extent it discussed the recent paper of Mr. F. E. Smith on cadmium amalgams. The lecturer said that theory and experiment alike suggest that there is no range at any temperature over which the E.M.F. of a Weston cell is absolutely independent of the percentage of Cd in the amalgam. Even if the materials are quite pure, the existence of surface energy must cause some variation. Within the range over which the E.M.F. is usually taken as constant the E.M.F. appears to rise, very slowly, with increase in the cadmium content. The rate varies, but is never more than a few millionths of a volt for 1% Cd. From the data it seems possible also to discover the precise way in which the use of the richer two-phase amalgams may lead to variability of the E.M.F. of the Weston cell. The interpretation advocated is that the irregularities are due to electrolytic skin effects arising out of want of uniformity of composition of the surface grains. The probable reason why the temperature co-efficient of E.M.F. of a Weston cell, always small, actually vanishes near 0° C. is indicated. An outline of the way in which the phase rule can be used to exhibit the nature of the incomplete equilibrium of the Weston cell is also given.

Effect of Thermal Treatment on Amalgams.

Mr. Rayner referred to hysteresis effects which, he said, were a source of serious trouble when working with Weston cells. He gave details of the behaviour of a particular cell during a period in which the temperature of the cell was raised from 14° C. to 25° C. for three days, and asked the author if he could explain the observed variations of the E.M.F. on the theory he had advanced. The lecturer argued that the utility of the theory he had described lay in the fact that it should be possible, by means of it, to discover what the effect on the amalgam of any particular thermal treatment would be. His object had been to discuss one cause of some of the variations of the Weston cell, and to indicate a theoretical limit to the accuracy obtainable.

Home Office Regulations Neglected.

Last March an electrician's labourer met his death while at work on a switchboard at the Cambuslang station of the Clyde Valley Electric Power Co. As a result, the company were charged on the 2nd, in the Hamilton Sheriff Court, with neglect, having "had extra high pressure conductors in a switchboard open from the front and from below, so that it was not adequately protected while dangerous work was being done by James Noble, electrician's labourer; also, that they failed to make such switchboard dead, or to separate the section of such board by removal screens while repairs were being made by a person without technical knowledge or experience, in consequence of which James Noble was killed." The Fiscal said that the Home Office asked for a penalty, though not a heavy one, as it was the first case in Scotland. In the end the company were fined £20.

THE INSTITUTION OF GAS ENGINEERS.

The annual general meeting of the Institution of Gas Engineers is to be held in the hall of the Institution of Mechanical Engineers, at Westminster, under the presidency of Mr. James W. Helps, M.Inst.C.E., Engineer and General Manager to the Croydon Gas Co., on Tuesday, Wednesday and Thursday; June 14 to 16.

The President's address will be delivered at the opening of the proceedings, after which a paper on "Public Lighting from a Municipal Point of View," by Mr. Jacques Abady, of London, will be read and discussed. In the afternoon a meeting of the Joint Commercial Sections of the United Kingdom will be held.

The report of the Gas Heating Research Committee is to be read and discussed, followed by papers and discussions on "Gas as a Universal Fuel," by Mr. H. L. Doherty, of New York; "Gas Calorimetry in the United States," by Mr. J. B. Klumpp, of Philadelphia; and "The Management of Small Gas Undertakings and Works," by Mr. F. J. Ward, of Knowle.

On Thursday the report of the Institution's Carbonisation Research Committee will be presented, after which, papers on "Experiments in Carbonisation on the Birmingham Coal Test Plant," by Mr. William B. Davidson, of Birmingham; "The Latest Installation of De Brouwer Stoking Machinery and Coke Handling Plant," by Mr. S. Y. Shoubridge, of Lower Sydenham, are to be read and discussed, and the report of the Institution's Refractory Materials Committee concludes the technical programme of the meeting.

A visit of inspection to the works of the Croydon Gas Co. is to be paid on Friday, June 17, the party proceeding in the afternoon to the Japan-British Exhibition.

WATER POWER IN ITALY.

Some interesting particulars have reached us concerning the further development of water power in Italy for electrical purposes. The current of the river Poglia is used in two falls, the total height of which is 1,400 metres. One is from the Lago d'Arno into the river, and the second is the farther fall of the river itself. The lake acts as a reservoir and holds 11,000,000 cubic metres. It supplies two cubic metres per second to the station at Isola, giving 20,000 h.p. for eight hours a day. The lower station at Cedegolo draws its water from an artificial reservoir and obtains 22,500 h.p. from five generators of 4,500 h.p. each. Current is supplied to Milan over a distance of 75 miles.

ELECTRIC RAILWAYS IN NORTH SWEDEN.

To complete the electrification of the Kiruna line up to the Norwegian frontier, it is proposed to establish a power station at Porjus waterfall to the south west of Gellivare. The total cost, including rolling stock, is put at about £1,200,000, and the work is to be finished before 1914. The amount of ore carried from Kiruna for export from the Norwegian harbour of Narvik will increase greatly next year, so that that section of the line will be pushed on energetically. The fall at Porjus is expected to supply sufficient power not only for the Kiruna-Narvik section, but for that between Kiruna and Lulea, and also for the mines.

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Free Trade or Protection?

British Electrical Manufacturers Discuss the Problem.

The discussion on the effects of Free Trade or Protection on the electrical industry was resumed by the National Electrical Manufacturers' Association (Incorporated) at Caxton House, Westminster, on Monday, June 6. Mr. H. W. Butler (Chairman of the Association) presided, being supported by Mr. J. E. Kingsbury (who opened the discussion on behalf of Free Trade), Mr. H. Hirst, M.I.E.E., Managing Director, General Electric Co., Ltd. (who championed the Tariff Reform scheme), etc.

Mr. Garcke quoted from a statement by Sir Alfred Bateman in the Board of Trade returns issued as far back as 1892, to the effect that "it is necessary more than ever that the changed conditions should be recognised, and we can scarcely expect to maintain our past undoubted pre-eminence, at any rate without the strongest effort and careful and energetic improvement in method." For some years past the average rate of unemployment in England, he said, was approximately double that of Germany. All nations had suffered in national credit, but England had suffered in a larger ratio than other countries. With regard to emigration, which was a very telling factor as to the condition of a country, emigration was greater from England than from other countries, and in Germany emigration was more than neutralised by immigration. Unfortunately, the fiscal problem had partaken of a political character, and was not, therefore, discussed in a spirit of compromise. Their views were not diametrically opposed. There was, he said, a basis for an arrangement. "The result of the policy of Free Trade," he continued, "is that our profits are being gradually eliminated. I do not admit that our ability to buy in the cheapest market has the best results if we also have to sell in the cheapest market. We are doing a vast amount of work and we have a large turnover, but there is scarcely any profit on it, and for this reason: our imports from abroad depress the prices of our own productions, which, as Mr. Hirst showed, cost us more to produce.

Great Cost of Production.

"Consequently, the margin of profits on our manufactures is reduced by greater cost of production and by reduction of price, and, as we are competing amongst ourselves as well as with the foreigner, there is a general all-round tendency to wipe out our profits. Our policy of Free Trade is destroying that freedom of exchange for which Free Traders plead. They defeat their own objects, because they encourage the creation of trusts and monopolies in foreign countries, one of whose objects is to crush our manufacturers. And when foreigners have killed our industries, consumers in this country will be at their mercy in regard to prices. At the present time our exports of home produce to France, Belgium and the United States, our principal competitors, are less than half the value of our imports from those countries. What is quite as serious is that we are losing control of our Colonial trade, and that our foreign competitors are gaining it."

Progress Cannot Be Protected.

Mr. Oppenheim, in defence of the Free Trade system, laid emphasis on the point that the rise of industrial Germany could be traced from the abolition of Protection in the German Empire in 1868, when the Zollverein was created. Progress could not be protected by Tariff Reform or any other means. The adoption of the metric system in 1872 was a further step by Germany in the direction of progress. How many could tell him what system of measurement and weight was in existence in this country? The biggest political and economical blunder ever committed by this country was the Merchandise Trades Marks Act. Up to 1887, which was the heyday of English success, we were general distributors of either our own manufactures or the manufactures of foreign countries. No one knew where our source of supply came from. The Merchandise Marks Act gave the most extensive and most expensive advertisement to the Continent. There was also the question of the nationalization of railways which had to be taken into account. Finally, he admitted that the electrical industry itself in this country was not what it should be. "It is ill certainly; it is suffering in spite of Free Trade, but it would be hopelessly ill, beyond recovery, if Tariff Reform ever came to its rescue."

The Handwriting on the Wall.

Mr. G. Byng followed with a vigorous advocacy of Tariff Reform. When the Free Trader spoke about cheap production he talked about cheap labour—cheap wages; but addressing the working man, he said, "Under Free Trade your wages are much higher than in a protected country." The Free Trader could not have it both ways! The real truth was that under Free Trade wages must come down, down, down. He ventured to assert that if we continued under the foolish Free Trade policy our poorer classes would have to pay the piper. The working classes would have gradually to work for lower wages until they came to the lowest. It was a wicked, stupid system, which contemplated ruin with the greatest complacency. No new industry could be established, no industry could grow under Free Trade. If a Free Trade industry was attacked that industry must go to the wall. Under Free Trade we were not free here. It was the foreign protected manufacturer who had got to say whether any industry was to exist or not, whether it was to be attacked or left alone. If people directed their attention to protection, they would come to his conclusion, that it was due directly and almost solely to our stupid system of Free Trade that we have declined in the nations' capacity of production. It was very terrible. The handwriting was on the wall—Free Trade meant dear production, and dear production meant decay of work. Nothing could prevail to improve matters but the abolition of Free Trade.

Competing with the World.

Mr. R. Hammond insisted that the true Free Trader did not want to injure any industry in this country. They did not want decaying industries protected. Those who wanted to decrease the imports would not increase work: they would change the character of it, but to the extent that we managed to keep out imports our exports would fall off, and our power of competing with the world in the open markets would suffer accordingly.

"An Unfortunate Example."

Mr. Berry introduced himself as one of the unfortunate examples of the effect of Free Trade on the electrical industry. If in later days he had achieved any slight measure of financial success it was due to the fact—entirely in spite of Free Trade—that he had found protection in these markets through the medium of the Patent Office. He had previously been "through the mill," and nearly succumbed through competition in foreign countries. He started, among others, a little patent lamp holder. When the patent lapsed, the foreign manufacturer stepped in, cutting down the price, and secured not only the foreign markets but our own. "The foreigner collared our speciality and supplied it to the extent of 80%," continued the speaker. And what of the British people thrown out of work and of the waste capital? A little tax on foreign goods would enable home manufacturers to fight the foreigner on even terms and feed the starving families of the workers.

Divergent Views.

Mr. Bond held that the position of the electrical industry would be relatively worse under Protection.

Mr. Bruce Anderson also favoured the introduction of Tariff Reform.

Reply By Mr. Kingsbury.

Mr. Kingsbury, replying on behalf of Free Trade, contended that unemployment was not a matter which depended upon Free Trade or could be cured by Protection.

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It was a social question which required most careful examination, and the Tariff Reformer who said, "Tariff Reform is work for all" was either taking a very narrow view of the subject, or——. According to Mr. Raworth, something like 90% of the tramway material in this country came from America, but he (the speaker) was told that the material from America would not exceed 5%! Referring to the cotton industry, he expressed the view that electric driving of cotton mills was bound to come if they treated the cotton manufacturer of Liverpool as if he knew his own business. His conception of the benefits of Free Trade did not depend upon any limitations whatever. Free Trade was more important to the manufacturing industry than to the rest. They did not find that Free Trade had ruined the electrical industry of Russia or France. Why was it that the electrical industry of England was selected as the alleged victim of Free Trade? He maintained that they could start the production of goods in quantities at any time in a Free Trade country when it would not pay to do so in a Protectionist country. The manufacture of goods in quantity went to the root of the whole question, and that was why he was a Free Trader. Manufacturing in quantity involved an expenditure in capital which must be dependent upon the quantity required. Mr. Hirst told them that if there were a 10% duty on imported lamps nobody would be a penny the worse; but he (Mr. Kingsbury) thought nobody would be a penny the better. What they got with one hand they would lose with the other. "You can juggle with money and figures," he continued, "but you cannot get over the fact that under Protection you will be working through resistances."

Mr. Hirst's Reply.

Mr. Hirst, in his closing speech for Protection, adverted to the remark by Mr. Oppenheim that Germany's prosperity began with the creation of the Zollverein. "Well," he said, "we want to put down a Customs duty between the various States, which go to make up this great Empire, and our prosperity will start from that point." He held that if, under Protection, manufacturers had to pay their workpeople 33% more than at present, it would amply pay them and leave them a margin for dearer food, clothing, and so on; and yet manufacturers could produce cheaper by the larger quantities, exactly as in the case of foreign producers. Talking of telephones, he said that in the early days there were a number of telephone factories in this country, but one by one they closed down, while manufacturers in other countries went ahead. In recent years three or four new factories had been started in this country for no other reason than that Tariff Reform or Protection was in the atmosphere, and that they acknowledged that it must come. Concerning "dumping," he said if there was any underselling by home producers in the home market, it must have an end, because the manufacturers were under similar conditions. But when the foreigner sold below the English cost of production, it did not follow that he suffered a loss: he got his reward by cheaper production through making a larger quantity, and, perhaps, for the time a higher price in his own market. The foreigner would ruin the industry in this country, and then the price would go back, not only to the foreign price, but probably higher.

No vote was taken, and the proceedings closed with the customary compliments.

NEW CUSTOMS TARIFF FOR SWEDEN.

It is just a few weeks since details of the new Japanese tariff were made known in this country, and electrical manufacturers found that goods were subject to rather severe duties. Now comes the announcement of a revision of the Customs tariff of Sweden, and from the list of rates of duties which we are able to publish thus early, it will be seen that in so far as the Swedish market for electrical machines and apparatus is concerned, the future is not very promising, the only redeeming feature of the new tariff being the substitution of specific duties for the existing *ad valorem* rate of 15% of electric machines, which should obviate much irritation in assessing the duties.

The rates of duty given below are abstracted from a report embodying recommendations made to the Swedish Legislature by a special parliamentary committee appointed to deal with the results of a laborious investigation conducted over a number of years by a Royal Commission, and although in a few cases the Customs tariff finally adopted by the Rigsdag last month is rather lower than was recommended by the Parliamentary Committee, the changes do not affect the industries with which we are concerned, nor do they materially alter the impression that the new scale of duties will bear hardly on the commercial interests of this country.

The weights and values in the table below are given in the Swedish currency: 1 krona (100 öre) = 1*s.* 1⅓*d.*; and 1 kilogramme = 2·2046 lbs.

Name of Article.	Rates of Duty. Present.	Proposed.
Insulators, buttons, conduit pipes, cover slabs, and other articles for insulating electric wires and conductors :—	kr. öre.	kr. öre.
	kilog.	kilog.
White	0 30	0 20
Other kinds ..	0 60	0 25
Electric furnaces, cooking apparatus, flat-irons, etc., arranged for heating by electricity; electric stoves, etc...	0 04	0 18
Wire: twisted into cords or cables, not insulated	0 15	Pays a surtax of 50% of the duty leviable.
Electric cables or lines with or without armouring :—		kilog.
Maximum diameter, 15 mm.	Free	0 12
Of greater diameter.. ..	10% *ad. val.*	0 10
Electric cables, coated with india-rubber, gutta-percha, or other insulating substances :—		
Armoured with iron or other metal	Free	0 25
Other kinds	10% *ad. val.*	0 35
Electric cables, insulated by paper textile materials, or varnish :	kilog.	
Not more than 0·5 mm. thick	1 00	1 00
Of greater thickness ..	10% *ad. val.*	0 50
	kr. öre.	kr. öre.
Electric cables, insulated in some other way	10% *ad. val.*	10% *ad. val.*
Electrical machines, such as generators, motors, converters, and transformers :—		100 kilogs.
Weighing each not more than 50 kilogs. net	15% *ad. val.*	70 00
Weighing each more than 50 kilogs., but not more than 100 kilogs.	,,	50 00
Weighing each more than 100 kilogs., but not more than 500 kilogs.	,,	35 00
Weighing each more than 500 kilogs., but not more than 3,000 kilogs. ..	,,	25 00
Weighing each more than 3,000 kilogs. net	,,	18 00
(Electrical machines coupled together on one bedplate are dutiable separately.)		
Stators, rotors, current collectors, magnet poles, & brush holders, when imported separately ..	,,	Dutiable as electrical machines plus 50%.
Accumulators:		
Unmounted cells; wooden frames and platforms for accumulators; accumulator plates, glass jars, etc.	10% *ad. val.*	100 kilogs. 10 00
Cells and batteries, wholly or partly mounted; also electrodes cemented together	,,	32 00
Incandescent Lamps:	Kilog.	Kilog.
With carbon filaments ..	1 50	1 50
With metal filaments ..	1 50	4 00

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Name of Article.	Rates of Duty. Present.	Proposed.
Arc lamps, even if with globes; Nernst lamps, with globes, luminous bodies and resistances; also reflectors	10% *ad. val.*	0 50
Carbon filaments, even if metallised; metal filaments, and bases for incandescent lamps..	—	Free.
Carbon, manufactured for electrical purposes—		
Weighing 3 kilogs. net or more per article	15% *ad. val.*	kilog. 0 03
Of less weight :—		
Carbon brushes	,,	3 00
Other kinds	,,	0 20
Safety appliances, mounted on porcelain insulators; reduction, regulating and combination resistances; controls and other electric regulators; also boards for electric apparatus and instruments, fitted ..	10% *ad. val.*	0 35
Safety appliances, including satefy plugs, fusible pieces, cartridge pieces, and excess voltage apparatus	,,	0 50
Current regulators (current interrupters and reversers) :—		
Oil transformers	,,	0 55
Other kinds	,,	0 75
Telephone apparatus:		
Weighing less than 5 kilogs. net per article	,,	1 50
Of greater weight ..	,,	0 20
Telephone switches and switchboards; also parts not specially mentioned, of telephone and telegraph apparatus and telephone switches and switchboards	,,	1 50
Special apparatus for electrical purposes, not separately named, such as apparatus for signalling or conveying messages, Röntgen ray apparatus, apparatus for wireless telegraphy or telephony, also Jack panels for telephone switchboards ..	Dutiable as manufactures or materials of which they are made.	0 20
Electricity meters and other electrical measuring instruments	10% *ad. val.*	10% *ad. val.*
Water turbines and running wheels—		100 kilogs.
Weighing not more than 1,000 kilogs. net per article	,,	25 00
Of greater weight	,,	10 00
Steam turbines and internal rotatory parts thereof :—		
Each weighing not more than 100 kilogs. net	,,	75 00
Each weighing more than 100 kilogs., but not more than 1,000	,,	50 00
Each weighing more than 1,000 kilogs., but not more than 5,000	,,	30 00
Each weighing more than 5,000 kilogs.	,,	20 00

When different machines are imported joined together in such a way that they cannot be weighed separately, the weight must be ascertained at the cost of the owner by some other means which the Customs regard as satisfactory. The fact that a machine is imported in separate parts which arrive on different occasions shall not prevent the application of the rate applicable to the machine as a whole, if the importer so requires. In declaring machines in parts for clearance or warehousing, the owner must supply an explanatory statement and specification of the parts, together with a drawing.

ECONOMY OF ELECTRIC MOTOR APPLICATIONS.*

By Charles Robbins.

There are certain types of tools in which the operations to be performed require constant speed, for which service the constant-speed type of motor should be used. Other types of tools call for a cycle of duties, in which the range of speed may vary almost from minimum to maximum conditions. In these cases the adjustable-speed type of motor should be used for the greatest economy. There are, therefore, in a single shop two distinct service conditions calling for different types of motors, different methods of applying the motors to the tools, and different methods of control.

Where direct current is available, these conditions can be met by the direct-current motor, *i.e.*, both a constant-speed and an adjustable-speed motor is available for machine-tool work. On the other hand, the alternating-current motor is essentially a constant-speed machine. At the present time no commercial method has been found for varying the speed of an alternating-current motor in such a way that it can be successfully used for machine-tool service. Thus it is apparent that the machine-tool designer must take into account not only the application of the motor to the tool, but also the class of current supply available in the manufacturing establishment in which the tool is to be used.

Because of the simplicity and the great desirability of alternating-current motors, the railroad companies have adopted them almost exclusively for constant-speed service, as exemplified in the machinery of their wood shops, and for miscellaneous power purposes, such as pumping, operation of fans, driving incidental sections of line-shafting for supplying power to the smallest types of tools, on which it would be inadvisable to employ individual motors, and to tools requiring constant-speed motors.

For tools whose operation calls for adjustable speed, the standard practice is to employ direct-current adjustable-speed motors, using a controller conveniently located to the operator in such a way that the variation from minimum to maximum speed can be made with great facility, thereby affording a ready means of obtaining the maximum output for which the tool is designed.

The same scheme of operation can be very advantageously employed when using central station service for the operation of machine shops or metal-working establishments in which machine tools are employed. Such a standardisation of tool equipments by the tool builders and the motor manufacturers would tend to place the operation of metal-working tools on a more economic basis, in that it would enable better tool equipments to be designed with a definite certainty that the motor requirements could be forecasted.

In metal-working establishments, where the motors can be located on the tools, or to some extent in close proximity to the metal structure, it is desirable to use a relatively low potential, say 220 or 440 volts. Thus in a measure there has been established automatically a standard for alternating-current service, consisting of 60-cycle, 3-phase, 220-440 volt, this standard being that used by most of the largest single purchasers of metal-working tools, *i.e.*, the steam railroad companies.

The Economics of Motor Drive as Determined by the Actual Performance of the Tools.

The economy of the individual motor drive, due to the fact that practically the exact cutting speed can be obtained for any operation, has been pointed out. This economy is not so important, however, as that of keeping a tool in continuous operation through longer periods of time, by reducing the time required for handling and other avoidable delays.

In discussing the economics of motor drive there will be a number of terms used which are here given with our interpretation of their meaning.

Applied to the operation :

Time factor.—Ratio of actual cutting time to total time required to complete a machining operation = actual cutting time ÷ total time to complete operation.

Applied to a machine tool :

Time factor in per cent. = total daily actual cutting time in hours ÷ total number of working hours × 100.

* Abstract of a paper read before the American Society of Mechanical Engineers, April 12, 1910.

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Average running load.—Average imput to motor while operating, usually expressed in kilowatts, but may be expressed in per cent. of full load input.

For rough calculations in this paper the input of a motor in kilowatts is assumed to be the same as the output in horse-power; that is, the motor efficiency in all cases is assumed to be about 75%. This low percentage will take care of the fact that motors operate at light loads a considerable part of the time.

Maximum load.—Maximum input to motor, expressed in the same terms as the average running load.

Average load—Average daily load.—Average input to motor during the total working hours; usually expressed in kilowatts. This load multiplied by the total number of working hours gives the total kilowatt-hours consumed per day, and is the basis of payment for energy. The average load multiplied by the number of hours per day and by the price per kilowatt-hour gives the cost of energy per day. The average load also equals the average running load multiplied by the time factor.

Load factor.—The ratio in per cent. of the average daily load to full load rating of the motor, or load factor = average daily load ÷ full load rating of motor.

Conditions Entering Into the Operation of a Machine Tool.

In order to obtain a maximum output from a machine tool, a careful analysis must be made of all the conditions entering into the operation of the tool. One method of doing this in the case of a motor-driven tool is to take power readings at frequent intervals and lay these out on a chart basis. Another and a much more convenient method is the employment of a suitable meter, designed to make a graphic curve, showing the exact condition occurring in the service when such a meter is applied to any motor-driven tool. [The author here gives curves obtained in the machining of certain pieces of which drawings were shown. These are omitted here due to lack of space.—Editor.]

By means of this meter record it is possible to discover all delays, and to check the rate of cutting metal. Those are the two fundamental factors which determine the rate of output on machine tools. Any deviation from the standard cycle of operation which can be previously determined and a curve plotted therefor, is at once detected from the form of the record. Observations of cutting speed and feed need be taken in only one case. The record will not only show the deviation therefrom, but will also indicate whether the modification is an improvement or a drawback to the rate of output.

The elimination of delay, however, is not the only advantage to be obtained from the use of a recording meter. The saving in time is clearly shown. An analysis of records of this kind, taken over a period of several days, gives a means of determining the most economical feeds and cutting speeds to employ on a given operation.

An investigation by personal observations over a short period of time often leads to erroneous results, as is shown by the following experiments: In turning shafts on a roughing lathe, the first trial was with a cutting speed of 80 to 100 ft. per min., and a feed of 0·026 to 0·044 in. per revolution. In the second case, a cutting speed of 40 to 50 ft. per min. at a feed of 0·05 to 0·07 in. per revolution was employed. A single job could be completed in either case in 16 min., 12 min. being required for cutting. However, the average time per shaft, during several days operation, was 22·6 min., with the higher speed, and 21·6 min. with the slower speed. The same number of cubic inches of metal per minute was removed in each case; but with the higher speed, more frequent regrinding of tools was necessary, resulting in more delays and giving the lower speed 5% advantage in time saving.

Summary of the Uses of the Graphic Recording Meter.

By means of the graphic recording meter, the following improvements in shop management can be effected:

(*a*) If individual motors are used to drive machine tools, the exact percentage of total working hours consumed in actual cutting can be determined; it is found to average from 40% to 50%, the maximum being as high as from 60% to 65% where the cut is of long duration; the minimum from 20% to 30% where jobs are short and the delay long in waiting for material, drawings, etc.

(*b*) The meter reveals all delays and suggests measures for eliminating those not essential and reducing all others to the minimum, thus materially increasing the time factor. All delays shown should be accounted for, and an attempt made to avoid them. Common delays are in assignment of the next job, in obtaining drawings, tools and other necessary materials, and in waiting for crane service.

(*c*) The rate of cutting indicated by the power consumption of motor-driven tools can be checked with a recording meter. The maximum rate is limited only by the nature of the work, the strength of the machine tool and of the cutting tool.

(*d*) The rate for maximum economy can be determined for different classes of work; and the records, considered as standard, can be compared with other operations of the same character, to see whether the proper rates of cutting were used. In a finishing operation the rate depends upon the accuracy required. A record can be made while an expert machinist does the job, and this record should be referred to when other jobs of similar character are machined.

By the use of curve-drawing meters, and a careful study of the data obtained, the superintendent of a shop in which the individual motor-driven system is employed can set a limit fair both to employer and employés, for roughing, finishing, adjusting and setting-up. Different methods of doing the same job can be compared to determine which is the most efficient.

So far we have dealt chiefly with the time required to do machining operations, time being a most important consideration with shop managers and those who use machine tools. The power consumption, however, is also of some importance, especially to those requiring motors for machine tool operation.

Selection of Motor and Tool Equipment.

In the selection of a motor-driven tool, there are certain features which should be taken into account and properly analysed, and specifications drawn to cover them. If a tool is for specialised manufacturing, there should be specified:

(*a*) The exact class of work which the tool is to accomplish.

(*b*) If the power required to remove the metal is not known, then a statement should be made as to the approximate feed and cutting speeds to be taken.

(*c*) Careful analysis should be made of the time required to load and unload the machine, to determine the feasibility of employing auxiliary means other than manual labour for loading the tools.

(*d*) From this information, an approximate determination can be made as to the intermittency of operation of the tool, in order to decide whether an intermittently rated motor or a continuously rated motor will be required.

(*e*) By a knowledge of the physical shape of the work, determination can be made as to whether an adjustable-speed motor will result in economy of time, if used on this particular class of tool.

(*f*) This will enable the tool builder to determine upon the proper type of controller, and its most desirable location from an operating point of view for the workman.

If a special type of tool is not desired and it is preferable to purchase one with such characteristics that it can be used for general manufacturing, one should determine as nearly as possible the range of material or work for which it will be used in straight manufacturing operations. A knowledge of this will undoubtedly permit of a better motor and tool selection than the simple purchase of a standard stock tool.

It should be realised that under present schemes of operation few tools are in operation more than 50 to 60% of the time, whereas, the load factor of those tools may be as low as from 10 to 40%. Thus we have it brought home to us clearly that much of the time the tool is in idleness and is often operated at much less than its maximum capacity.

The direct-current motors are built for speed adjustment over a range of 1 to 2, 1 to 3, and in some instances 1 to 4. With the proper selection of controller the speed adjustments may be made in small increments of from 10 to 15%, and since these small increments of speed adjustments are

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available, it is essential that a controller be selected of such type that it can be mounted conveniently to the operator, so that he may take full advantage of them.

Where it is necessary to employ the alternating-current motor, it may be absolutely essential to employ a gear box to obtain the various speed adjustments. When such a machine is employed, the fine gradation of speed obtainable with a direct-current adjustable speed motor is absent, and the gear box will practically take the place of the ordinary cone pulley arrangement. It has, however, one advantage when motor-driven, and that is, that the tool is supplied with positive power at all times, and will take care of the maximum conditions without slipping or loss of power, which frequently occurs when belt drive is used. In some instances it has been found possible to make good use of the so-called multi-speed alternating-current motor. This form of motor consists in certain different types of windings, permitting of a multiple method of pole grouping, such as, for instance, a speed of 1,800, 1,200, 900 and 720 r.p.m., according to the method of winding the motor. In some cases, this type of constant-speed motor, when used in conjunction with a gear box, will permit of somewhat finer gradations of speed than are possible with a constant-speed alternating-current motor and a standard gear box.

General Conclusions.

The economical operation of a machine shop requires a thorough analysis of all the operating costs; that is, overhead and operating charges of all kinds, and an accurate knowledge of the operating conditions of all machine tools. Investigations of these conditions must be conducted by someone familiar with both the engineering and the shop features of the apparatus manufactured. The investigator should also be familiar with the characteristics of the various types of motors and methods of control, in order that the most advantageous electrical equipment as well as the best machine tool equipment may be installed, with suitable tools for different sets of conditions.

Such investigations lead to the following improvements which result in increased productive capacity: (*a*) More flexible arrangement of tools. (*b*) Greater facilities for handling materials at the tools. (*c*) Greater facilities for handling materials between tools. (*d*) Better facilities for obtaining auxiliary material, drawings, tools, etc. (*e*) Better facilities for making adjustment of the tools during machinery operation. (*f*) Removal of causes of unsuspected or avoidable delays due to small accidents and improper characteristics of the drive. (*g*) All lost time, due to whatever cause, and which can be avoided, is immediately brought to the attention of the superintendent, and an analysis of these losses will result in their elimination.

With motor-driven tools this analysis can be made much more conveniently and with less expense than can similar studies with any other form of machine-tool drive.

While in many shops there are elaborate systems of time keeping, with time clocks, etc., all of which are based on keeping an exact record of the workman's time and seeing that he works the maximum or full shop time, yet the most important consideration in manufacturing with machine tools is that the tools shall operate at their full capacity, on account of their greater hourly value.

In comment on this conclusion it may be said that our tests have not been confined to metal-working tools alone. We have found similar conditions in the wood-working industries, to some extent in cement mills, steel mills, brass and copper rolling mills, to a less extent in the textile mills, where it is a supposition that every machine is running the maximum number of hours, and at its maximum load at all times; and in several minor industries, in which the information therein contained is no less important, even though it might be different than that obtained with machine tools or metal-working tools, as ordinarily installed.

The Edison and Swan United Electric Light Co., Ltd. have brought out the seventh edition of Section VIII of their general catalogue, which deals with electric fans. These are shown in a large variety of forms.

The Typewriting Telegraph Corporation, Ltd.—Mr. C. S. Beale, 72, Bishopsgate-street Within, has been appointed liquidator of this company.

LOURENCO MARQUES ELECTRIC LIGHT.

At an extraordinary general meeting of the Delagoa Bay Development Co., Ltd., with Mr. H. K. Heyland, chairman, presided, when the following resolutions were adopted:

(1) "That each of the 32,600 shares of the company of £1 each at present unissued be sub-divided into two shares of 10s. each, and that the 65,200 shares resulting from such sub-division be numbered 267,401 to 332,600, inclusive."

(2) "That the capital of the company be reduced from £300,000, divided into 267,400 shares of £1 each and 65,200 shares of 10s. each, to £166,300, divided into 332,600 shares of 10s. each, and that such reduction be effected by cancelling capital which has been lost or is unrepresented by available assets to the extent of 10s. per share upon each of the 267,400 shares which have been issued and are now outstanding, and by reducing the nominal amount of each such issued share to 10s."

In the course of his speech Mr. Heyland said: In the circular addressed to you we tell you that we contemplate acquiring a controlling interest in the Electric Light Co. of Lourenco Marques. The acquisition of this property has been under the consideration of the board for some time past. For the last two years the Electric Light Co. has declared a dividend of 2½% on its share capital of £50,000. The interest on the proposed issue of £25,000 six per cent. debentures, which would be given to the Electric Light Co. in exchange for their £50,000 worth of shares, would amount to £1,500 per annum, or £250 per annum more than the dividend which has been declared by them for the last year or two. We have also told you in the circular that the Corporation's consulting engineers (Messrs. Mordey & Dawbarn) have reported that a considerable saving will result from the joint working of the two companies. For some time past the board has felt that the fact of there being two different electric power stations in Lourenco Marques is somewhat anomalous. To bring both under one management and administration must obviously result in a considerable saving in working costs. Therefore that saving will enhance the value of the shares of the Corporation. This economy will, I think, amount to some £1,500 to £2,000 per annum. We hope, at an early date, to submit for your consideration and approval a resolution for extending the directors' borrowing powers, so as to enable them to complete the proposed arrangements. That is, of course, with regard to taking over the Electric Light Co. of Louren o Marques. I may add that there is also really a third power station in Lourenco Marques belonging to the Portuguese Government for working their railway shops and, in part, their cranes in the wharf. We, at present, supply a certain amount of power to them for supplying their wharf, and we hope eventually to be able to come to some agreement with them for the supply of all the power they require for their wharf and railway purposes. Therefore I think it is obvious to you, and it appears to me to be sound, simple, pure, common sense, that if the three stations can only be merged into one, and that one belonging to the Corporation, it would mean considerable saving to the shareholders of the Corporation. I now beg to move the first resolution contained in the notice.

Mr. W. Bryson Butler seconded the resolution, which was carried unanimously.

The Chairman then formally moved the second resolution.

Mr. Bryson Butler, in seconding this, said that when the directors met the shareholders in November last he had an opportunity of referring to the comparative improvement which had set in in the affairs of the Corporation. That improvement, however, had only then been in progress for a very short time. On the present occasion—six months later—the directors were able to state that it had continued; so that they had had the experience of it for now nearly 10 months, and this had been the inducement to the directors to lay the present proposition before the shareholders, together with the fact that advantage was being taken of the opportunity to acquire control of the Electric Light Corporation, in doing which they thoroughly believed—and they were confirmed in their belief by the consulting engineers—that they were doing good business for the shareholders.

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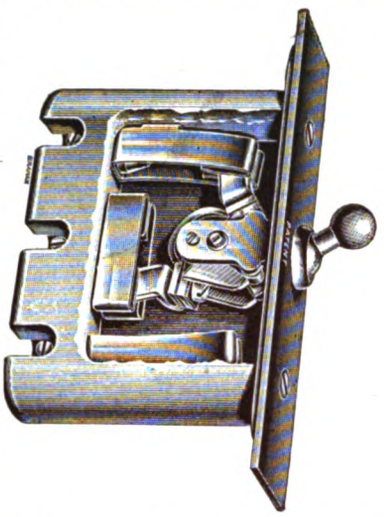
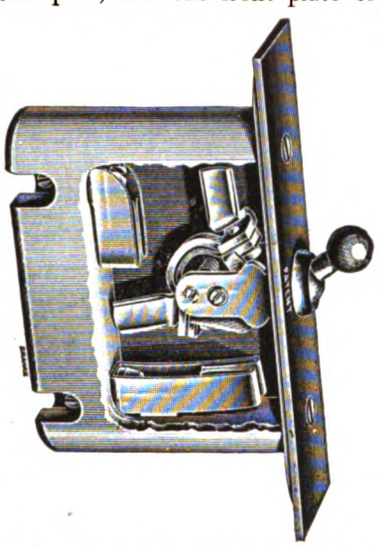
PANEL SWITCH.

Messrs. A. P. Lundberg & Sons have sent us a sample of their two-way "Klymax" panel switch of 5 amperes capacity. This is a new type for flush work, which has been produced to meet a demand for a narrow-pattern switch of minimum dimensions. In our illustrations the sides are purposely broken through to show construction. It will be readily understood that considerable economy in space, labour and material is obtained by its use. The switch movement adopted, and the arrangement of the contact springs and blades, are quite novel, being made under their Patent No. 17410/08. Mica and porcelain are employed for insulating the current-carrying from other metal parts. The switch is supplied in two types, single way and two way, which are identical in size. All moving parts are enclosed in a porcelain casing, and the fixing lugs are covered by a brass front plate 3 $\frac{1}{8}$ in. × 1 in. They also fit special fronts of other materials to requirements. The method adopted allows the articles to be grouped into very small space, and one front plate of comparatively small dimensions can be made to serve for a number of switches, which is a great advance. The break is quick and long, the contact arms being of the efficient knife-blade type entering double contact springs. The switches can be fitted into suitable iron boxes to meet requirements. When double pole and intermediate switches are required, these are simply and neatly obtained by coupling the knobs of two single or two way switches respectively, by a short cylinder piece. Two-pin wall connections of various gauges can also be arranged on the same porcelain parts, enabling combination sets to be made up in minimum sizes.





UNIVERSITY OF BRISTOL.

The following have been appointed External Examiners in the Faculty of Engineering :—

Civil Engineering.—S. M. Dixon, M.Sc., M.A., B.A.I. (Dublin), M.Inst.C.E. Professor of Civil Engineering in the University of Birmingham.

Mechanical Engineering.—W. Ripper, D.Eng. (Sheffield), M.Inst.C.E. Dean of the Faculty of Engineering in the University of Sheffield.

Electrical Engineering.—S. P. Thompson, D.Sc. (London), F.R.S. Principal of the Finsbury Technical College, London.

Mathematics.—P. T. Wrigley, M.A. (Cambridge). Lecturer on Mathematics in the Imperial College of Science and Technology.

Chemistry.—S. Young, D.Sc., F.R.S. Professor of Chemistry in Trinity College, Dublin.

CROYDON ELECTRICITY WORKS.

In the course of a lengthy and interesting report to his Council, Mr. A. C. Cramb, M.I.E.E., Borough Electrical Engineer of Croydon, declares that the effect of the metal filament lamp has continued to exercise a marked effect on the output, and although the nett increase in consumers over two years ago is 617, the electricity sold for lighting purposes is only 18,000 units more.

Last summer the following reductions in tariffs were made: Lighting, 4½d. to 4d.; public lighting from £16 to £15 per lamp. These reductions have resulted in the following concessions to consumers during the year: Lighting consumers, £1,274; public lighting, £315, making £1,589.

In addition to the above reductions in revenue, further large savings were effected by consumers more generally adopting metal filament lamps. The estimated loss of revenue resulting from this cause amounts to approximately £2,000. It appears that although these lamps were recommended two years ago to consumers, many only changed during this year, and even now a considerable number still adhere to the old type.

The total capital expenditure in 1909 was £343,464 4s. 2d., and in 1910 £348,341 0s. 2d., making an increase of £4,876 16s. The whole of this expenditure was incurred on distribution, and only becomes fully remunerative in time.

A further reduction has been made in the value of stores held, and the following figures show the progress made in this direction in five years: 1905, £5,380 11s.; 1910, £1,705 9s. 1d., a decrease of £3,675 1s. 11d.

The total expenditure in 1909 was £34,975 8s. 1d., and in 1910, £31,549 4s. 9d., a decrease of £3,426 3s. 4d. The works expenditure was in 1909, £18,974, and in 1910, £15,985, a decrease of £2,989. The total receipts were in 1909, £64,650 7s. 7d., and in 1910, £64,982 10s. 2d., an increase of £332 2s. 7d.

Although the output is 531,044 more units, the revenue shows only a small increase owing to large reductions in prices charged.

Some of the general details are of interest. The price per unit obtained for general supply fell from 3·4 in 1909 to 3·1 in 1910, a decrease of ·3. The number of units generated rose from 7,294,643 to 7,961,395, and the number of units sold from 6,040,551 to 6,571,595. The efficiency of distribution rose from 82·59% to 82·97%, an improvement of 38%, and we find the load factor raised from 20·92% to 22·85%.

If the cost per unit for 1909–10 had been the same as in 1903–4, working expenses would have been £18,800 more.

These economies in working expenses have enabled the Committee to reduce the prices charged so that consumers have paid approximately at the rate of £18,800 per annum less for electricity.

The total amount standing to the credit of the reserve fund is now £34,906 16s. 7d.

The mileage of cable now laid in the streets is 214, and there are 38 transformer sub-stations and pits. The replacement of all the old type transformers has been completed, and the new ones are giving satisfactory results, in better maintenance of pressure. The series gear will increase the life of the transformers, and is reducing the units lost in distribution. For street lighting, 253 arc lamps have been replaced by high candle metal filament lamps, doubling the light, and are giving satisfaction. A number of arc lamps in the centre of the town have yet to be replaced, otherwise all high candle power lamps have now been renewed.

The efforts of the Sales Department have given satisfactory results, and many consumers have expressed satisfaction at the inauguration of showrooms, where they can get advice.

There has again been a considerable increase in motors connected. The total horse power in motors is now 1,070, and in all cases the users express satisfaction, and, judging from enquiries received from time to time, it is only a question of time before practically all machinery in the area will be motor driven.

There has been a considerable amount of inquiry for electric cooking and heating, but as apparatus is not hired out, little business has resulted, and the restricted powers are severely handicapping the progress of the undertaking.

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COMPANIES REGISTERED.

NEW AFRICAN CONCESSIONS SYNDICATE.—£50,007, in £1 shares. Business: To acquire the undertaking of the African Concessions Syndicate, Ltd., (incorporated in 1895), to carry on business as suppliers of electric light, heat and power, sinkers of wells and shafts, builders and constructors of reservoirs, waterworks, etc., and to adopt an agreement with the said old company and its liquidators. Minimum cash subscription, seven shares. First directors are W. A. Wills, Hon. J. R. Delap Tollemache, A. H. D. Cochrane and W. Praeger and P. S. Inskipp. Qualification (except first directors), £100. Remuneration as fixed by the company.

RADIANT-HEATING.—Capital, £10,000, in £1 shares (2,000 6% Cumulative Preference). Objects: To carry on the business of engineers, mechanicians, manufacturers of steam and other engines, etc., and to acquire from W. A. Bone, J. W. Wilson and C. D. McCourt, the benefit of certain existing inventions and discoveries relating to heating apparatus. Private company. The first directors (to number not less than three nor more than five) are to be appointed by the signatories. Qualification £250. Remuneration, as fixed by the company. Registered office, Carlton Works, Armley, Leeds.

BRUSH ENGINEERING CO.

Foreign Competition and Electrical Industry—The Outlook.

The general meeting of the shareholders of the Brush Electrical Engineering Co., Ltd., was held at 1, Kingsway, W.C., Mr. E. Garcke (chairman) presiding.

The Secretary (Mr. F. M. Hodson) read the notice convening the meeting and the auditors' report.

The gross profit for 1909 amounted to £22,528. After debiting general charges and maintenance, the amount carried to net profit and loss account is £1,811. Debenture and other interest charges and bad and doubtful debts written off have absorbed the sum of £23,042, leaving a loss of £21,230. The volume of business secured in 1908 was, owing to the severe trade depression, much below the average, and the amount of work in hand at the close of that year was small. The conditions at the beginning of the year 1909 were therefore unfavourable, and although the orders secured in that year showed a considerable improvement over the previous twelve months, it was not possible to make up for the shortage of invoicing during the earlier months. The year 1910 will benefit by the larger volume of unfinished work in hand at December 31 last. As compared with 1908, a reduction of over £16,000 has been effected in the company's general charges for the past year. The directors regret that the depression which has so long affected the engineering industries of the country still continues, and, although there has been some improvement of late, the demand for steam and electrical machinery, as well as for rolling stock, is still far below the normal, and the great competition renders the prices obtainable for the most part unsatisfactory. There has, however, been an increased output from the works during the first five months of the year 1910, and it is hoped that this increase, coupled with the reduced working expenses of the company, will lead to improved results.

The Chairman said: When, last year, I accepted the position of chairman of this company, I did so without any allusion to the difficulties which had to be encountered or the responsibilities of the position. The past year has been one of great worry and anxiety to the directors and staff, and the best that I can say is that my anxieties with regard to the position are less now than they were a year ago. In my opinion, the troubles of this company and other similarly situated manufacturing companies are largely due to the excessive competition to which we are opposed, particularly from abroad. The foreign competition for electrical orders in this country is very keen, and reduces not only the output of English manufacturers, but also the price which we are able to obtain for our goods, and hits us also in other ways. The cost of obtaining orders is enormously increased by this competition, and, of course, it intensified the large competition which would exist in any case. If it were not for the imports from abroad, manufacturers in this country might be able to come to terms in regard to this destructive competition; but with the doors open, there is nothing to be gained by agreement among ourselves either with regard to output or prices. This position has been accentuated during the last few years by the advent of the metallic filament lamp, which has reduced the necessity for power house extension plant. We are also interested largely as manufacturers of rolling stock, and in that respect we have been hit particularly hard during the last few years by the fact that there have been very few extensions of railways, tramways, or light railways in this country, consequently the little profit we are able to make on the engineering side is more than neutralised by the cost of keeping open rolling-stock shops which are not fully employed.

In these circumstances the only thing to be done is to attend closely to all the details of the business and reduce expenditure to the smallest possible limits and to hold on until conditions improve. All electrical manufacturing concerns in this country are in a similar position; some are losing more than others, but all are working under most unfavourable conditions. We have during the past two years made very substantial reductions in our expenditure. These reductions are to some extent the result of a reduced volume of business, and do not imply unnecessary expenditure in the past; but it is satisfactory to observe that we have been able to make large reductions in our standing charges in response to the smaller volume of business. I am glad to say that during the current half-year business has been to some extent better. The engineering shops have more orders than for some time past, but until general conditions with regard to industrial undertakings in this country revive, we see little prospect of receiving orders for rolling stock to keep our large car-building shops employed. I could make a long speech with regard to our troubles, but I do not think anything more need be said. Everything is being done by the directors and staff to improve the position. As chairman, I am giving full attention to the affairs of the company, and Mr. Madgen (the vice-chairman) is attending to the business practically to the exclusion of all his other affairs, and I cannot speak too highly of the services rendered to the company by the officers. At the works they are working with all their might, contending against adverse circumstances and trying to overcome obstacles. At present it is an anxious time, and the shareholders must be patient. I will now move that the report of the directors and the statement of accounts to December 31, 1909, now presented, be received and adopted.

Mr. W. L. Madgen seconded.

In answer to questions, the Chairman said there was not a single item that was not clearly set out in the balance-sheet, and he did not think it was necessary to refer to them. With regard to the promise held out last year as to the metallic filament lamp, there had been more delay in putting it on the market than was anticipated. They must not expect him, in the difficult position the company was in, to make too hopeful a statement, and he would rather not say anything for which he might be held responsible at their next meeting. He could assure them no pains were spared by the Board to make the operations of the company successful, and all their efforts were in the direction of retrieving the position of the company. They must meet their liabilities. Their indebtedness with regard to borrowed money had been considerably reduced. Last year they had made an issue of prior lien bonds, but they had considerably reduced the amount of the loan.

The report and balance-sheet were adopted.

A vote of thanks to the chairman terminated the proceedings.

ELECTRICAL ENGINEERS TERRITORIALS (London Division).—Orders for week ending June 18:—Monday, June 13, "A" Co., Recruits' Infantry Drill, 6 to 6.45 p.m.; Technical Drill, 7 to 9.30 p.m. Tuesday, June 14, "B" Co., Recruits' Infantry Drill, 6 to 6.45 p.m.; Technical Drill, 7 to 9.30 p.m. Wednesday, June 15, Gynasium, 6 to 9.30 p.m. Thursday, June 16, "C" Co., Recruits' Infantry Drill, 6 to 6.45 p.m.; Technical Drill, 7 to 9.30 p.m. Friday, June 17, "D" Co., Technical Drill, 6.30 to 9.30 p.m.—(Signed) P. H. Campbell, Capt. R.E., Adjutant.

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PUBLICITY.

In this Section of "The Electrical Engineer" we give Publicity to New Inventions and Specialities.

Portable Instruments for D.C. and A.C.

Messrs. Nalder Bros. & Thompson, Ltd., of 34, Queen-street, London, E.C., have recently placed upon the market a complete line of portable, and portable standard instruments, suitable for continuous and alternating currents.

These instruments are of the dynamometer type, fitted with air-damping to render them dead beat; they have been carefully designed with a view to giving great accuracy on either continuous or alternating current circuits. The instruments have been thoroughly tested, under the varying conditions met with in practice, and give the most satisfactory results.

Instruments of this type comprise ammeters, voltmeters and wattmeters; they are fitted in portable polished wood cases with strap handle, lock and key, the case being protected with rubber feet, which ensure that no sudden jar shall be received whilst the instrument is in use, and are arranged with anti-parallax mirror. The pointers are of the edgwise pattern, and the scales very finely and accurately divided, so that observations can be taken at a considerable degree of accuracy. It will be noticed that the instruments are supplied with a zero adjustment, so that in the event of any slight variation in zero, it can be set quickly and easily.

One of the features of these instruments is that they can be made multi-range, thus the portable standard voltmeter illustrated shows ranges of 15, 150 and 600 volts (*see* Fig. 1).

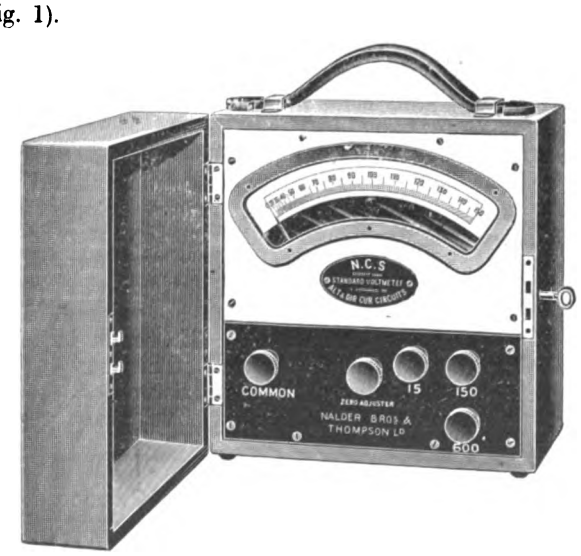

FIG. 1.

The ammeters are wound self contained for currents up to 50 amperes, beyond which portable series transformers are supplied.

The wattmeters are arranged self contained for pressures up to 300 volts, and currents up to 50 amperes. For pressure over 300 and up to 650 volts, an external resistance box is used and for currents above 50 amperes portable series transformers, as in the case of the ammeters. For high tensions circuits potential and series transformers are employed.

An excellent portable standard wattmeter just introduced is self-contained for circuit voltage up to 150 volts and not exceeding 20 amperes.

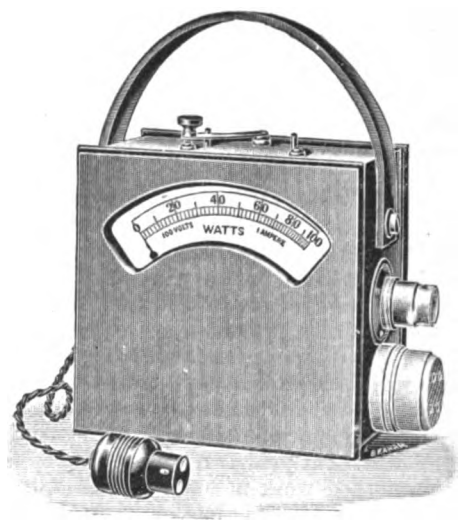

FIG. 2.

Another instrument suitable for continuous and alternating currents, and constructed on the dynamometer principle, is the lamp testing wattmeter, shown in Fig. 2. This instrument is arranged for two voltages, say 100 or 200 volts, and with a 2-way switch key, which when placed on the contact corresponding to the voltage required, is then depressed and an indication on the instrument obtained. The instrument reads directly the actual watts consumed. The instrument is fitted in polished wood case with strap handle, and one side carries the lamp-holder and fuse, and is equipped with a length of flexible wire fitted to a plug, which can be inserted into the standard lamp-holders.

The dynamometer type of dead beat instrument is also made in switchboard pattern case, black enamelled and nickel or copper finish.

In the construction of their instruments, we understand Messrs. Nalder Bros. & Thompson make a very strong point of the fact that they use only English material and strictly exclude everything of foreign origin, excepting, of course, such material as is not obtainable in this country.

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Contracts, Patents and Small Advertisements by 9 a.m. on Wednesday.

Terms for displayed advertisements may be had on application.

Second-hand Plant and Machinery Advertisements, 24 words 1s. per insertion, three insertions for 2s. 6d., each additional line of eight words 4d.

Situations Vacant, 24 words 1s., three insertions 2s. 6d.

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Municipal Central-Station Engineers and Tramway Managers are invited to send advance notes of new work being undertaken by them, and of successful results obtained from the undertakings under their charge.

Secretaries and Managers of Companies are asked to furnish Notices of Meetings, Issues of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers.

Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

Contractors can make use of our columns to obtain the names of the makers of any specialities they require in their business.

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BUSINESS AND ENGINEERING.

In his address to the Technical Department of Tulane University, New Orleans, Mr. G. H. Davis reminded his audience that Edison's recipe for success is 2% inspiration and 98% perspiration. But, of course, labour, whether mental or physical, must be guided by that small percentage of inspiration, which must itself be tutored by wisdom born of business capacity. "An engineer," said Mr. Davis, "himself must be an efficient engine maintained in perfect condition to the end of his career," for the best cannot be got out of either mind or body without health. But given health, the power to plod is within the reach of everyone, and training should bring ability to form swift judgment and to act promptly thereon. Another essential for the successful engineer is that he should be a skilful organiser of men and affairs. "Engineering skill, business ability, and capital resources are, singly or in combination, powerless without labour. No great engineering work has ever been executed without the aid of great bodies of men in concerted action. This means organisation and generalship. . . . . Leadership is not only essential to great engineering and operating results as illustrated in the officers of large railroad systems, but is equally as necessary in the mercantile, manufacturing and industrial corporations." Now, it is possible for a man to be an inventive genius, a painstaking plodder with the ability to perspire even to the limit of the prescription, he may be a born leader of men, and yet fail to make the most of his life and opportunities solely because the absence of native cuteness in the management of affairs has not been compensated for by sound business training. In these days of vast interests and complicated social and industrial organisation it is the business ability that counts, not only with the men at the head of affairs, but

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with all holding responsible positions in an organisation. Mr. Davis' plea, therefore, is that while an engineer should take a broad view of all that is necessary for him to learn in connection with his profession, and then specialise on some branch, he should also take efficient means to gain a business training. And in this phrase he includes office routine, shop management, and the higher branches of financing, patent and commercial law. "A complete knowledge of report forms, estimate forms, specifications, contracts and accounting is essential. An engineer should give a most exhaustive study to specifications and contracts. This knowledge is vital in business practice. Specifications cannot be too complete in detail, and contracts cannot be too specific and binding. When work is done under the most thorough specifications and supervision, there will still develop many imperfect features. What are owners obtaining for their money when work proceeds on faith alone?" Practically this means specialising on the "commercial side" in school life, for the student when he enters the engineering schools will have little time or opportunity for acquiring the elements and fundamental principles underlying business methods. There must be a sound foundation in early youth. But beyond this, says Mr. Davis, the engineer should take every care that the business side of affairs should not be neglected as he enters seriously on his career. Then, while keeping up with technical progress, he should devote considerable attention to details of organisation, to finance, and to commercial law. For all this is necessary in order to gain prominence in civil, mechanical or industrial engineering. There is much truth in this, and we are beginning to realise it on this side of the Atlantic, though there is still ample room for improvement in our school and technical college organisations in this direction. It should be recognised that the engineer, no matter what his special branch, is increasingly called upon to exercise power of organisation and to manifest business capacities of a high order.

CORRESPONDENCE.

All communications intended for the Editor should be addressed "THE EDITOR, 149, Fleet Street, London, E.C." Anonymous communications will not be noticed. Letters should reach the Editor not later than Tuesday afternoon to be included in that week's issue of the Journal.

The Editor is not responsible for, nor does he necessarily endorse opinions advanced by correspondents.

LOCATING "GROUNDS" IN A.C. SYSTEMS.

SIR,—The following description of an adaptation of the induction method of locating "grounds" in the alternating-current power system on these works may be of interest to some of your readers.

This method has been found very useful by me, especially in cases when it is desirable to locate a fault without shutting the power off the feeder or branch on which it occurs. The system is 3-phase, 440 volts, 50 cycles.

At the power station switchboard ground detectors are provided for each bus bar. Immediately the detectors show that a ground or partial ground has occurred, a 3-pole adjustable liquid rheostat consisting of three iron plates immersed in weak sodium carbonate solution contained in an iron drum is connected with the bus bars. The containing drum is connected to earth through an ammeter and a mechanically-operated oil-immersed contact breaker, usually driven by a small motor, and arranged to make and break the circuit about 1,400 times per minute.

The detector consists of an ordinary telephone receiver connected by a flexible cord with a rectangular coil about 30 in. long and 12 in. broad wound with 2 lbs. of No. 36 D.S.C. copper wire.

The overhead feeders all radiate from a cable tower about 30 ft. high. By walking round the tower, while holding the receiver to the ear and holding the coil under the various lines in succession, with its plane parallel to the lines, the faulty feeder can be readily distinguished by the loud rattling sound heard in the receiver. The strength of the current flowing from the drum to earth is adjusted by the rheostat till the sound heard is of the desired intensity. The operator now walks from the tower along the feeder or hands line guided by the sound until the fault is located. On these works faults have by this method been quickly and easily located in pole line lightning arresters, rubber insulated branch cables, and in the stator windings of motors, etc. The same method, with certain modifications, has proved successful in the location of faults in paper-insulated lead-covered underground telephone cables, of which some 15 miles are in use on the works.

Yours faithfully,

R. S. MANSEL.

Cape Explosives Works,
Somerset West,
Cape Colony.
May 17, 1910.

THE LIGHTING STRUGGLE IN LONDON.

The *Electrical World* of New York devotes an editorial to the fact that in your City of Westminster the gas company has scored a victory, of a sort, over the electric light undertaking. The writer says that the figures given in response to the tenders invited, indicated that the gas company was willing to lose a little money for the sake of glory, and that the electric company, more cautious as to finances, had raised itself out of the game. "The matter of renewals in the more powerful gas lamps," continues the *World*, "is one about which singularly little has been allowed to become public. Earlier experience with such lamps indicates that the mantles must be replaced very frequently in order to keep them anywhere near their rating. Observation upon mantle gas lamps in this country leads, for the smaller units, to precisely the same view. As a result, it is safe to predict that if the undertakers in this case are held rigorously to their contract specification of candle-power, they will not have a very pleasant time of it, and it is safe to say that the electric fraternity in London are quite active enough to see that their competitors are not allowed to escape their obligations. Meanwhile, it is interesting to note that the major part of the electric lighting in the city of Westminster is being done at a good price under a contract which runs until 1931, by which time there will be plenty of experience in press-gas and ample opportunity for the improvement of the arcs. Upon the whole, therefore, we are not disposed to extend commiseration to the electric company that lost the particular contract which is here under discussion. It looked, in fact, as though it had dexterously stepped aside and allowed its competitor to fall into a hole."

PERSONAL.

Mr. G. Tough, Borough Electric Engineer of Coventry, has had his salary increased from £350 to £450 per annum.

Mr. E. L. Harvey, South Shields Borough Tramway Manager, has had his salary increased from £250 to £300 per annum.

The death of Mr. Alfred Colsen, who for so many years filled with conspicuous ability the difficult dual position of manager of the Electricity and Gas Works of the Leicester Corporation, will be felt by a wide circle, for he was much respected both for his professional and personal qualities.

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Electrical Contractors' Section.

A Survey of New Things and Business Prospects.

NOTICE.

Contract and Miscellaneous Advertisements should reach this Office by Mid-day on Wednesday. For rates apply to the Manager, 153, Fleet Street, London, E.C.

CONTRACTS.

CORPORATION OF RAWTENSTALL.

ELECTRIC TRAMWAYS.

Contract No. 5: Permanent Way Construction.
Contract No. 6: Steel Poles, Overhead Line Equipment and Accessories.
Contract No. 7: Cables, Conduits, Trenching, Section Boxes and Accessories.

THE CORPORATION invites TENDERS for the LABOUR and MATERIALS required in the CONSTRUCTION OF A PROPOSED TRAMWAY along Burnley-road East from Bacup-road, Waterfoot, to Dean-lane, Water.

Plans may be seen, and copies of the General Conditions, Specifications, and Quantities, and Form of Tender may be obtained on and after June 10, 1910, for Contract No. 5 on application to Mr. James Johnson, Borough Engineer, Municipal Offices, Rawtenstall, and for Contracts Nos. 6 and 7 on application to Mr. C. L. E. Stewart, Borough Electrical and Tramways Engineer, Electricity Works, Cloughfold, near Manchester, on payment of the sum, as a deposit, of Five Pounds, which will be returned on receipt of a bona-fide tender, and the return of all papers, drawings, etc. Additional copies of either specification, etc., may be obtained on payment of half-a-guinea per copy, which will not be returned.

Sealed Tenders, on the prescribed forms, endorsed "Tender for Contract No. 5, 6, or 7," respectively, and accompanied by the General Conditions, Specification, Quantities and Drawings, must be delivered to the undersigned on or before July 1, 1910.

The Corporation does not bind itself to accept the lowest or any tender.

By order,
JAMES WHALLEY, Town Clerk.

Municipal Offices, Rawtenstall.
June 2, 1910.

CITY AND COUNTY OF BRISTOL.

TO ELECTRICIANS AND CONTRACTORS.

The SANITARY and IMPROVEMENT COMMITTEE of the CORPORATION are prepared to receive TENDERS for the Supply and Erection of ELECTRICAL PLANT and FITTINGS at the proposed Refuse Destructor, Eastville, Bristol.

The Drawings, General Conditions, and Specification may be seen at 63, Queen-square, and Copies of same obtained Deposit of Two Guineas, which will be returned on receipt of a bona-fide Tender.

Tenders must be made out on the forms provided, and all blanks must be filled in, otherwise they will not be considered.

Sealed Tenders, enclosed in the envelopes provided, must be delivered to 63, Queen-square, not later than 10 a.m. on MONDAY, June 13, 1910.

The Committee do not bind themselves to accept the lowest or any tender.

By Order,
THOS. HENRY YABBICOM, M.Inst.C.E.,
City Engineer and Surveyor.

Offices, 63, Queen-square, Bristol.
May 28, 1910.

UNIVERSITY OF BRISTOL.

TO ELECTRICAL ENGINEERS.

The Council of the University of Bristol invite TENDERS for the ELECTRIC LIGHTING and other ELECTRICAL WORK in connection with the NEW CHEMICAL and PHYSIOLOGICAL BUILDINGS, BRISTOL.

Specifications, with Forms of Tender, may be obtained at the Registrar's Office on or after MONDAY, June 6, on payment of £2 2s. for each Specification, which sum will be returned on the receipt of a bona-fide Tender.

By appointment the Drawings may be seen at the Offices of the Consulting Engineer, HERBERT THOMAS SULLY, M.I.E.E., Scottish Widow's Buildings, Baldwin-street, Bristol.

Tenders addressed to the undersigned, and marked "Electric Lighting," must be received not later than Noon on SATURDAY, June 11, 1910.

The Council will not be bound to accept the lowest or any Tender.

JAMES RAFTER, Registrar.

University of Bristol.

CONTRACTS OPEN.

HOME.

BELFAST.—Committee of Management of the Belfast District Asylum invite tenders for electric lighting installations in the new asylum buildings on the Purdysburn Estate. Particulars from Messrs. Watt, Tulloch & Fitzsimons, 77a, Victoria-street, Belfast. June 13.

BIRMINGHAM.—Corporation Tramways.—2,100 tons grooved steel girder tramway rails, together with fishplates, bolts, nuts, and tiebars. (Specification, £3 3s., General Manager, 147, Corporation-street). June 20.

BRISTOL.—Corporation invite tenders for supply and erection of electrical plants and fittings at the refuse destructor works. Drawings and particulars (42s.) from the Borough Engineer. June 13.

BRISTOL.—University of Bristol invite tenders for electric lighting and other electrical work in connection with new chemical and physiological buildings. Particulars from Mr. H. T. Sully, M.I.E.E., Baldwin-street, Bristol. June 11.

DEVONPORT.—Corporation invite tenders for supplies for year ending June 30, 1911, as under: (1) Direct current meters, (2) paper insulated cables, rubber covered wires and cut-outs, (3) lubricants and oils. Particulars from Borough Electrical Engineer. June 15.

EALING.—Borough Council invite tenders for surface condensing plant. Specification (£2) from Borough Electrical Engineer July 4.

ERITH.—Urban Council invite tenders for supply and erection of (1) Lancashire boiler complete with mechanical stokers, superheaters and all necessary fittings to couple up to existing steam range. (2) 750 kw. impulse turbo 3-phase alternator and exciter, complete with surface condenser, air and circulating pumps, etc. Particulars from Mr. A. Coveney, Electrical Engineer, Erith. June 20.

ILFORD.—Urban Council invite tenders for 1,600 yards of conduit. Particulars from Mr. A. H. Shaw, Electricity Works, Ilford. June 14.

LIVERPOOL.—Corporation invite tenders for three years' supply of tramway passenger tickets from January 1, 1910. Approximate annual supply 130,000,000. Conditions from Manager. June 22.

LONDON.—County Council invite tenders for the manufacture and supply of (*a*) 250 electric tramcar bodies, (*b*) 250 sets of centre-bearing swing bolster car-trucks, (*c*) 250 complete electrical equipments for operation upon both conduit and overhead trolley systems of traction. Specifications (40s. for each section) from Cashier, County Hall, Spring-gardens, S.W. July 5.

MORTLAKE.—Barnes Urban District Council.—Triple concentric, paper insulated, lead sheathed and jute scroll cable, 660 v., B.E.S. (4,000 yds., 25 ft. by 25 ft. 125 sq. in.). (Particulars, Engineer and Manager.) June 14.

PORTSMOUTH.—Corporation invite tenders for (*a*) one year's supply, (*b*) two years' supply of best Durham small and best North country screened Nut coal for the electricity department. Quantities, 10,000 to 12,000 per annum, from August next. Particulars from Town Clerk. June 22.

RAWTENSTALL.—Corporation invite tenders for labour and materials of an electric tramway: Contract No. 5, permanent way construction; No. 6, steel poles, overhead line equipment and accessories; No. 7, cables, conduits, trenching, section boxes and accessories. Particulars (£5) from Mr. C. L. E. Stewart, Borough Electrical Engineer. July 1.

SOUTHAMPTON.—County Council invite tenders for supply and erection of electric light plant, wiring for electric light, and installation of steam and hot water heating for the County Asylum, Knowle, Fareham. Specifications and plans (£5 5s.) from Mr. J. R. Wyatt, Clerk to the Committee of Visitors, Knowle. June 28.

WEST HAM.—Borough Council invite tenders for electric light installation at three schools. Specification (20s.) from W. Jacques, 2, Fen-court, Fenchurch-street, E.C. June 20.

OVERSEAS.

ADELAIDE, S.A.—Postmaster-General.—Cordless switchboards (Specification No. 3,381.) July 6.

ADELAIDE, S.A.—Deputy-Postmaster-General.—120 common battery switchboards, cordless, for private branch exchanges, four (4) line, equipped for two (2) extension and one (1) main line only; 70 common battery switchboards, cordless, for private branch exchanges, six (6) lines, fully equipped; 30 common battery switchboards, cordless, for private branch exchanges, ten (10) lines, fully equipped. (Specification No. 338.) July 6.

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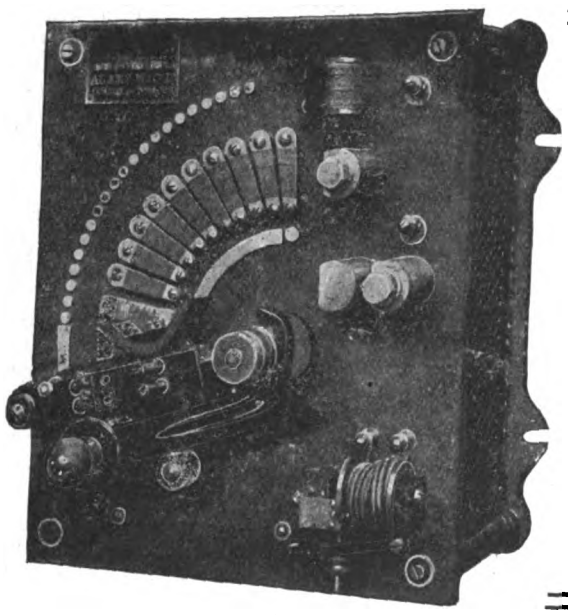

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Machine Tool Controllers

ARE USED.

PATENTS.

S. SOKAL, Chartered Patent Agent,
AND
Certified Austrian Patent Attorney (Patentanwalt), Specialist for German Patents and Patent Litigation.

55, CHANCERY LANE, LONDON, W.C.

THE PROPRIETOR of LETTERS PATENT No. 12210, of 1901, relating to "Electrostatic Separators," desires to dispose of the Patent or to grant licences to interested parties on reasonable terms with a view to the adequate working of the Patent in this country. Enquiries to be addressed to CRUIKSHANK & FAIRWEATHER, Ltd., International Patent Agency, 65-66, Chancery-lane, London. W.C.

THE PROPRIETOR OF THE PATENT NO. 13891 of 1907, for "Apparatus for Treating Liquids Electrolytically," is desirous of entering into arrangements by way of license and otherwise on reasonable terms for the purpose of exploiting the same and ensuring its full development and practical working in this country. All communications should be addressed in the first instance to—HASELTINE, LAKE & Co., Chartered Patent Agents and Consulting Engineers, 7 and 8, Southampton-buildings, Chancery-lane, London, W.C.

PLANT FOR SALE.

Advertisements under this heading: Twenty-four words, 1s. per insertion; three insertions for 2s. 6d.; or each additional line of eight words, 4d.

EIGHTY MOTORS AND DYNAMOS for sale or hire.—MARTIN, 320, Witton-road, Birmingham.

PLANT WANTED.

PLATINUM UTENSILS, SCRAP, LAMP TOPS.—Best prices given by DERBY AND CO., LTD., 44, Clerkenwell-road, London, E.C. N.B.—Platinum Sold.

MISCELLANEOUS.

FOR SALE.

COMPLETE VOLUMES of THE ELECTRICAL ENGINEER for years 1906-7-8, bound in neat red covers; also for 1909 (half-year), unbound, with loose cover. All in very good condition. What offers?—BOX M, 45, c/o THE ELECTRICAL ENGINEER, 149, Fleet-street, London, E.C.

SITUATIONS VACANT.

WELL established firm of Engineers, Birmingham, have vacancy for young man desirous of gaining insight and experience in commercial and technical branches. No premium asked for, but highest references required from applicant, who must be willing to learn and work. Permanency offered or assistance to salaried post when qualified if satisfactory.—Address, Box 45, c/o THE ELECTRICAL ENGINEER, 149, Fleet-st., E.C.

REPRESENTATIVE WANTED in England by a leading incandescent lamp factory for the sale of their first-class carbon filament incandescent lamps. Offers should be addressed to—Z2244Q, HAASENTEIN & VOGLER, Basle.

SITUATIONS WANTED.

WIREMAN WANTS WORK, 12 years' experience; screwed conduit.—G. H., 14, Sterndale-road, West Kensington.

WIREMAN wants sit. or job power lighting telephones, bells.—E. C., 65, St. John's-hill, Clapham Junction, S.W.

ENGINEER seeks CHARGE ELECTRIC PLANT; gas or petrol engines, or Engineer in factory; lathe experience, all branches engineering; married.—ENGINEER, 28, Adelaide Road Chislehurst

GOOD WIREMAN, Coil Winder, age 19. Four years' experience.—W. S., 51, Blackheath Hill, S.E.

ENGINEER (General) desires situation, railway and lighting experience; good draughtsman, speaks Spanish; splendid references.—H., 25, Finborough-road, South Kensington.

THE ELECTRICAL ENGINEER REPRINTS.

New Series No. 1.

"LIGHTNING CONDUCTORS,"

By ALFRED HANDS, F.R.Met.S.

Author of "Scientific Protection," "A Guide to the proper Application of Lightning Conductors," "Lightning and the Churches," etc.

PRICE THREEPENCE.

Post free, Threepence Half-penny.

THE ELECTRICAL ENGINEER, LTD., 149, Fleet Street, London, E.C.

ANTWERP.—Lower Scheldt Works.—Electric lift for vehicles on floating pier. Dep., £320. Specification No. 19, 2d., plans 1s. 5d., Direction du Service Spécial de l'Escaut Maritime. June 16.

BELGRADE.—Monopolies Administration.—One five-ton electric crane. (Dep. 20%.) (Particulars, Administration Autonome des Monopoles.) June 25.

MELBOURNE.—Postmaster-General.—400 telephones, wall sets, magneto, complete (specification No. 220 and pattern C. No. 11); and 200 telephones, bridging table (specification No. 221, and pattern N.S.W. 339, schedule 321.) July 9.

NIMEGEN, HOLLAND.—Steps are being taken by a committee, called "De Maaskanter," to obtain powers for extending the Nimegen-Wychen-Dreumel light railway to various districts in the vicinity of the present line. It appears further that, in all probability, the Nimegen Town Council will shortly take over the steam tramways at present worked by the "Nymeesche Tramwegmaatschappij," in which event arrangements will be made immediately for the substitution of electric for steam traction throughout the system.

ROME.—Italian State Railways invite tenders for supply of: 19,600 glass shades for electric lights in railway carriages: tenders will be received up to June 14. Tenders should be addressed to the "Direzione Generale delle Ferrovie dello Stato, 16, Via Ludovisi," Rome. Only those firms (Italian and foreign) on the special list kept by the Italian State Railways Administration are generally allowed to tender.

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It is impossible to start the Motor with a weak field and the shunt resistance is split up into a large number of sections giving gradual and easy acceleration.

"IGRANIC" Controllers are made in the largest electric control factory in this country.

They have 20 years' experience behind them — experience gained by experts who have devoted their brains and energies to the one subject of Electric Control.

Descriptive pamphlet post free on request.

ADAMS' MANUFACTURING CO., LTD.,

106, New Bond Street, London, W. Works: Bedford.

ROME.—Tenders are invited by the Italian State Railways Administration for the supply of the following: (1) 200 junction boxes for electric current and 100 plugs; tenders will be received up to June 8. (2) 3,000 tyres for locomotive and tender wheels; tenders will be received up to June 8. (3) 6 parallel lathes; tenders will be received up to June 26. Tenders should be addressed to the "Direzione Generale delle Ferrovie dello Stato, 16, Via Ludovisi," Rome. Only those firms (Italian and foreign) on the special list kept by the Italian State Railways Administration are generally allowed to tender. Local representation is, in any case, practically necessary.

THE HAGUE.—An application has been lodged in respect of a concession for the working of a line of electric tramways from The Hague to Leyden, *via* Wassenaer.

TENDERS ACCEPTED—Home.

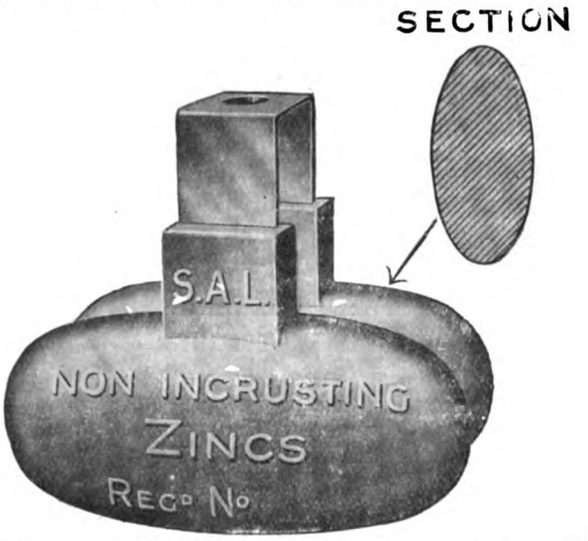
LONDON.—The County Council have accepted the following tenders: (1) Supply of car bodies with roof covers for London County Council tramways—Hurst, Nelson & Co., Ltd., Motherwell, N.B., £14,040 (accepted); The Brush Electrical Engineering Co., Ltd., Loughborough, £14,469; The United Electric Car Co., Ltd., Preston, £14,742; The Metropolitan Amalgamated Railway Carriage and Wagon Co., Ltd., Birmingham, £15,366. (2) Supply of swing bolster trucks for London County Council tramways—The United Electric Car Co., Ltd., Preston, £4,880 (accepted); Hurst, Nelson & Co., Ltd., Motherwell, N.B., £4,980; The Metropolitan Amalgamated Railway Carriage and Wagon Co., Ltd., Birmingham, £5,040. (3) Supply of electrical equipment for cars on London County Council tramways—The British Westinghouse Electric and Manufacturing Co., Ltd., London, W.C., £12,753 (accepted); Dick, Kerr & Co., Ltd., London, W.C., £13,006 10s.; The British Thomson-Houston Co., Ltd., London, E.C., £13,045 10s.

NOTES.

Non-Incrusting Battery Zincs.

More than once recently we have had occasion to mention the thoroughly practical aluminium soldering process placed on the market by the Standard Alloys, Ltd. It is with pleasure that we draw attention to an equally important and steadily growing branch of this firm's business, the manufacture of non-incrusting battery zincs. Unlike ordinary zincs—which are merely surface coated with mercury—the metal is chemically treated and uniform throughout, with the result that corrosion is equalised

and the life of the zincs considerably lengthened. Apart from this essential difference as regards amalgamation, it will be seen from our illustrations that the Standard Alloys people have also introduced radical novelty in design. The zincs for Leclanché cells for ordinary domestic use as well as for telegraph and telephone work is triangular, with rounded edges. This not only conduces to equalising of loss, but also greatly facilitates cleansing, as only three scrapes are necessary. It will also be observed that the wire of the ordinary zinc has been replaced by a screw terminal, to receive the connecting wire, which can easily be covered over with insulating tape. Perfect contact is thus obtained and safeguarded, without the trouble



and inconvenience of soldering. The other type is equally original. It is intended for gravity Daniel cells, chiefly used for traction work. The peculiar form, oval with rounded edges, has been adopted after lengthy experimentation as giving the best results as regards activity and wear. Instead of being eaten away unequally, they simply dwindle away gradually, retaining their original shape until the end. These zincs mark a distinct advance in manufacture.

Central Battery Instruments and Telephone Condensers.

Messrs. Siemens Bros. & Co., Ltd., are bringing forward two sets of appliances worthy of particular attention, both for private house and business premises work. Their central battery telephones are arranged to work with every type of central battery switchboard, the patterns being suitable for fixing on walls, sides of tables, as well as for standing on desks or tables. The hand micro-telephone supplied with most of the types is similar to the latest Post Office standard instrument. They are carefully made and look extremely well. Another branch of telephony is represented by the condensers. These are of the rolled type, being built of tin-foil and specially prepared and impregnated paper. They are particularly compact, and are made in several sizes and shapes to suit general conditions and requirements of telephone and telegraphic work. Illustrated leaflets with full details of both sets of appliances are issued.

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Laboratory Equipment.

In these days of careful school equipment, scientific and popular lecturing, and private experimentation, laboratory appliances for electrical work are increasingly asked for. Mr. Robert W. Paul, who has long made a speciality of electrical and scientific instruments of precision and experimentation, has just issued a capital little pamphlet on "The Equipment of a Modern Elementary Electrical Laboratory," and has thereby filled a want which has often been expressed, but only received partial satisfaction. The little book is concisely written, but is most interesting and is well illustrated. It contains a list of fifty experiments, covering a wide field of exposition, the instruments required in each case being stated. It may be well to state that the book has been read and has met with the approval of such leading technical teachers as Dr. S. P. Thompson, of the Finsbury Technical College, Professor T. Mather, of the Central Technical College, Dr. Drysdale, of the Northampton Institute, and Dr. Sumpner, of the Birmingham Municipal Technical Institute. It ought to find its way into the hands of every science master and every serious student.

Candle-Shaped Osram.

After careful attention to points of manufacture, the General Electric Co. have been able to produce their standard pattern, 10 c.p. Osram candle-shape lamp, 25, 33, 50 and 55 volt, in a globe measuring 26 mm. in diameter. The shoulder of the cap measures only 23 mm.; therefore, the lamp is suitable for using in practically all designs of candle fittings. From the illustration it will be seen that the lamp in its new form is particularly attractive, lending itself well for most forms of decoration. Being all of one size they are all interchangeable. The price will remain as before, viz., 3s. 3d. each.

CONTRACTS WORTH WATCHING:—

Below is a list of contracts recently given or tenders invited. Although we have no means of ascertaining whether in all these cases electricity is to be used, it is to be presumed, from the nature of the cases that this will be so.

Acton.—The District Council propose building a school for 850 children.

Belfast.—Early in the autumn the Senate of the Queen's University propose enlarging the buildings, at a cost of £52,000.

Bentham.—Education. Architect, Wakefield. Head Teacher's house.

Bristol.—Messrs. Bernard & Son, surveyors, 26, Orchard-street, Bristol: Extension of Infirmary: new ward for 180 beds; operating theatre and consulting department.

Chester.—Mr. J. Strong, architect, 11, Dale-street, Liverpool. Fire Station.

Dewsbury.—Messrs. Kirk, Sons & Ridgway, architects, Market-place. Alterations and additions to Club.

Durham.—Mr. F. E. Coates, Shire Hall, Durham. Alterations and additions to two schools.

Edinburgh.—The Corporation have invited designs for a new hall in Lothian-road. These are to be adjudged in July, and building should commence in the autumn.

Halifax.—Messrs. Medley Hall & Son, architects, Halifax. Eight dwelling houses.

Kirkham.—Messrs. Croft & Son, contractors, Preston. Graham School, at cost of £8,000.

Merthyr Tydfil.—Mr. F. Harvey, Borough Engineer. Alterations and additions to Cyfarthfa Castle, for conversion into a secondary school.

Tendring.—Mr. G. H. Page, Trinity-chambers, Colchester. Reception Home for children at Workhouse.

West Ham.—Borough Engineer. Attendants' quarters at Convalescent Home.

West Hartlepool.—Mr. Stanley Rogers. Renovation of Grand Theatre.

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SPECIALISTS
IN
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F. CARSON & EVANS.
34 Fenchurch Buildings
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The Latest and Most Novel Patterns.
The Best and Cheapest in the End.
For Lists and Particulars apply to
The Leysner Electrical Instrument Coy.,
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THE ONLY EFFECTIVE SOLDER FOR ALUMINIUM AND ITS ALLOYS
S.A.L. ALUMINIUM SOLDER
EASY TO USE
PERMANENT JOINTS
LOW MELTING POINT
NO FLUX REQUIRED.
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TRADE MARK
6½ PER SAMPLE STICK
1/6 PER LARGE STICK (QUARTER POUND)
REPAIRS BROKEN & CRACKED CASTINGS COOKING UTENSILS &c EQUAL TO NEW.
Write for trade terms, showcards and particulars to—
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Telegrams: "Cuivre, London."
Telephone: 196 Eastern.
66"
COPPER EXPANSION PIECE.
EXHAUSTING TURBINE ENGINES.
HIGH-CONDUCTIVITY CASTINGS & COPPER FORGINGS
JOHN DORE & CO.
Coppersmiths and Brass Founders,
BROMLEY, LONDON, E.

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Which retain their high efficiency under the most severe working conditions.

JOINTING COMPOUNDS & BOX COMPOUNDS.

MAJOR & CO., LTD.,
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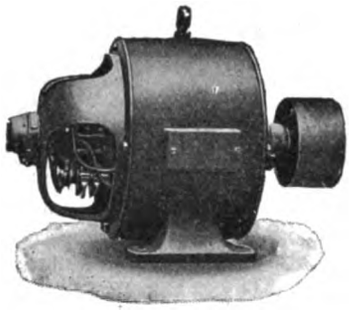

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Large discount allowed to retail dealers.

Expert representatives required.

TECHNICAL CLASSES.

ENGINEERING AND CHEMISTRY.

CITY AND GUILDS OF LONDON INSTITUTE.

There are two City and Guilds Colleges providing Courses of Instruction in Engineering and Chemistry. The **City and Guilds Central Technical College** (Exhibition Road), and the **City and Guilds Technical College, Finsbury** (Leonard Street, E.C.). The Entrance Examinations to both Colleges are held in September, and the Sessions commence in October. Particulars of the Entranc Examinations, Scholarships and Courses of Study, may be obtained from the respective Colleges, or from the Head Office of the Institute, Gresham College, Basinghall Street, E.C.

CITY AND GUILDS CENTRAL TECHNICAL COLLEGE.
(EXHIBITION ROAD, S.W.)

A College for higher Technical Instruction for Day Students not under 16 preparing to become Civil, Mechanical, or Electrical Engineers, Chemical and other Manufacturers, and Teachers. The College is a "*School of the University of London*," and also forms the *Engineering Section of the Imperial College of Science and Technology*. The Entrance Examination includes the subjects of Mathematics, Mechanical Drawing, Physics, Chemistry, English Composition, and French or German Translation, and the Courses of Study for the Associateship of the Institute cover a period of three years. Fees, £36 per Session. Professors :—

Civil and Mechanical Engineering ..	W. E. DALBY, M.A., B Sc., M.Inst.C.E., (Dean for the Session).
Electrical Engineering	T. MATHER, Wh. Sch., F.R.S.
Chemistry	H. E. ARMSTRONG, Ph.D., LL.D., F.R.S.
Mechanics and Mathematics ..	O. HENRICI, Ph.D., LL.D., F.R.S.

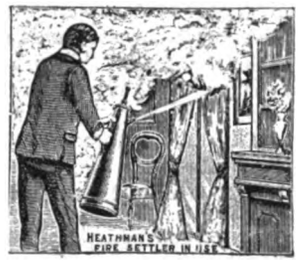
CITY AND GUILDS TECHNICAL COLLEGE, FINSBURY.
(LEONARD STREET, CITY ROAD, E.C.)

A College for Day Students preparing to enter Engineering and Chemical Industries, and for those who have already served an apprenticeship, and also for Evening Students. The subjects of the Entrance Examination are Mathematics, and English Composition and Precis Writing. The Day Courses in Mechanical or Electrical Engineering cover a period of two years, and those in Chemistry three years. Fees, £20 per Session. Professors :—

Physics and Electrical Engineering	SILVANUS P. THOMPSON, D Sc., F.R.S., Prin. of the College.
Mechanical Engineering and Mathematics ..	E. G. COKER, M.A., D.Sc., F.R.S.E., M.Inst.M.E.
Chemistry	R. MELDOLA, F.R.S., F.I.C.

City and Guilds of London Institute,
Gresham College, Basinghall Street, E.C.

HEATHMAN FIRE SETTLER



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Telephone No. 9999 Central. Telegraphic Address; "Standardizing, London."

Tests every kind of Electrical Instruments, Apparatus and Material.

A Scale of Fees will be sent on application to the SECRETARY.

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Electrical Progress at Home & Abroad.

A Review by our Special Correspondents.

TYNESIDE.

NEWCASTLE-ON-TYNE.

Following my notes in a recent issue concerning the claims of the Tyne as a suitable location for a naval repairing base, it may be of interest to mention that on July 7 the First Lord of the Admiralty is to receive a deputation representing the associated Chambers of Commerce of Great Britain in order to discuss the question. It will be remembered that in March a resolution proposed by the Newcastle delegates that such a base was necessary, and that steps should be taken regarding the matter was passed by the Association of Chambers of Commerce in London. Besides Newcastle and Gateshead, the other municipalities on Tyneside, together with Hull, will be represented on the deputation, and one may now hope for a speedy settlement of a question interesting to engineers of every description.

Mechanical Coal Cutting.

The labour-saving qualities of mechanical coal cutters, including those operated by means of electricity, have brought in their train a certain number of industrial complications arising from the dislike of the hand-hewer to his supersession by the "iron man." Although in most instances these difficulties have been satisfactorily overcome, one occasionally comes across movements such as that introduced by the Ashington delegates to the Northumberland Miners' Council at their recent annual meetings. This was in effect a prohibition of tendering for "bargains" in any seam, or for any "bargains" in connection with coal-getting machinery, such as the Dix, percussion, chain or bar type, where tonnage prices had not been paid, and to seek to have work of this nature paid for by the shift at the coal fillers' wages. In relation to coal getting, one effect of the recent scare with regard to electricity in mines was that electric coal cutters were thrown out of the pits in several instances; but I now understand that in some cases these have been restored. There are, however, advocates among the electricity supply authorities in this area of discouraging the use of electric coal cutters on the pressures usually adopted for electrical installations in collieries, having regard to insulation risks and the relatively small power demand which the coal cutters make in relation to pumps, haulages and fans.

Traction Undertakings.

Electric traction has not appeared in an altogether favourable light in this area during the past week. In the first place, the fact that the affairs of the Sunderland District Electric Tramways, Ltd., have reached an acute stage, rendering the appointment of a receiver necessary on behalf of the debenture holders, has not tended to encourage public opinion on the north-east coast in favour of electric traction. It appears that no interest has been paid on the preference or ordinary shares, and at a shareholders meeting in May it was stated that the debenture holders interest due on July 1 would not be paid. This disappointing result is probably due very largely to the heavy industrial depression which has existed in this area for some time. This view is strengthened by the fact that in spite of the splendid work accomplished by Mr. A. S. Blackman, the electrical engineer to the Sunderland Corporation, in reducing working expenses, the municipal electrical undertaking has shown a loss of £112 at the end of its last financial year. It is probable, moreover, that but for the careful management displayed the loss might have been much greater. On the other hand, it is pleasant to record that the South Shields Corporation have marked their appreciation of the satisfactory results of their tramways undertaking, reported last week, by increasing the salary of their tramways manager, Mr. L. E. Harvey, to £300.

General Trade.

A very curious state of affairs appears to exist at present among the electrical industries on Tyneside. Although there are positive signs of a general improvement in the shipbuilding and engineering industries, bringing in its train more work for electrical engineers, the electrical firms in the area are, almost without exception, complaining of the dearth of orders. Why this should be the case is most difficult to understand. In the meantime it may be of interest to record that Messrs. Siemens Bros. & Co., Ltd., have obtained an important contract to lay a submarine telegraph cable between Newbeggin, on the Northumberland coast, and Arendal in Norway, involving a cable of about 400 miles in length. It is reported that the North Eastern Railway are contemplating the conversion of the premises at Darlington occupied by their paint shops into a power house, and that tenders may shortly be enquired for in connection with the requisite machinery. In connection with the big developments which are proceeding at Darlington, however, it is satisfactory to note from a recent speech by Mr. Wilson Worsdell, the retiring chief mechanical engineer, that it is not in contemplation to reduce the engineering work of the company at Gateshead to any serious extent. Another interesting rumour which, if correct, is of very great importance, is that the Mercantile Dry Dock Co., Ltd., of Jarrow, are contemplating the electrification of their graving dock, including a supply of lighting and power from the mains of the power in bulk supply company operating on the south side of the Tyne.

THE MIDLANDS.

BIRMINGHAM.

An interesting contribution upon the construction of the electric furnace was made by Mr. J. H. Stansbie, of the Municipal Technical School, during a discussion on "Refractory Materials," at a meeting of the Birmingham Metallurgical Society last week. He referred to Moissan's experiments with lime, magnesia and carbon. Working at the temperature of the electric arc, in the region of 3,500° C., Moissan found that the only refractory substance not liquefied under these conditions is carbon. Nothing can remain solid in the electric arc except the carbon rods between which it is formed, and even these are rapidly volatilised without passing through the liquid state. Lime, when pure, shows no sign of fusion or even softening at 2,000° C. (the estimated temperature of the oxy-hydrogen blowpipe flame), but Moissan found that with a current of 800 amperes at a pressure of 110 volts he could volatilise over 100 grams of lime in five minutes. Therefore, said Mr. Stansbie, the lining of an electric arc furnace, composed of lime, will gradually disappear by volatilisation, though it is only where the furnace cavity is very small that the volatilisation is rapid. As the size of the furnace space increases, the power absorbed remaining the same, the temperature of the walls decreases, and only glazing of the surface takes place. The low conductivity of lime for heat, however, is an important factor, as this material allows practically the whole of the heat developed in the furnace space to remain there, with consequent increase in temperature. But the reaction which takes place between lime and carbon at electric arc temperatures, by which calcium carbide is formed, limits its use when carbon is to come in contact with the lining.

Magnesia.

Magnesia does not react with carbon to form a carbide, but it is a good conductor of heat. Moissan got over the difficulty by using plates of magnesia backed by blocks of

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lime. Another method was to use carbon plates for the inside lining with thin plates of magnesia between them and the lime. The principal objection to carbon for furnace lining is that metals brought into contact with it very often take up some of it and are thus rendered impure. Magnesite bricks gave good results when carefully used. An excellent form of arc furnace for experimental work could be made by chipping out the crucible cavity from two bricks and clamping them together to form the body of the furnace. The top was formed by a third brick chipped out, so as to form a dome over the crucible cavity. The carbon rods for making the arc passed through channels in the ends of the furnace. The substance to be heated was placed in a carbon crucible standing in the furnace cavity just below the carbons and clear of them. The magnesite soon showed signs of glazing, but the furnace might be used a number of times before it broke down. The temperature of this furnace, when working with a current of 100 amperes at 110 volts (about 13 h.p.), was estimated by Mr. Whipple, of Cambridge, on a recent visit, at 3,400° C. Mr. Stansbie gave the following as the analysis of a magnesite brick he was now using supplied by Messrs. Grayson, Lowood & Co., of Deepcar: Magnesia, Mg O, 91·06, Silica Si O_2 4·44, oxide of iron $Fe_2 O_3$ and alumina $Al_2 O_3$ to ·8. In resistance arc furnaces, as used on a large scale, Mr. Stansbie said, the temperatures reached are much lower, and dolomite lime is a much used material, especially for bed linings. The presence of silica in such materials was necessary if it was to possess good working properties.

Tramway Rail Welding.

The Birmingham Municipal Tramways are being made the object of what is locally a novel experiment in permanent way construction. In connection with the relaying of rails in High-street, Bordesley, electric welding has been brought into use, the contract for the work having been obtained by the Tudor Accumulator Co., Ltd. The particular form of the process adopted by this firm is stated to be a German invention introduced to this country about 12 months ago. The plant required consists of a welding wagon, containing a motor generator, and an electric grinding machine. The originating current being obtained from the tramway overhead wires. The transformed current is carried by a flexible cable to the rail joint, and the arc formed between the carbons of the welding lamp reduces the alloy steel applied to the joint to a liquid state in a few minutes. Both top and bottom flanges of the rail are thus welded and the surface is afterwards smoothed with the electrical grinding machine. The object is to form the line into a continuous rail and so reduce the jolting and the consequent wear and tear of rolling stock.

LANCASHIRE.

MANCHESTER.

There are indications that considerable extensions of plant will be put down shortly by some of the smaller towns in the district. These extensions are required principally to meet the demands which works and mills generally are now making for electric power. Many causes lead factories now using other forms of power, to enquire into the advantages of electricity. Steam engines wearing out or becoming too small is one great cause, and at present many works find it much cheaper in cost alone to take a supply from the mains and scrap their old plant than to buy a new engine plant of their own. Another cause of power load coming on to the station is the sad experience of those who have tried gas engines, in small or fairly large units, and found them wanting. The gas engine is rapidly making a most unenviable reputation for itself in the Lancashire towns. It works well for the first few years, in skilled hands, and then gives continual trouble till replaced by motors. Every power station can show several notable instances of gas engines which had to be taken out on account of unsatisfactory performance, and replaced by motors. Few gas works can show instances of motors turned out by gas engines, through causes other than fancied expensiveness, and still fewer can show that these conquests have not in their turn become reverses, with the motor back again.

Developments at Ashton.

It will be remembered that a Local Government Board Enquiry was recently held here to consider the borrowing of £48,000 for plant extensions. The result of this enquiry is not yet known, but it is hardly likely that sanction to proceed with the work will be withheld. At present the system at Ashton is low tension D.C. only, for lighting, traction and power. In order to cope with the demands for power which have been made during the last two years—amounting to several thousand horse-power, more plant is urgently required. This it is proposed to supply by a 3,500 volt, 50 cycle, 3-phase system. The proposed lay out is intended for 10,000 h.p., but this will not be all installed at once. The steam plant will consist of 8 watertake boilers, or possibly of 10 Lancashires. The buildings will be extended to provide space for half the capacity of the lay out, and a new chimney will be erected. Steam turbines will be used, for which the present section of engine room, though rather cramped for reciprocating engines and D.C. plant, will be quite ample. At first two units of 1,250 kw. capacity will be installed. An extension to the D.C. plant is just now being put in, which has some interesting features. The extension was wanted for 400 kw. chiefly for balancing, and for reasons of space and fuel economy, the engineer wanted to use an exhaust turbine to drive it. On getting prices, however, for such a D.C. set, it was found to be too dear. The scheme was then altered so that the exhaust turbine formed an A.C. set, giving when desired the D.C. supply through a 400 kw. motor generator set. This is now being installed, and its advantages over the purely D.C. extension originally proposed are partly in cost and also that it enables a start to be made immediately with the A.C. supply for which there will thus be 800 kw. of plant available—using the motor generator set as a generator—if the load necessitates this, while up to the 400 kw., the exhaust turbo and the M.S. set act as stand byes to one another. The turbine being installed is the Willans impulse type, with low level counter flow jet condensers by Allens, and a Blasberg cooling tower. The electrical equipment is by Bruce Peebles. There are already sound 3 miles of ducts laid in three principal directions, and capable of dealing with about 900 h.p. These were laid by the engineer some time ago, with a view to future D.C. or A.C. extensions before the present scheme matured. The first contract for an A.C. supply has just been taken—to supply a 75 h.p. motor; an extension for a rubber works. The high tension will be taken into the consumers premises and transformed down. This will probably be the plan adopted for all power supply work with A.C.

Lighting.

It is interesting to note that although gas is only 2s. 4d. a 1,000 cu. ft. to the lighting consumer, still the electricity station are successfully lighting the streets at the price that the Gas Co. formerly charged. Brockie Pell arcs are at present in use, but it is proposed to increase the candle power before next winter by substituting flame arcs. For side streets two 55 watt Osram lamps per lantern are used, and the engineer's experience is that in a good position about 2,000 hours is the lamp's average life. Motor wagons are responsible for many breakages, owing to excessive vibration. To shield the lamp from this jarring, the mains engineer has devised an ingenious support, attached to the top of the reflector by four spiral springs, on which the lamp holders rest, the reflector itself being attached to the lantern. This is proving very satisfactory. For private lighting quite a good proportion consists of three or four metal filament lamps per consumer for this work, as for most of the lighting work, Bastian meters have been found much more suitable than the more expensive types, as they start with much smaller current and cheapen the service expense. Incidentally, it is the practice at Ashton to pay all service charges out of revenue, and not from capital, as is done in some places. Mill lighting is chiefly done on the two-rate system—at about a 1d. per unit except during peak loads, when it is 2½d. to 3d. This system encourages the use of light in the winter days, and is popular with the manufacturers, who thus only pay about 1¼d. per unit on the average, which is quite a reasonable figure. The charge for the two-rate meter prevents the small consumer from taking advantage of this system. The domestic load has not yet

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been cultivated—the cost is 1½d. per unit, which, with the cheap gas available, is rather dear; however, the flat iron has proved a success as far as it has been tried. Altogether, the prospects of developments in Ashton during the next two or three years is a very bright one. Already the concern is in a very flourishing condition, and the department hands over to the rates just about four times as much in proportion to its capital expenditure as Manchester does.

GERMANY.

BERLIN.

Some interesting official statistics are just to hand showing that Bavaria possesses 2,386 electricity producing works, including concerns that make electricity for their own use but do not sell it. Of this number, 1,620 belong to private firms. The total output for 1909 was 275,472 kw., nearly half produced by steam-driven dynamos, and less than one-tenth by water power alone. The balance is accounted for by explosion motors and combinations of the various driving powers. Thus 30% of the energy is the joint production of steam and water power. The invested capital is put at 230 million marks (say, £11,000,000 sterling).

A. E. G. Metallic Filament Lamps.

The following table shows the lasting properties of these lamps. It is based on experiments made with lamps selected at random from stock:—

Hours lighted.	No of lamps that failed.	Intensity of light: the initial intensity being taken at 100. For the last two figs the broken down lamps are of course omitted.	Watt consumption per Hefner Candle.
500	—	101·5	1·20
1,000	—	97·5	1·27
2,000	—	91·5	1·36
3,000	—	86·0	1·37
4,000	—	84·0	1·36
6,000	—	81·5	1·41
8,000	1	77·0	1·51
10,000	2	75·0	1·60

Electric Tempering.

An electric tempering furnace is described by Straube in the "Deutsche Strassen und Kleinbaen Zeitung." The switches permit of using a high tension heating current at first so as to obtain the necessary heat quickly, and of then lowering the potential to the point necessary to keep the temperature unchanged. It is well known that exact regulation of temperature is the most important point in tempering steel.

Company Notices.

The Felten & Guilleaume Lahmeyer Werke A.G., of Mulheim, made a gross profit of 13,893,107 marks and a net profit of 4,063,475 marks in 1909. Both figures were higher in 1908 at 14,618,885 and 5,562,722 respectively. The dividend will consequently be 6% only, as against 8%, on the capital of 55 million marks. The falling off was due to bad trade generally, especially in the dynamo factory, which worked for the year at a loss. Business, however, is now picking up again, and the directors are sanguine as to the results of the present year. The number of employees has increased from 11,355 to 12,318.

The Bergmann Elektrizitatswerke A.G., Berlin, is paying 18%. Its capital is to be increased by 8 million marks to 29 millions. The new shares are being taken over by an underwriting syndicate at 75% premium, and will be issued as respects 7 millions to persons already shareholders at 80% premium. The remaining million will be offered to outsiders. The net profit was 3,905,516 marks in 1909 and 3,168,011 marks in 1908.

The Aktien Gesellschaft Mix and Genert, Telephon und Telegraphen Werke increased its net profit from 131,256 marks in 1908 to 400,931 in 1909, and so can pay a dividend of 3%. There was no dividend for 1908. The capital is seven million marks.

The Deutsche Niederlandische Telegraphen Gesellschaft A.G., of Cologne, made a somewhat smaller profit for 1909 than for 1908, viz., 743,927, as against 770,376 marks. The dividend will, however, remain at 6½%.

The Akkumulatoren Fabrik A.G., Berlin-Hagen made a net profit of 1,588,895 marks in 1909, 81,383 more than in 1908. One million marks will be devoted to paying a 12½% dividend, and 72,206 marks will be carried over to 1910 account; 260,265 marks are reserved for re-building, as against 300,000 devoted to that purpose in 1908.

The Aluminium Industriegesellschaft Neuhausen made a net profit of 2,061,274 francs in 1909, as against 2,820,957 francs in 1908. The dividend has fallen from 18 to 12%. The capital is 13 million francs. The directors note that whereas, in 1909, electrical businesses were for the most part developing steadily and quietly the case was quite different as regards the electric production of aluminium. The sharp competition which began in 1908, lasted throughout 1909, and made it impossible to obtain orders without making large concessions in the matter of prices. At the same time the cheapening of aluminium will be an actual advantage in the future, as it permits of new uses being found for the metal, so that largely increased turnovers will probably more than compensate the makers for the falling off in the profit per lb. of aluminium. This is, of course, assuming that there will always be a profit. Increased turnover means increased loss if the profit is negative. The power works for utilising the river Rhone at Wallis are rapidly approaching completion, and will be partly in action during the present year. The large increase in the water power available thereby secured will enable the company to make nitric acid and cyanamides from atmospheric nitrogen as well as aluminium.

The Deutsche Ueberseeische Elektricitatsgesellschaft, of Berlin, made a net profit for 1909 of 8,346,094 marks, as against 7,811,581 in 1908. The dividend will be 10%, as against 9½%, and the carry over increased from 232,572 to 244,147 marks. The business continues to increase, and new plant has been necessary, including two 7,500 kw. steam turbines which begin work early in the present year.

UNITED STATES.

NEW YORK.

A noteworthy paper on the parallel operation of three-phase generators with their neutrals interconnected was read at the recent Pacific Coast Convention of the American Institute of Electrical Engineers by Mr. George Rhodes, the assistant engineer of the Interborough Rapid Transit Company, of New York. Mr. Rhodes presented a lucid analytical study of the difficulties of operating three-phase star-connected generators with their neutrals in parallel, in the course of which he pointed out that the neutral currents are of triple frequency and are produced by those harmonics of electromotive forces which cannot exist between the lines of a three-phase system. When two such generators are connected in parallel a difference of potential will exist between their neutrals equal to the vector difference of the third harmonics in their coil wave forms. If the machines are exactly similar, are running at exactly the same load with the same excitation and have exactly equal instantaneous angular velocities this potential is zero and no currents will flow if their neutrals be connected. An inequality in any one of these conditions causes a neutral current to flow. The greatest trouble from neutral currents is in synchronising. When a machine is synchronised with several others already operating in parallel, the neutral currents are even greater than when two machines are concerned on account of the parallel paths offered by the other machines. Differences in momentary angular velocities of the prime movers cause swings of load which produce corresponding neutral potentials; these are not as great as when synchronising, however. If the neutrals are closed after the terminals are paralleled, the interchange of neutral currents is not so dangerous. Several ways exist of reducing the third harmonic and therefore the neutral potentials. One is by distributing the coil windings over 120 electrical degrees of space under each pole, instead of 60 degrees as usual; this eliminates the third harmonic entirely. Another way is by making the generator with a uniform air-gap, so that the distribution of the armature reaction flux will be of the same form as that of the magnetomotive force; also by distributing the field windings so that the field flux distribution will be sinusoidal. While these latter methods cannot easily be carried out so as to eliminate the third harmonic entirely, they can at least reduce it to a negligible value. Where it is necessary to use star-connected generators in parallel, it should be specified that the neutral

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potentials should not exceed 1% of the excitation electromotive force. In the course of the discussion which followed Mr. Rhodes' paper, Professor Ryan said that the author had done the profession a real service in demonstrating that all problems which owe their origin to non-sine-wave conditions may be solved by the usual sine-wave methods, applied to the multifrequency components of the original irregular alternating waves or values.

The Adjustment of Rates.

The problem of the adjustment of charges to consumers for electric light and power is dealt with in a thoughtful editorial in the current issue of the *Electrical Review*, of Chicago. It is a problem which is made distinctly different from any of those encountered by other industrial undertakings, partly because of the multifarious character of the demand upon the resources of a corporation supplying electric energy and partly because the uncertainty in the relationship between conjectural and actual demand renders it almost impossible to establish definite principles on which to base a system equitable both to consumer and supplier. "Ever since corporations settled into the definite business of generating electrical energy for supplying the needs of private consumers," says the *Review*, "there have been great efforts made to establish systems of charging which would satisfy the consumer and at the same time render the service profitable to the corporation. Many plans have been suggested, some of these classical in their nature and in the scope of the investigation which has been undertaken to determine the principles upon which they are based. Many companies have established systems which differ entirely from the methods employed in even contiguous territories, but the prevailing system is apparently that based upon the kilowatt-hour rate, modified by discounts for prompt payment, for various classifications of service, and with various initial or minimum charges aimed to cover a conjectural service cost. Under the system of charging by the kilowatt-hour rate it has been difficult for the central station clearly to indicate the elements which enter into the making up of the charge, but further than this the system is unfortunate in that where there is a great and distinct advance in the art of improving the efficiency of the unit which is under the control of the consumer, the central station has no means by which it can forestall a loss to it where it supplies a lessened amount of the commodity for which it is paid a running rate and at the same time increases greatly the expense for delivery of this commodity. Where the consumer demands the installation of tungsten lamps the cost to the central station company is just as great as and possibly greater than it ever was before, but the income based upon the running current charge is reduced, and while it is true that the lessened demand on the part of the consumer releases so much more capacity for the supply of new customers, the cost of serving these new customers is out of proportion to the additional revenue produced. It can be readily appreciated by any student of this subject with what apprehension the industry looks forward to the tearing down of systems which have been built up at the expense of a long education of the customer and the tireless effort of those engaged in seeking to establish a definite basis for charging."

A Wireless Consolidation.

With a capital of £1,000,000 sterling the Massie Wireless Telegraph Company, the Clark Wireless Telephone and Telegraph Company, the Pacific Wireless Telegraph Company, and the Collins Wireless Telegraph Company, of Newark, N.J., have been consolidated under the name of the Continental Wireless Telephone and Telegraph Company, of New York. The plans of the consolidated companies contemplate transcontinental commercial business, as well as the continuance of the marine reports and shipping messages which have up to this time constituted the greater portion of wireless endeavours. The new company will enter into competition with the old wire telegraph companies for commercial and public patronage and its promoters say it will mean a considerable reduction from the tariffs now in force by the old telegraph concerns. The officers of the Company will be: President, F. T. Davis, of Philadelphia; vice-president, Walter W. Massie, of New York; general manager, Thomas E. Clark, of Detroit, Mich.; technical director, A. Frederick Collins, of Newark, N.J., the inventor of the wireless telephone; and the head offices will be in New York.

The Third and Fifth Harmonics.

In the course of a paper prepared for the San Francisco Electrical Convention by Mr. J. J. Frank, of the transformer department of the General Electric Company, results were given of a long series of observations of the influence of harmonics in the current and voltage wave shapes of transformers. One of the first conclusions which emerged from these observations was that the fifth harmonic is found in the complex wave, whereas in previous investigations harmonics above the third were disregarded. It was also found that the amplitude of the third harmonic increases with the density in the core, the limiting value being dependent somewhat on the higher harmonics present. The distortion of the current wave shape in transformers is neither a cause nor an effect of the energy loss in the core, but results only from the varying permeability of the steel. The amount of the distortion varies with the density, since the greater the density the more prominent are the higher harmonics. The investigation was also extended to single-phase transformers interconnected in various ways as a three-phase bank, also to three-phase transformers and to transformers in actual service. In connection therewith was observed what are increased potential strains distributed throughout the windings of star-delta connected transformers resulting from distorted potential wave shapes. These materially reduce factor of safety of the insulation of high voltage transformers used on long transmission lines. The final general conclusion of the author is that in any distributing system disturbances of current and potential are to be expected unless provision is made to maintain sine potential across the individual transformers. In the absence of Mr. Frank, the paper was read by Mr. Faccioli, who spoke of how the use of the new Silicon steel had affected the triple-frequency current. Its use, he pointed out, reduces core losses, but has a tendency to increase the distortion of the magnetising current because of the lower permeability of Silicon steel at high tension.

The Human Element.

There were some singularly fine passages in a striking paper which was read at the recent meeting in Indiana of the Central Electric Railway Association by Mr. E. F. Schneider, President of the Cleveland and Columbia Railway Company. His subject was how to run a railroad without accidents, and his text was the amazing fact that it costs the people of the United States $125,000,000 per year for accidents that are, or should be, absolutely preventible. "I believe in man," said President Schneider; "I believe in the human agency and the human element. I have faith in human beings. I don't want a cigar sign or an automaton for motorman or conductor, but what I do want is to have that human element, that human agency educated, not educated necessarily in the sense of book learning, but educated in his business so that he knows. Education being merely a result of experience and the deductions therefrom, it is not necessary for each individual to have the personal experience in order to know. You have heard managers say that a motorman is not a good man until he has had an accident, until he has had the personal experience of running off a derailer, or has met with some other mishap. That is all bosh. He does not need the experience; what he does need is to have the matter brought to his attention in so graphic a way that it will make a lasting impression upon him. Think of the 16 and more big disasters on the best equipped, best controlled, best officered trunk lines in the world during the winter just passed. What was the trouble? poor equipment? No. Safety devices? No. Block signal systems? No. Any proper safeguards or appliances for the better protection of the public missing? No. What was it? The human element? Yes. What was the matter with that human element? It had not been properly taught, that's all." That is Mr. Schneider's system in a nutshell. It's no good putting the fear of God into the motorman. You must educate him up to the no-accident standard, and Mr. Schneider has done it by a long series of personal talks to his men. In one of his talks he said, "I am tired of hearing the phrase so easily and so thoughtlessly spoken, 'You can't run a railroad without accidents.' I say you can"; and in effect the record of his line proves it.

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Central Station Distribution.

Dealing with the enormous expansion in the field for the distribution of electric energy, the New York *Electrical World* observes that the great central station networks constitute a new problem in the economical distribution of energy towards the solution of which electrical engineers are only yet beginning to feel their way, and goes on to discuss the question of sub-dividing the generating plant. Thus if a central station requires a generating equipment of 75,000 kw. it becomes a debatable question whether it would not be wise to install two or three turbine plants with big units rather than to gather all the generators under a single roof. There is a strong chance that such sub-division would save enough in the cost of the distributed energy to make up such small difference as may exist between generation in three 25,000 kw. stations and one 75,000 kw. station. If the separate plants were arranged on the ring system of transmission, the total number of units need not be any greater with the units separated than it would have to be were they all side by side, since for the purposes of reserve equipment a spare generator in any station would be entirely available. It would be far easier to keep everything going in case of an accident than it generally proves to be now. With a ring system fed from several stations the cutting out of even one complete station would not ordinarily be disastrous to the service. In any event, the separated stations have the advantage of supplying energy at relatively short range and gaining a very considerable measure of operating security.

Short-Circuiting and its Prevention.

Mr. C. W. Stone, in a paper read at the May meeting in New York of the American Institute of Electrical Engineers discussed, among other points, certain protective features of electric lighting systems. He pointed out that although with small systems a short-circuit could readily be handled by existing switch apparatus, in large modern turbine plant the destructive effect of short-circuiting was almost uncalculable. Mr. Stone's remedy is to instal a re-actor in the circuit in each machine, by which means it would be possible to keep the current incident to short-circuit within reasonable limits. If such a re-actor is used with each machine and the buses are divided into sections—each section with not more than 50,000 kw.—and there is placed in circuit between the sections a re-actor of such reactance as to allow the transference in either direction of the full output of one unit, the short-circuit current can be kept down sufficiently low to make it possible to handle it successfully with modern switching devices, and the disturbance to the system will probably be kept down sufficiently to make it possible to keep synchronous apparatus in step. As the individual units become larger it would be advisable to design them for low potential, thus making it possible to use deep slots in the armature and a distributed winding, and thereby obtain a higher reactance, thus reducing the value of the external reactance which will have to be used. But the re-actors must be built to withstand enormous strains; they must be thoroughly insulated from ground, and must be of the coneless type, as the introduction of any iron in the unit would limit its instantaneous effect.

Current Items.

The American "Z" Lamp Company of this city is putting on the market a new tungsten lamp in which there is no blackening of the bulb through the decomposition of the traces of carbon which remain in the filament after the tungstic oxide has been reduced. The "Z" Company nullifies the presence of the carbon by introducing a phosphorous-nitrogen-hydrogen compound known as "phospham" into the lamp bulb or incorporating it with the filament in such a way that the carbon will react and form a compound not detrimental to the life of the lamp nor to its efficiency from the lighting point of view. It is claimed that not only is the nitrogen in the compound released in vacuo at a comparatively low temperature and when set free forms with carbon, cyanogen or cyanogen compounds, but likewise the phosphorus which is set free at the same time combines with the oxygen still present further to reduce the tungstic oxide.

A new insulating material, known as "Hemit," has been put on the market by the Hemming Manufacturing Company, of New York. It is a composition moulded under pressure into various forms and shapes required for all kinds of electrical insulation. While it is not brittle, it is very hard and will take a high polish. It also has great tensile strength, and not being subject to contraction and expansion, metal parts may be fixed in place during the moulding process. It is also claimed to be both fire and waterproof. Among the forms in which this material has been made up, the following may be mentioned: Switch handles, switch bases, insulating bushings, controller parts, commutator rings, brush holders and overhead insulators.

In competition with English firms, the Dayton Electrical Manufacturing Company has just despatched its fourth shipment of electrical outfits to Bangkok, Siam.

At the present rate of progress few homes on this continent will be without an electric iron. The Muskogee (Oklahoma) Gas & Electric Company has entered into an agreement with a local daily newspaper by which as a special premium offer, an electric iron (sale price, $4), is given with an annual subscription to the paper at the regular rate of $4. The nominal loss in selling price is shared equally by the company and the newspaper, each accepting $2 of the customer's $4 payment as payment in full of its share for material furnished. While the central station company thus loses the difference between $2 and the actual net cost of the iron, it believes that the addition of this energy-consuming device to its lines will soon repay this deficit, after which the iron becomes a revenue producer. Fayetteville, in the same State, with a population of 8,000, has 512 connected residence customers and 502 electric irons installed. According to the local manager, out of the entire number of these irons, which were placed on a 30-day trial proposition, by various methods of house-to-house canvassing, only four were returned. The same methods are in use in various other States with equal success.

A COMPREHENSIVE CATALOGUE.

Messrs. Siemens Brothers Dynamo Works, Ltd., have sent us a copy of their new price list of electrical supplies. It is certainly one of the most complete and well compiled that we have had the pleasure of examining. In fact, this price list covers all the articles used by an electrical contractor in his business, which can be furnished direct from the firm's supplies department at 39, Upper Thames-street, E.C., and from their various branches at home and abroad. It may be pointed out that the list contains particulars of various novelties of great interest to those connected with the installation business; for instance, on page 3 are given the new reduced prices of "Tantalum" lamps, which were issued after the list was printed, and of the "Tantalum" focus lamp, which is also a new introduction. On pages 202 to 228 appear particulars of the now famous "Zed" cartridge fuses of the latest type, that is supplied with indicating window, which are of special interest in view of the paper on the standardisation of fuses read recently by Mr. H. W. Kefford at the Birmingham Local Section of the Institution of Electrical Engineers. The manufacture of these is being taken up at Messrs. Siemens' Stafford Works. On pages 151 and 152 are listed water-tight switch boxes, in which use is made of these fuses. Turning to pages 177 to 201, we find listed all the wires and cables usually required by contractors, together with accessories, such as jointing materials, required in their work. The latter part of that section, viz., pages 194 to 201, contains particulars of "Stannos" wires and accessories manufactured by Messrs. Siemens Bros. & Co., Ltd. As our readers know, these wires are now used extensively for installation work by many of the leading contractors, and are becoming more and more to be relied upon by the average contractor in all towns in this country. A decided novelty, referred to on pages 224 and 228, is the special line of cheap knife switches, and we understand that arrangements have now been made at the Stafford Works for manufacturing these in large quantities. Finally, on pages 234 to 241, are listed the latest forms of horn lightning arresters. This section will be found specially useful abroad, where overhead wires are in more general use than in this country.

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Business Notes and News.

LIGHTING AND GENERAL—Home.

BEXHILL.—The Corporation electricity department had an income for the year ending at the end of March of £10,244, the expenditure having been £5,086. After paying interest and contributions to sinking fund, the net profit was £859, which together with accumulated profits came to £1,350. Of this, part was written off for depreciation and part for payment of meters, leaving an unappropriated balance of £696.

BRIGHTON.—In presenting the annual report of the Corporation Electricity Department, the chairman said that the savings effected at Southwick Station had more than paid interest on the large expenditure there. The revenue for the past year was no less than £94,000, showing a trading profit of £51,000 which was equal to 6% on the capital, and would have been available for distribution as dividend had the undertaking been run by a company. A sum of £19,000 had been paid in interest, and £26,000 in reduction of capital, leaving a clear net profit of £6,000. In 18 years they had paid off no less than £220,000. In a comparatively short time they would see a profit of £25,000, and within the lifetime of members of the Council the profits would be a clear net sum of £50,000, which would be available for the reduction of rates.

CAMBORNE.—The Council have, so far as lay in their power, consented to the Cornwall Electric Power Supply Co., Ltd., installing an overhead supply cable from Hayle Harbour to Carn Brea.

COATBRIDGE.—Plans have been passed for a central station to be erected for the Aidrie and Coatbridge Electric Supply Co. at a cost of £200.

COLCHESTER.—Mr. W. Frisby has issued his first report, which reads well. The deficit of £21 odd in 1908 has been turned into a profit of £414. The net revenue was £15,145, an advance of over £800 on 1908–9. The total costs of production have been reduced from 1·47d. per unit to 1·46d.; the works costs, however, show an increase from 1·21d. to 1·23d. per unit, due to extraordinary repairs.

COVENTRY.—The electricity works have turned the corner, and now £2,500 has been paid in aid of rates and a substantial sum placed to reserve. The policy of supplying current at as low a figure as was consistent with sound business was endorsed, as this, it is held, really benefits the ratepayers, by encouraging commercial enterprise.

HAMILTON.—The Lanarkshire County Council have entered into an agreement with the Clyde Valley Electrical Power Co., 53, Bothwell-street, Glasgow, for the working of the Provisional Orders obtained in 1906 from the Board of Trade for the supply of electric light in Bothwell, Belshill, Shetleston, and Uddingston. The arrangement will permit of residents obtaining electric light from the company at a reasonable rate.

LONDON, BETHNAL GREEN.—By the casting vote of the Mayor, the Borough Council have decided to adopt the Shoreditch Borough Council's flat rate scheme for the supply of electricity in bulk for a period of seven years.

LOUGHBOROUGH.—The work's costs at the Borough Electricity Works has been reduced from 2·254d. per unit in 1908 and 1·852d. in 1909, to 1·361d. per unit. There was a credit balance of £853 on the trading account, but after paying interest and sinking fund a debit balance of over £3,800.

NOTTINGHAM.—The electricity undertaking has done excellently during the past year. The revenue account shows a gross income of £92,459, with expenditure £47,489, the balance carried to net revenue account being £44,969. The sale of current amounted to £89,607, and its generation and distribution £31,964 and £1,882 respectively. With a surplus interest on reserve fund investments of £772, the total net income was £45,742 Interest on consolidated stock and loans, with contributions to sinking fund and instalment for repayment of loans (£13,204), etc., absorbed £28,957, and £16,700 is to be contributed to the general district rate 1910–11, leaving an unappropriated balance carried forward to the next account of £83 9s. 10d.

SHEFFIELD.—Over £78,000 is to be spent on extensions at the Neepsend Electricity Works.

ST. HELENS.—The feature in the satisfactory annual report of the borough electricity department was the demand for energy for power purposes, which was largely responsible for the increase, as additional motors aggregating 410 h.p. were connected, bringing the total horse-power up to 2,030. The income amounted to £20,142, an increase of £608 16s. over the previous year, and notwithstanding the increased number of units sold the working expenses were reduced to £9,735 15s., a decrease of £19 13s. 9d. The gross profit, therefore, amounted to £1,046, a return of 6·35% on the capital. After paying the interest and sinking fund, they had a surplus of £1,031, £600 of which had been credited to the plant renewal and accident funds, and £431 carried to reserve. The economies effected in the cost of production had resulted in the total cost being reduced from ·77d. to ·66d. per unit.

SWANSEA.—A curious condition of affairs reigns here, the Harbour Trust competing with the Corporation Electricity Committee in supplying current, at about 1½d. per unit for power purposes, to manufacturers having premises adjacent to the Trust's property. The Harbour Trust is, of course, a public body, on which the Corporation have nine members.

WILLESDEN.—The District Council have decided to hire out electric irons, kettles and other domestic appliances, and also to hold an Advertising Electrical Exhibition.

WIMBLEDON.—Discussing the electric light undertaking, Councillor Dudley Stuart, chairman of the committee, in answer to adverse criticisms, said the undertaking had a gross profit of 9·14% last year, and it had paid over £6,000 in relief of rates. He found that 19 London companies had an average of only 1·82% on capital outlay, and 39 provincial companies an average of 1·75%.

WORCESTER.—In the course of his annual report, Mr. C. M. Shaw refers to the output of electricity generated at the Powick hydro-electric works. The 1908–9 year's output of 497,289 units had fallen to 371,011 units, a decrease of 126,278 units. This decrease was mainly due to the following causes:—(a) Continued floods during October, December, January, and February; (b) cessation of working for 20 days during July and August to enable improvements to be carried out in tail race, etc.; (c) Waterworks ceasing to take surplus power, pending settlement of terms. The effect of deepening the tail race last autumn had greatly improved the efficiency of the turbines, and recently a rearrangement in the size of the pulleys on alternators had added to this improvement, so that a 10 to 15% benefit had resulted. If this work had not been carried out the output would have been still less, and having regard to such a small alteration resulting in a 10 to 15% improvement, the work of further deepening the stream below the works should receive the serious consideration of the committee, especially in view of the fact that the whole of the public electric lighting, together with the waterworks motors, could now be wholly supplied for a considerable portion of the year.

LIGHTING AND GENERAL—Overseas.

CALCUTTA.—Messrs. Kilburn & Co., Calcutta, have supplied the electrical department of the East Indian Railway with 137 of the russa electric fans, 220 volts, 100 watt, complete with hangers, three blades and down tubes 5 ft. long.

MUSSOORIE.—The Municipal Board have completed the installation of the electric light in the 82 houses which it had contracted to supply.

SAN JOSÉ.—The Costa Rica Government have granted a concession to a private company for the electric lighting of the city.

TRACTION—Home.

BELFAST.—Extensions of the Corporation tramways have been sanctioned in Donegall-road, Botanic and University-avenues, Stranmillis-road, Ligoniel, M'Art's Fort, Castlereagh-road, Blomfield, Old Park-road and Old Park Lodge-road.

BLACKPOOL.—A proposal is being considered by the Corporation to convert the present conduit system for the tramways in the centre of the town to the overhead system.

BURNLEY.—The Corporation tramways brought in £65,525 last year, of which £64,472 was for passenger traffic and £822 for parcels. Over £5,400 was paid over to the Borough fund, and additions made to the reserve fund, which now amounts to £42,393.

MAIDSTONE.—The Corporation are considering a proposal to extend the electric tramways of the borough to the neighbouring town of Chatham—a distance of nearly seven miles. It is estimated that the carrying out of the scheme would involve an expenditure of £60,000, and that a yearly net profit of about £2,000 would be earned.

NOTTINGHAM.—It is expected the Corporation Bill will be up before the Unopposed Committee of the House of Commons on the 15th inst., and will soon become law. With a view to save time and expense, it has been decided to ask for tenders and enter into provisional contracts for the carrying out of the Carlton-road tramways, the contracts being subject to the Bill passing.

SUNDERLAND.—Mr. Charles Eves, C.A., has been appointed receiver and manager of the property charged by the First Mortgage Debentures of the Sunderland District Electric Tramway, Ltd.

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TRACTION—Overseas.

ROME.—The Ministry of Public Works have approved the application lodged by Sigg. Andreucci, Allegra e Cia. for a concession for the construction and working of an electric railway from Rome to Nettuno *via* Anzio. Further the "Società Italiana dei Trasporti" have applied for a concession for the construction and working of a railway from Montecelio to Palombara, the cost of construction of which is estimated at over 1,500,000 lire (£60,000).

TRIPUNITRAH, INDIA.—A proposal is before the Cochin Durbar to connect Tripunitrah, the seat of H.H. the Rajah's family, with Ernadulam by means of an electric tramway.

COMPANIES' MEETINGS AND REPORTS.

TRACTION AND POWER SECURITIES.

The report for the year 1909 states that the profit and loss account shows a credit balance of £24,848, which, added to £5,775 brought forward, gives a total sum of £30,623 to be dealt with. Out of this the directors have transferred £25,000 to the investment reserve account, leaving £5,623 to be carried forward. The investment reserve account now stands at £110,000.

UNITED ELECTRIC TRAMWAYS OF MONTEVIDEO.

The report for the year to March 31, 1910, states that net receipts were $495,722, an increase of $102,861. The amount received from La Sociedad Comercial de Montevideo in respect of dividend and interest was £106,197. The profit and loss account for the year, after providing for administration expenses and charging £39,800 for Debenture interest, shows a credit balance of £63,863. To this must be added the balance of £11,118 brought forward from last year, making a total to be dealt with of £74,981. There has been set aside for the purpose of the Debenture stock redemption fund £2,200, and there has been transferred to renewals and contingency account £15,000. The following interim dividends were paid on December 15, 1909, in respect of the half-year to September 30, 1909:—On the Preference shares, at the rate of 6% per annum, less income tax, £11,197; on the Ordinary shares, at the rate of 4% per annum, less income tax, £7,533. The directors now recommend the payment of the following dividends for the half-year to March 31, 1910:—On the Preference shares, at the rate of 6% per annum, less income tax, £12,135; on the Ordinary shares, at the rate of 8% per annum, less income tax (making 6% for the year), £15,066; leaving to be carried forward £11,847.

ANGLO-ARGENTINE TRAMS.

The report states that the gross receipts for the year to December 31 amounted to £1,938,887; less working expenses (which include £50,000 carried to depreciation renewal funds, in addition to the amounts expended no ordinary maintenance), £1,207,222, leaving £731,665. Add amount brought forward, £12,839; interest on Debentures of amalgamated companies, £16,728; and sundry items as per net revenue account, £7,370, making a total of £768,603. Less annuity to "City Company," £70,660; 4% Debenture stock interest, £160,499; 4% Debenture stock sinking fund, £19,728; 4½% Debenture stock interest, £78,002; 5% First Preference dividend, £160,000; 5% Second Preference dividend, £112,191; rent of Metropolitano Tramways, nine months, £20,250; sinking fund for re emption of share capital, £6,300; and interim dividend on 300,000 Ordinary shares and on 200,000 Ordinary shares for six and three months, both to June 30, being at the rate of 6% per annum, £60,000, leaving a balance of £80,972. Out of the balance, the directors recommend that a final dividend be paid on the 500,000 Ordinary shares for the half-year to December 31, at the rate of 6% per annum, less income tax, which will absorb £70,625, leaving £10,347 to be carried forward.

LEAMINGTON AND WARWICK ELECTRICAL.

The thirtieth ordinary general meeting was held in London, Mr. Emile Garcke presiding. The chairman moved the adoption of the report, which mentioned that the working accounts showed a credit balance of £5,504 16s. 9d. from the tramways and electricity supply, and interest and sundry receipts amounted to £160 1s. 1d. Deducting therefrom the administration and general expenses, amounting to £1,281 2s. 5d., and interest on debentures and £350 provision for renewals, there remained a balance of £2,458 15s. 5d. To this had to be added the sum of £282 16s. 5d. brought forward from the last account, making a total amount available for distribution of £2,741 11s. 10d., which the directors recommended should be applied as follows: £800 to depreciation and reserve account, raising it to £5,400; £350 to be placed to sinking fund for redemption of debentures, making £1,087; £120 10s. as dividend of 5% on the cumulative Preference shares; £1,351 16s. as dividend at the rate of 2% on the Ordinary shares; and £119 5s. 10d. carried forward. The unsatisfactory weather had an adverse effect on the tramway traffic receipts, but there was a slight increase compared with last year. The supply of electricity had progressed during the past year, and every endeavour was being made to improve this part of the business, but the depressed state of trade in the district during the year had made the extension of the business slow. Mr. J. W. Mann seconded the resolution, which was carried.

TORQUAY TRAMWAYS.

At the third annual general meeting of the Torquay Tramways Construction Syndicate, Ltd., held at 21, Cornhill, London, Mr. L. B. Schlesinger presided and moved the adoption of the report and accounts for the year to December 31 last, along with those of the Torquay Tramways Co., Ltd., for the same period. The profit on the year's working, he pointed out, was £2,426 16s. 4d., and that sum had, with the approval of the directors, been carried forward, The traffic receipts showed an increase of £489 15s. 4d. over those of the previous year, but owing to the heavy costs of working the surface contact system there was a decrease in the profit. The Board of Trade had intimated that they would not renew their sanction to the use of the surface contact system after October 31 next, and, in consequence, negotiations had been opened with the Corporation for installing the overhead system. Powers for the extension of the tramways on the overhead system to Paignton had been obtained, and when this line was constructed and the overhead system installed in Torquay there would be a large increase in the net profits of the company. The capital for the construction and equipment of the extension, and for installing the overhead system, would have to be raised by an issue of Prior Lien Debentures, which would be amply secured.

Mr. W. Herbert Fowler seconded, and the report and accounts were unanimously adopted.

KALGOORLIE ELECTRIC POWER AND LIGHTING CORPORATION.

The report for 1909 states that owing to the destruction by fire of the greater part of the machinery of the Great Boulder Perseverance Gold Mining Co. (one of the Corporation's largest consumers), the demand for power was not so large as in the previous year, and the increased cost of fuel and water, also a reduction in the maximum price received for power, together with the extra expense incurred in handling the firewood in consequence of wood strikes, considerably reduced the profits of the year's trading. The Preference dividend has been paid, and a further £4,000 placed to reserve for depreciation and renewals, bringing up the total amount under this heading to £19,000. In view of the larger amount of power required by the Great Boulder Perseverance Co. for their new plant, now nearly completed, to put the Corporation into a position to supply additional power under other contracts and maintain our usual standard of reserve, it has become necessary to instal another unit of plant. The orders for this have been placed. To provide for the cost, to discharge the bank overdrafts, and to put the Corporation's finances on a sound commercial basis, a further part of the £60,000 6% First Mortgage Debentures created has been sold, making the total amount placed £56,600. The matter of the dispute referred to in the previous report in connection with the last new unit of plant is still *sub judice*.

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WINNIPEG ELECTRIC RAILWAY.

The net earnings for 1909, after providing for all operating expenses, taxes, the city of Winnipeg's proportion of earnings, and other fixed charges, amounted to $863,405. Out of this the directors declared four quarterly dividends amounting to $600,000, leaving a surplus of $263,405, which has been transferred to the credit of profit and loss account, making a total credit to this account at December 31, 1909, of $861,430. The company's hydraulic works at Pinawa Channel of the Winnipeg River were very satisfactory up to November 23, when one of the penstocks burst, which resulted in the closing down of the whole plant for six days. While the hydraulic plant was closed down the steam plant was put in operation, and a partial service maintained in all departments. All expense in connection with this breakdown has been charged against operating expenses. In accordance with the plan of extensions adopted at the last annual meeting, the following improvements and additions to the company's equipment and system have been made in the various departments. Track and road-bed—4·995 miles of track was laid, 4·037 miles of which was track with concrete foundation and asphalt pavement, the balance being surface track with ballast. Rolling stock—30 large double-truck, closed cars were constructed in the company's Winnipeg shops and put into service. Electric lighting and power-distribution system—749 new poles were erected and 120,141 lb. of wire, with 129 transformers, put up in extension of the company's lighting and power-distribution system. Gas distribution system—26,914 ft. of new gas main were laid and 747 new gas services installed.

IMPERIAL TRAMWAYS.

When presiding at the annual meeting, held at Bristol, Sir Geogre White said that for sixteen years the Ordinary share dividends had averaged 10% in cash, apart from the distribution of bonus shares, so that the absence of any dividend now was naturally more unpalatable. This absence of dividends was due to their having received no dividend on their holding of Preference shares in the London United Tramways. When the London United resumed payment of even half its Preference dividend the Imperial Co. would at once be able to pay its Preference dividend in full. The London United system was undoubtedly a valuable property, having even now, in spite of competition, a gross income of well above £300,000 and a net revenue of between £90,000 and £100,000 a year. The fact that the traffics were £10,000 up on twenty-one weeks this year showed vitality. It had not the restricted outlook of a provincial concern, for with the marvellous growth of western London and its suburbs so many things were possible. For these reasons he felt that the market was unduly pessimistic in to-day assessing the whole of the company's Debenture stock and share capital at less than £1,500,000 for a property upon which £3,500,000 in cash had been laid out during a comparatively few years past. He believed the undertaking could be, and should be, pulled round. While, however, the market quotation of the London United holding showed depreciation so largely in excess of the Imperial Co.'s £130,000 reserve fund, it would be unwise to make any payment on account of Imperial Cumulative Preference shares.

The report was adopted.

MONTEREY RAILWAY LIGHT AND POWER.

The report for 1909, submitted to the meeting in Toronto on April 20 last, states that during the year 1906 the company acquired all the bonds issued by and all the shares in the capital stock of the Waterworks Co., and in this way controls the waterworks and sewerage system, and has the benefit of the Government 10% guarantee. Until the works of the Railway Co. and Waterworks Co. were well advanced towards completion, the directors arranged for the necessary financing without making any public issue of securities; and it was not till 1908 that the company made in London an issue of Debenture stock to the amount of £1,000,000. The proceeds of this issue were used for the capital expenditures required for both the Railway Co. and the Waterworks Co., and the bonds and stock of the Waterworks Co. form with the Railway Co.'s properties part of the mortgage security for the repayment of the company's Debenture stock. During the year 1908 the company purchased all the capital stock of the Monterey Light & Power Co., thus obtaining control of this company. Prior to the acquisition of these shares the directors had been negotiating with the Government of the State for a concession to enable the company to do an electric and gas business in and about the city of Monterey. During the year 1909 the negotiations were completed and resulted in the issuance to the company of a new concession for 99 years from March 10, 1905, for an electric lighting, motive power and gas service in the city on satisfactory terms, and under this concession the company will continue and develop the business of the Monterey Light & Power Co. The intention is to amalgamate the power plants of the Railway Co. and the Light & Power Co. and to produce from the one plant all the power required. Considerable progress has already been made towards this end, including the acquisition on reasonable terms of valuable property adjoining the site of the present electric light plant, which is situated in the centre of the city, where the company owns 2½ acres of land. Various delays have been occasioned by the late deliveries of turbines and other machinery, etc., but it is expected that the combined services of railway and lighting will be operated from the new central station by the end of April. The directors believe that the amalgamation of the plants, together with the central location of the car barns, workshops, store buildings, etc., will result in greater efficiency of management and in considerable reduction of operating expenses.

POTTERIES ELECTRIC TRACTION.

The report for 1909, to be presented to the meeting to be held on 26th inst., states that the total receipts for the year amounted to £108,182. The traffic receipts, which amounted to £91,932, show a decrease of £399, due to the continued depression of trade in the district during the earlier months of the year. The working expenses, however, have been decreased by £5,136. After deducting all expenses chargeable to revenue, including £12,158 for Debenture and other interest, there remains a balance of £26,169, making, with £1,121, the balance brought forward from the previous year, a total of £27,291, as compared with £21,781 for 1908. The directors recommend that the amount available for distribution should be applied as follows:—Depreciation, reserve account, £2,000; general renewals account, £7,090; dividend at the rate of 5% per annum on the Preference shares, £12,250; dividend at the rate of 2% per annum on the Ordinary shares, £4,900; carry forward to next account, £1,050. The depreciation and reserve account will then stand at £22,000, and there will be a credit balance on the general renewals account of £5,500. During the year £8,996 has been expended on the improvement, renewal and repair of the permanent way, of which £5,406 has been charged against the year's revenue, and £3,590 to the general renewals account. Further important work is in contemplation for the improvement of the permanent way, and additional provision for this purpose out of the year's profits is recommended, but the improved position of the company has, in the opinion of the directors, justified the resumption of a distribution of dividend to the holders of the Ordinary share capital. The capital expenditure during the year amounted to £1,680, made up principally of the cost of additions to the permanent way, and to the distributing system.

FIFE TRAMWAY, LIGHT AND POWER CO.

Presiding at the first ordinary general meeting in Edinburgh, Mr. William Low, the chairman, said by the Order of 1906 the Dunfermline and District Tramways Co. were authorised to build tramways from Dunfermline to Townhill, and from Dunfermline to Cowdenbeath, Lochgelly, and Kelty. The whole of these lines have been constructed with the exception of the branch line to Kelty, and small portions of line in Dunfermline. The contract for the tramways construction was signed on July 3, 1909, and the work was started about the middle of August. The sections between Dunfermline and Townhill and Dunfermline and Cowdenbeath were opened for traffic on November 2, 1909,

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after the usual Board of Trade inspection. After that date the weather was very unfavourable for the contractors, but, notwithstanding this, the remaining section was inspected by the Board of Trade, and opened for traffic on December 23. With little over one-half of the tramways running for less than two months, the Tramway Co.'s earnings were such that the Tramway Co. was able to pay a dividend to that company amounting to £1,111 2s. 8d. It was due to the rapid construction of the tramways that the directors had been able to show a credit balance on revenue account after only six months' existence, and he expressed his opinion that the contractors, Messrs. Balfour, Beatty & Co., Ltd., were entitled to the thanks of the shareholders for this satisfactory result being attained. In addition to owning practically the whole issued capital of the Tramway Co., that company also acted as managers of the property for an annual fee. The directors were giving serious consideration to the construction of the Kelty branch, and it was probable that this line would be constructed during the summer of this year.

The company made an agreement to acquire all the shares of the Fife Electric Power Co., but was not to have any interest in the earnings of the Power Co. until after December 31 last, therefore no revenue from this source was included in the accounts. The directors were satisfied with the position of the Power Co.'s business, and they felt sure that it would this year make a substantial contribution to the revenue. The Power Co.'s plant at Townhill had been largely extended, and overhead transmission lines and underground cables were laid to enable it to cope with the tramway and other additional business. Sub-stations have been built at Cowdenbeath and Lochgelly, and coupled up to supply cables so as to conveniently supply Cowdenbeath and Lochgelly areas. The application to Parliament for powers to construct, equip, and operate tramways from Dunfermline to the Rosyth Naval Base and from Lochgelly to Lochore had been passed by the Commissioners, and there was no reason to doubt that the Confirming Bill would in due course receive Royal assent. The Wemyss and District Tramways Co. also applied for powers to construct extensions to enable them to connect up the Leven-Kirkcaldy system to the Dunfermline and district tramways at Lochgelly. The Fife Electric Power Co. had made an arrangement with the Wemyss Co. whereby the latter was to take from the Power Co. the whole of its supply of electricity, both for the existing Wemyss tramways and for any extensions constructed under the Extensions Order at present before Parliament. The company issued in March last £85,000 5% debenture stock, of which £61,300 was offered to the public, and £23,700 allotted in part payment for the shares of the Fife Electric Power Co. The amount of such stock which the company had power to issue was £125,000, thus leaving unissued £40,000. The debenture stock offered to the public was underwritten on terms favourable to the company. After satisfying all existing commitments, the company have a substantial cash balance. It was proposed to pay preference dividends half-yearly, the first interim dividend being payable after the expiration of the half-year—viz., June 30 next.

EDUCATIONAL.

EAST LONDON COLLEGE.

A special series of three lectures on "The Illumination of Interiors" began on Wednesday at the East London College (University of London). Mr. J. T. Morris, M.I.E.E., is responsible for the two first, the synopsis of which we give below :—

Lecture I.—"Principles, and Daylight Illumination." (June 8, 8.p.m.) Daylight and its fluctuations. Window efficiency. Mr. Waldram's figures for the ratio of interior to exterior illumination of certain buildings. The constancy of such ratio. Effect of the colour of the walls of the room. Action of direct light falling on the pupil of the eye. Value of shadows, and troubles caused by shadows. Illumination photometers.

Lecture II.—"Artificial Illumination by Gas and Electricity." (June 15, 8.pm.) Gas lighting: ordinary, incandescent, and high-pressure burners. Dependence of efficiency on calorific power of gas. Electric lighting: carbon and metal filament lamps and arc lamps. Inverted arcs, Moore vacuum tube light. Candle power per square inch of various sources. Flickering of source. Shades and Holophane globes and reflectors. Position of fittings. Suitable illumination largely dependent on use to which room is to be put. Examples.

Syllabus of Lecture III., by Professor C. A. M. Smith, B.Sc. :—

Lecture III.—"Illumination by Petrol Air-Gas." (June 22, 8 p.m.) Introduction and brief historical notes. Theory of absorption of volatile liquids by air—difficulties occurring in practice. The three general types—direct petrol supply; saturated air systems; "safety" gas systems. Leading types of (1) direct petrol supply systems; (2) saturated air systems; (3) unsaturated air systems. Relative cost of air gas and other gases—(*a*) on heat basis; (*b*) on light basis. Summary and conclusion.

LONDON.

City and Guilds of London Institute.—Dr. Dalby, Dean of the Central Technical College, in his report, refers to the Electrical Department as follows :

New Plant.—To the ordinary equipment have been added a hot wire oscillograph and a magazine camera for use with the instrument, two large sub-divided choking coils, each capable of carrying 100 amperes at 200 volts, 50 frequency. Several smaller choking coils, an improved form of sechommeter with commutators running in oil, a Duddell-Poulsen arc, and a new form of "jigger" for wireless telegraphy have been constructed in the workshops. Messrs. Richards & Co., of Manchester, have constructed a 16 cwt. electric hoist, designed by two third-year students, Messrs. Burford and Hutt, which is now being erected. A new 5½ in. centres screw-cutting lathe, with gap bed 5 ft. long, has also been purchased.

Research Work.—Under the direction of Mr. Robson, Messrs. Hawes and Mack, third-year students, made an investigation on interpole motors. They are now (October, 1909) completing the work with a view to its publication. Mr. Irwin has developed a new form of magazine camera for use with oscillographs, which is exceptionally convenient in use. The instrument was shown, along with his latest form of hot wire oscillograph, at the Exhibition of Scientific Apparatus held by the Physical Society in December last, and again at a conversazione of the Rugby Engineering Society. He has applied his method of magnification by looped wires carrying a mirror to indicate the movements of a telephone diaphragm and like purposes, and succeeded in obtaining magnifications of about 10,000, with a natural frequency of 2,000 to 3,000 per second. The same principle of magnification he employs in electrostatic oscillographs, on the development of which he is now engaged. During the summer, Mr. Irwin's instruments were used in an investigation on the wave forms of current and pressure on the South London line of the London, Brighton and South Coast Railway, which is being equipped for operating by single-phase alternating currents. Dr. Haworth commenced a research on the rectification of alternating currents, which is still in progress.

Dr. Sylvanus P. Thompson, Principal of the City Technical College, Finsbury, says :

In the Department of Electrical Engineering good progress has been made in rearranging the old dynamos and motors in the laboratories. A set of apparatus has been fitted up for illustrating the process of synchronising alternators; a water resistance has been fitted up in one of the cellar areas as an artificial "load"; a special transformer arrangement has been devised for fuse testing and calibration of instruments; and a stand-by arrangement for driving the motors of the engineering shops has been provided. Want of an adequate space in the basement still precludes us from expending the sum granted two years ago for a battery of accumulator cells to take the lighting when no machinery is running. Much remains to be done of the improvements that were sketched out three years ago, and meantime our various machines, though useful for service, are becoming more and more antiquated. Except the motor-generator set which lights the college, the whole of the dynamos and motors are of types now becoming obsolete. I venture to suggest that the committee should direct an enquiry to be made as to the electrical equipment of other technical schools and colleges, that it may be fully informed as to the comparative equipment of its electrical department at Finsbury.

LONDON.

Northampton Polytechnic Institute (St. John-street, E.C.).—The new agenda has now been issued. It is a handy volume, well illustrated, a large section being devoted to the electrical department. Work in this department (which is under the immediate direction of Dr. Mullineux Walmsley, Principal of the Institute) comprises lectures, laboratory work, workshop practice in the instrument workshop, and, for the advanced students, special drawing office work in the design of electrical machinery and apparatus.

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PATENTS.

Electrical Storage Battery.

5062.—1909. A. W. SOMERS & R. J. CROWLEY, Bradford. The object is to construct a battery in which sulphating will not take place, and which will have a larger capacity per lb. weight than batteries now in use. The positive plates consist of a series of grids filled in with a paste composed of red lead, sulphuric acid and water. The plates are then dipped in water, and while still hot are dipped in a 10% solution of sodium silicate. After which the plates are again baked. The negative plates are comprised of zinc or zinc amalgam. The electrolyte comprises a solution of sulphuric acid and soda which has no action on the zinc amalgam, and is a good conductor of electricity.

Testing Electricity Meters.

7754.—1909. DR. M. KALLMANN, Berlin. The load resistances employed in the testing apparatus consist almost exclusively of variation resistances of high positive temperature coefficients arranged in divisions, a sufficient number of which are switched into the circuit to take up the variations of potential, and at the same time to supply all the resistance necessary. One or more of the divisions, however, may be provided as a variation resistance in series with a constant resistance, and, if necessary, a regulating resistance to permit a constant potential to be also obtained.

Electric Conductors.

7791.—1909. R. K. GRAY, Cannon-street, E.C. These conductors comprise a number of component metallic parts interlaced with each other and braided on the outside of a central conductor. Some of the component parts may be constructed of magnetic material in order to diminish or neutralise the capacity effects of the cable.

Electric Locks.

10345.—1909. B. P. K. GREENHILL & R. E. GODDARD, Putney. This is an improvement in locks of the class in which the locking bolt is moved by means of a magnetic zone set up in one or other of two solenoids. The improvement consists in the employment of a snecking device which is automatically put into action by the electrical current passing through one solenoid, and lifted when the electric current passes through the other solenoid.

Electrolyte for Primary or Secondary Galvanic Batteries.

10791.—1909. G. SCHAULL, Upper Holloway. This electrolyte for primary and secondary galvanic batteries is applicable also as an electrolytical resistance for electric currents of an order. It is composed of either flaked rice, accasin, bassorine, cerasin, dextrin, liqnin, lichenin, cellulose, tragacault phytocolla, or glutin paramylum or inulin, soaked and mixed with an equal quantity of water, heated and treated with an addition of 20% chloride of zinc which is well mixed, and a subsequent addition of 80% ammonium, aluminium or magnesium chloride. The whole is well mixed until a S.G. of 1,150 and an electrical conductivity of 3 to 4 ohms are reached.

Control of Electric Motors.

11445.—1909. A. T. DAWSON & A. P. PYNE, Westminster. This is an improved method for controlling motors of the kind in which the speed is regulated by varying the voltage of the current supplied by an electric generator to the motor armature. A centrifugal governor driven from the motor and adapted to open and close the shunt circuit, forming part of the circuit of the field windings of the electric generator supplying current to the motor. If the motor exceeds a pre-arranged speed, the revolving weights of the governor separate more widely, and cause the shunt to be opened, so that the current must pass through the resistance in the generator field. The degree of such resistance is sufficient to decrease the voltage of the current supplied and to reduce the motor speed.

Electric Tablet System of Controlling Railway Traffic.

11460.—1909. A. T. BLACKALL & C. M. JACOBS, Reading. According to the improved method of working, the current which restores the tablet instruments to their normal condition after withdrawal of a tablet, is derived from an auxiliary battery situated at an occupation instrument.

Connecting Up the Subscribers of a Telephone Exchange.

11497.—1909. J. PETICKY, F. SUCHANCK, J. CIZEK, Tisnow. The invention consists in the improvement and simplification of devices by means of which impulses are sent from the subscribers' apparatus to cause the selection of idle selectors and connector. The 24 claims of the invention are graphically described in a specification of 25 pages.

Electric Arc Lamps.

15881.—1909. H. J. J. JABURG, Amsterdam. The lamps have two downwardly directed and converging self-supported electrodes and a third movable electrode in a vertical plane perpendicular to the plane of the axes of the two other electrodes. The third electrode has a larger sectional area than the self-supporting electrodes. The two electrodes contain substantial quantities of luminous salts, but the third contains only a minute quantity, if any. A horizontal guide-rod is arranged on each carbon holder of the self-supporting electrodes, and serves to counteract the bending of the supporting electrodes under the influence of the pressure exerted by the common weight.

Electric Transmission for Motor Vehicles.

16331.—1909. W. MORRISON, Des Moines, Iowa, U.S.A. The electric transmission comprises a prime mover, a dynamo operated thereby and provided with windings so arranged that a number of independent electric currents are produced which may be utilised for propelling purposes either in series or parallel. All desired changes of speed and traction are obtained by means of a single switch and a pole changer.

Hangers for Electrical Conductors.

17326.—1909. E. M. MUNRO, Finsbury Pavement, E.C. The hanger comprises two or more flanged members, each made to support a conductor, and so constructed that they can be bolted together to form a rigid compound hanger, and subsequently separated without cutting the supporting cross wire.

Electric Conduit Joints.

26021.—1909. W. R. SYKES & C. J. COOKE, London, S.W. The conduit consists of two or more sections of bitumen pipe, a wooden box covered with a metal casing provided with a lid, and tapered sockets. The section ends rest in the sockets, and are gripped by metal clamps connected together by ribs.

Electro Magnetic Couplings.

26574.—1909. J. VERNEY, Seine. The invention consists in the introduction of a starting rheostat into the exciting circuit of the magnetic field, which returns automatically to zero when the exciting circuit is opened, and by means of which the exciting current can be either regulated by hand or automatically. This transmission can be applied, by special means, to motor cars, both for the purpose of obtaining transmission between the motor and the wheels and for effecting changes of speed, and also for braking.

Polarised Relays for Selective Electric Signalling.

30579.—1909. W. J. THORROWGOOD, Wimbledon Park. The relay armatures are each controlled by means of a permanent magnet which causes the armature to rest normally in a neutral position in relation to the relay magnet. The armature is restored to such position immediately the operating current cease. Means are provided whereby the pole pieces of the permanent magnet may be adjusted transversely with respect to the axis of the magnet.

Driving Magneto Electric Machines.

6962.—1910. L. L. BELLEM & G. J. B. BRÉGÉRAS, Nevilly. Between the shaft of the magneto and the shaft that drives it is a driving connection of such construction that the two shafts which are normally co-axial can be relatively displaced so that they are no longer co-axial when starting is to be effected, and can be returned to the co-axial position when the engine is running.

FORTHCOMING BOOKS.

Messrs. Harper & Bros. announce for immediate publication: (1) "Electric Trains," by H. M. Hobart, M.I.C.E. An authoritative work giving a detailed description of the characteristic features of the various systems of electric traction; (2) "Continuous Current Machine Design," by Wm. Cramp, M.I.E.E. Deals exhaustively with this branch of the study of electricity, and is designed for the student and the professional worker.

RUSSIAN DEMAND.

A recent German consular reports refer to the increasing demand in the Government of Saratoff for electrical material and accessories of all kinds, especially in view of the desire on the part of the inhabitants for the installation of electric light in their residences. There is a steady demand, too, in the district for motor vehicles; this trade, however, offers still brighter prospects in Samara.

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TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns per week.			Increase or decrease.		Miles of track open.		Accounts for past year.					
	Ending	1909-10.	1908-9.	Week.	Current year.	1909.	1908.	Ending	Total receipts.	Passengers carried.	Car miles run.	Receipts per Passenger.	Receipts per Car mile.
		£	£	£	£				£				
Aberdeen Corporation	May 25	1,439	1,381	+ 57	— 567	27½	27½	May 31	71,930	17,517,304	1,566,119	·98	11·02
Ayr Corporation	Sept. 18	671	562	+ 108	—	8	8	—	—	—	—	—	—
Baker Street and Waterloo Ry.	Nov.	8,141	6,070	+2,071	—	4·25	—	—	—	—	—	—	—
Birkenhead Corporation	May 29	1,021	1,066	— 45	— 75	24·003	13·52	—	—	—	—	—	—
Birmingham Corporation	May 28	6,546	6,751	— 205	—	56·792	58·52	—	—	—	—	—	—
Blackburn Corporation	Oct. 6	1,100	1,293	— 173	— 1,036	24·53	28·3	—	—	—	—	—	—
Blackpool Corporation	Aug. 26	2,152	2,050	+ 102	+ 732	—	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams	„ 8	2,304	2,309	— 24	—	—	—	—	—	—	—	—	—
Bolton Corporation	Oct 10	2,416	2,337	+ 79	— 259	42	42	Mar. 31	117,799	25,492,902	2,492,147	1·1	11·34
Bournemouth Corporation	July 21	1,681	1,723	— 42	— 23	29½	29½	„ 31	86,225	13,991,328	1,766,068	1·47	11·71
Bradford Corporation	May 28	5,111	4,834	+ 277	— 722	98	54·81	„ 31	235,258	47,839,569	5,331,007	1·17	10·59
Brighton Corporation	June 6	904	1,247	— 343	— 684	9·5	—	—	—	—	—	—	—
Bristol Tramway Company	June 3	5,632	7,285	— 1,653	—	57	51½	Dec. 31	265,362	46,652,389	5,756,842	—	—
Burnley Corporation	June 4	1,183	1,403	— 220	—	19½	19½	Mar. 31	64,261	12,355,958	1,202,330	1·23	12·83
Burton Corporation	June 5	267	318	— 51	— 61	6½	6½	„ 31	14,918	3,221,595	430,913	1·04	8·30
Cardiff Corporation	April 3	2,000	1,957	+ 43	—	—	—	„ 31	109,979	25,058,146	2,497,169	—	10·67
Carlisle Tramways Company	June 19	170	175	— 5	— 89	—	—	—	—	—	—	—	—
Central London Railway	June 4	6,044	5,949	+ 95	+ 2,315	6·32	6·32	Dec. 31	350,150	41,898,373	1,456,781	2·01	5·769
Charing X, Euston, & Hamp. Ry.	Nov.	6 822	6,092	+ 730	—	7·75	—	—	—	—	—	—	—
City and South London Railway	June 5	3,215	3,251	— 36	— 193	7·26	7·26	—	—	—	—	—	—
Colchester Corporation	July 14	200	219	— 39	—	8	—	Mar. 31	10,983	2,308,721	349,539	1·09	7·74
Cork E. T. and L. Company	June 2	515	501	+ 14	+ 1,617	9·89	9·89	Dec. 31	24,044	5,737,478	896,945	—	6·43
Croydon Corporation	May 20	2,506	1,416	+ 1,090	+ 1,230	11½	—	Mar. 31	74,132	16,277,418	1,884,137	1·06	9·56
Darwen Corporation	Oct. 1	239	256	— 17	— 201	7·23	7·23	„ 31	13,899	2,557,654	245,584	1·30	13·68
Dover Corporation	Sept. 18	230	252	— 22	— 395	7	—	„ 31	11,593	2,697,672	316,754	·98	8·78
Dublin and Lucan Electric Ry.	June 3	139	202	+ 63	+ 29	7	7	—	—	—	—	—	—
Dublin U.T.	June 3	5,380	6,289	— 908	+ 3,556	54½	54½	—	—	—	—	—	—
Dundee City Tramways	Oct. 6	1,332	1,305	— 27	— 569	—	26½	May 15	60,573	16,367,911	1,281,552	·875	1·9
East Ham Corporation	June 4	1,018	1,234	— 216	— 63	15	15	Mar. 31	47,430	15,355,703	1,091,586	·73	10·26
Glasgow Corporation	May 28	18,802	17,800	+1,002	+ 6,010	194½	189	May 31	907,494	226,948,290	20,766,722	·96	10·49
Gloucester Corporation	Oct. 6	395	425	— 30	+ 535	15	—	—	—	—	—	—	—
G.N., Piccadilly and Brompton	Nov.	13,429	9,354	+ 4,075	—	9·25	—	—	—	—	—	—	—
Halifax Corporation	—	—	—	—	—	52·574	37	Mar. 31	81,872	20,378,672	1,786,390	11·40	11·13
Huddersfield Corporation	Dec. 4	1,613	1,357	+ 256	+ 2,663	28	28½	„ 31	84,704	16,200,020	1,960,329	1·29	10·37
Hull Corporation	June 4	2,680	2,697	— 17	+ 1,018	29	26	„ 31	128,722	30,964,254	3,022,844	1·	10·22
Ilford Corporation	Feb. 12	451	391	+ 60	+ 1,969	10	10½	„ 31	25,328	6,385,466	634,446	·87	9·58
Ilkeston Corporation	June 2	121	175	— 54	— 94	4	4	„ 31	7,214	1,968,850	198,415	9·1	7·9
Kirkcaldy Corporation	Sept. 8	259	266	— 7	—	7½	7½	May 15	14,993	4,874,199	459,066	·711	7·838
Lancashire United Tramways	June 1	1,215	1,462	— 247	+ 256	39	39	Dec. 31	68,904	12,554,593	2,244,344	—	—
Leeds Corporation	Sept. 18	6,896	6,624	+ 272	+ 3,662	108	96½	Mar. 31	340,368	75,734,083	7,694,989	1·06	10·62
Leicester Corporation	Sept. 11	2,162	2,130	+ 32	—	—	—	—	—	—	—	—	—
Liverpool Corporation	Nov. 19	10,803	10,687	+ 116	— 1 977	109	104	Dec. 31	572,822	124,043,239	12,231,799	1·108	11·24
Liverpool Overhead Railway	May 29	1,390	1,336	+ 54	+ 789	6·65	2·40	June 30	79,004	11,171,515	1,106,386	—	—
London County Council	May 7	40,802	35,395	+ 5,407	+ 23,837	132½	123½	Mar. 31	1,274,660	279,166,461	25,591,028	1·08	11·74
Lowestoft Corporation	Dec. 11	155	150	+ 5	+ 30	3½	—	Sept. 30	11,399	2,646,206	370,320	1·03	7·36
Maidstone Corporation	Mar. 6	157	100	+ 57	—	7·4	—	—	—	—	—	—	—
Manchester Corporation	Sept. 11	15,631	15,297	+ 334	— 2,871	183	181	—	—	—	—	—	—
Metropolitan District Railway	June 4	10,778	10,331	+ 447	+23,424	24	24	—	—	—	—	—	—
Metropolitan Railway	June 5	17,424	17,377	+ 47	+ 12,644	24½	24½	June 30	680,357	99,846,735	—	1·46	—
Nelson Corporation	Oct. 16	151	131	+ 20	+ 7	2½	2½	Mar. 31	7,362	2,060,712	204,710	·85	8·63
Newcastle-on-Tyne Corporation	May 28	3,749	3,926	— 177	— 1,628	60½	59½	„ 31	211,085	46,203,164	4,411,745	1·10	11·48
Newport (Mon.) Corporation	Oct. 9	663	638	+ 25	— 311	14½	14½	„ 31	35,531	8,174,003	798,029	1·04	9·89
Oldham Corporation	Jan. 24	1,778	1,516	+ 262	— 386	—	—	—	—	—	—	—	—
Portsmouth Corporation	Oct. 10	2,046	1,809	+ 237	—	28½	28½	Mar. 31	97,741	21,247,048	2,309,439	1·10	10·15
Reading Corporation	May 19	764	558	+ 206	— 5	13½	13½	„ 31	32,769	7,933,572	915,481	—	8·93
Rochdale Corporation	Dec. 26	1,240	1,126	+ 114	+ 746	20·9	20·93	„ 31	56,558	10,196,148	1,252,925	1·32	10·83
Rotherham Corporation	Feb. 4	555	587	— 32	—	—	—	—	—	—	—	—	—
Salford Corporation	Sept. 27	4,096	4,662	— 66	— 3,326	78	74½	Mar. 31	244,065	45,771,611	5,486,150	1·25	10·67
Scarborough Tramways Co.	—	—	—	—	—	—	—	—	—	—	—	—	—
Sheffield Corporation	May 29	5,710	5,759	+ 49	+ 3,460	39½	37½	Mar. 25	289,745	17,568,686	7,065,380	·896	9·842
Southampton Corporation	May 25	1,171	1,063	+ 107	+ 449	18	18	„ 25	52,647	10,121,887	1,157,451	1·25	11·33
Southend-on-Sea Corporation	Aug 21	995	557	+ 438	+ 1,483	—	—	—	—	—	—	—	—
Stockport Corporation	—	—	—	—	—	25	25	Mar. 31	52,004	9,155,172	1,335,911	1·34	9·342
Sunderland Corporation	Jan. 27	1,310	1,336	— 26	— 7,984	—	—	—	—	—	—	—	—
Swindon Corporation	May 25	152	137	+ 15	—	—	—	—	—	—	—	—	—
Torquay Tramways	Aug. 26	630	647	— 30	—	8·41	—	Dec. 31	15,065	2,880,420	353,297	1·40	1·023
Wallasey U.D.C.	May 28	905	925	— 20	— 349	12·68	12·45	Mar. 31	43,823	8,331,038	891,540	1·2	11·79
Warrington Corporation	—	—	—	—	—	—	—	—	—	—	—	—	—
West Ham Corporation	May 19	3,085	2,248	+ 837	— 436	27	14·7	Mar. 31	122,881	35,502,836	2,556,854	·789	10·95
Wolverhampton Corporation	Nov. 3	841	823	+ 18	— 206	21½	—	„ 31	44,432	9,440,369	975,714	—	10·929

a Train Miles. h Half-year's figures.

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THE
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NOTES.

Sheffield's Lighting Tariff.

During the course of a Local Government Board inquiry into an application for powers to borrow £78,207 for purposes of extending the electricity supply, certain ratepayers made a determined demand for lower tariff for lighting. It was contended that 4d. was too high, and that 3d. would be quite enough to pay, all the more so as the lowering of price would lead to a great extension in demand. It was seriously alleged that private light consumers were being charged too high so that large power consumers could be supplied at very low rates. But it is, after all, a question of supply and demand. It was stated that the load factor for lighting was only 5 to 6%, while the power factor was 50% and improving. That being so the discrepancy in charges is understandable and justifiable.

Hotel and Public House Light.

Meanwhile, Sheffield is trying an interesting experiment. It has long been contended that proprietors of hotels and public houses were being unfairly treated by being placed on a par with ordinary consumers, not only because they had, house for house, more lights than private consumers, but chiefly because they lighted up early and kept alight to eleven or twelve o'clock. As in a city like Sheffield licensed premises are numerous and important, they must provide a very useful, because steady and improving load. The matter was gone into fully and as a result the general manager has been given discretionary powers as to special discount, which may reach as much as 50%. This should undoubtedly lead to the bulk of the licensed houses coming in, and to more liberal use of lamps. The effect, however, cannot show itself at once, but ultimately it may not be without influencing the general fall of price of electricity for lighting purposes in the City of Steel.

Gas!

It would be laughable if it were not rather saddening to witness the reactionary jubilation that has gone up in certain quarters because a good part of the City of Westminster and the Metropolitan Boroughs of Hackney and Bethnal Green, have foresworn electric lighting for public purposes and gone in for gas. It is chiefly a matter of prejudice. Unquestionably, gas illumination has vastly improved of late years, thanks first to the incandescent gas burner, next to the inverted burner of that type, and finally to high pressure supply. But equally certainly this improvement is due to the keen competition of electricity. It must not be forgotten, however, that high pressure supply of gas has its extra dangers, especially for private consumers. As regards the alleged economy, that is very doubtful when proper photometric tests are taken into consideration, although it is possible that here and there, thanks to older works and a broader basis of supply for general purposes, specially advantageous terms may be made for public lighting purposes. Taking the matter all round, however, to go back to gas is a retrograde action, and, in the long run, a costly one. If gas has its improved burners and high pressure, electricity can show for public lighting its metallic filament lamps susceptible to any form of grouping, and improved lanterns. These certainly give more and better distributed light.

Determination of the Resistance of Liquids.

At the last meeting of the Faraday Society Mr. C. V. Biggs and Mr. W. Pollard Digby made a most useful demonstration with appliances for the rapid determination of the resistance of liquids and also for the determination of the specific resistance of oils. The former apparatus consists of a megger furnished with a scale reading reciprocal megohms, used in conjunction with a glass U-tube to contain the liquid under examination. Polarisation is minimised by the use of annular platinum electrodes and by having the tube very long compared with its sectional area, the voltage employed being about 250. A reading is obtained in a few seconds. The apparatus is particularly suitable for checking the purity of the water supply for boilers, for controlling the softening of hard water, and for similar engineering purposes, as well as for scientific investigations. It is a most handy arrangement, and possesses distinct advantages over low voltage apparatus, because the high voltage overcomes polarisation, which is the disturbing factor in such investigations.

Specific Resistance of Oil.

The second apparatus, for measuring the resistance of oil, is equally simple. It consists of two parallel metal discs of 100 sq. cm. area, insulated from one another. These are separated by a micrometer head to a distance of about 100 mils, immersed in the oil placed in a dish, and then connected to a megger and a series of readings taken. The mean specific resistance is calculated as the mean of the series of readings. It is a thoroughly practical device, which can easily be applied in daily practice, and should prove of great service to electrical engineers.

Natal's Water Power.

Dr. F. H. Hatch, M.Inst.C.E., Consulting Mining Engineer to the Government of Natal, has just drawn up an exhaustive report on the mines and mineral resources of the Colony, and in conclusion draws attention to the possibilities of hydro-electricity. He says: "Another valuable asset, hitherto neglected by the Colony, is its water-power resources. All the big rivers of the Colony take their courses at or near the Drakensberg, at an elevation of some four or five thousand feet above sea-level. The Tugela and its tributaries, the Buffalo, Bushman's, Blaukrantz, Sunday's and Mooi rivers, the Umgeni and its tributary the Klarkloof, and the Umvoti may be quoted as examples. Their flow eastward is marked at intervals by important falls, at which places stations for the development of power in considerable quantities could easily be established. The power could be applied directly to factory work, or transmitted electrically to more favourably situated sites for industrial utilisation."

METROPOLITAN ASSOCIATION OF ELECTRIC TRAMWAY MANAGERS.

A meeting of the above Association was held at the offices of the Metropolitan Electric Tramways, Ltd. Mr. T. B. Goodyer, A.M.I.E.E., the hon. secretary, reported that he had received further communications from America respecting the registration of accidents, and that he had been invited, as representing the Association, to join the Committee for the Protection of Electrical Industries. A definite policy was agreed to as regards the proposal to establish a Central Bureau for the Registration of Claims. Subsequently the members present visited the Car Repair Depot of the M.E.T. at Hendon, and were particularly interested in the Motormen's Training School maintained by the company.

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Municipal Electrical Association.

Annual Convention, Glasgow.

The Incorporated Municipal Electrical Association is holding its fifteenth annual Convention at Glasgow this week under the Presidency of Mr. W. W. Lackie, Chief Engineer of the Electricity Department of the Glasgow Corporation. The numbers attending are about 222 members and delegates, 61 visitors, and 75 ladies, a total of 358. The place of meeting is the new buildings of the Institute of Engineers and Shipbuilders in Scotland, and the beautiful suite of rooms, conveniently near the headquarters at the *Windsor Hotel*, which were retained for the Convention, have added materially to the success of the meetings.

On Tuesday morning the Lord Provost of Glasgow, the Hon. A. McInnes Shaw, met a full muster of the Convention at the place of meeting. He said it afforded him very great pleasure to be present at the opening meeting of their important Association, and to extend to them on behalf of the citizens a cordial welcome to Glasgow. This was the second time that they had done Glasgow the honour of holding their Convention there, and he felt sure that they would spend a most enjoyable time. Glasgow would ever be associated with the name of Lord Kelvin and the stupendous work he performed in the interest of civilisation. Since their last meeting in Glasgow great progress had been made in the appreciation of the possibilities of electrical energy for domestic and industrial purposes. Since then many municipalities had added the supply of electrical energy to the departments of public service under their control. Many of them remembered the Association's former Convention in Glasgow, and they were able to appreciate the importance of the work which the Association had performed. The supply of electrical energy was now one of the most important departments of municipal enterprise. No town was considered to be properly equipped for the needs of a modern industrial community unless there was a supply of electrical energy available from a central source.

Bailie Willock, Convener of the Electricity Committee of the Glasgow Corporation, also added a few words of welcome.

Mr. Lackie proposed a hearty vote of thanks to the Lord Provost for so kindly welcoming the Convention to Glasgow, and thereupon delivered his

Presidential Address.

Mr. W. W. Lackie (Chief Electrical Engineer, Glasgow), said: It is a matter of regret that some members and associates may not be present at the Convention. From the nature of our business we cannot all be absent from duty at the same time. This naturally leads one to make an acknowledgment of indebtedness to those who assist us, and to the members of our staff. In the early days of central station work the best assistants one could get had generally been connected with anything and everything rather than electric plant. I can remember that one of our chief assistants—a sort of general emergency man—was a full-fledged painter. I can assure you that he was a very useful man electrically when he was not "painting town red." One is glad to think that these days are past. Thanks to an improved system of organisation and a grading scheme, it is possible now to get a staff of competent assistants. This Association met in Glasgow in 1901 under the chairmanship of Mr. Chamen, and it again visited Glasgow for one day when the Convention was held in Edinburgh under Mr. Newington's presidency in 1905. The progress made in the supply of electrical energy during the nine years which have intervened since the Convention was last held in Glasgow, may be best shown by the following figures:—In Glasgow in 1901 electrical energy cost, including interest, depreciation and sinking fund, 2·96d. per unit as against 1·73d. to-day. Excluding the standing charges, the works costs then were 1·41d. per unit as against ·562d. per unit to-day.

Very important work has been done by your Council during the past year. Last August the Electric Lighting Acts Amendment Bill received the Council's careful consideration and the amendments made upon the Bill embodied in the Act now passed are practically all in accordance with the expressions of opinions received from the representatives of the municipalities interested. To the Scottish municipalities it was particularly gratifying that an amendment was accepted at the last moment protecting both authorised private companies and authorised municipal undertakings from unfair and unreasonable competition on the part of unauthorised companies. You will remember that this matter was left to the Scottish representatives as it was their areas that were to be first invaded. The clause of the same Bill regarding the raising of capital by municipalities for the purpose of wiring consumers' premises, and the hiring-out of motors, etc., was opposed by your Council, and was dropped out entirely. If the clause authorising the work in consumers' premises to be done "through a contractor only," had been passed it would have been contrary to the existing Electric Lighting Acts and Orders, and undoubtedly would have been found quite unworkable. I do not know if the mover for the addition of the words "through a contractor only," realised that all municipalities would require, if these words became law, to engage a contractor to erect the main fuses and switches, and connect, disconnect, remove, and repair all meters. I think I am not overstating the facts, nor doing violence to the reputation for efficiency of the local contractors, when I say that there is not an electrical contractor in Glasgow, nor in any other municipal area, who would feel himself qualified to undertake this work as cheaply or as well as the municipalities are doing it at the present moment.

It has been alleged that the electrical industry has suffered through municipalities obtaining powers to raise money for electrical purposes. This is a fallacy. Municipalities have done much to advance our industry. In many burghs they undertook the supply of electrical energy at a time when no company would have ventured to do so. Further, they borrow money at a low rate of interest, the benefit of which is directly reaped by the public in a cheapened supply of energy; and nothing is, or can be better for the whole industry than such a supply. It leads to more than an equivalent amount of plant being installed in consumers' premises and the supply of such plant is, as a rule, left to private enterprise—in any case, the manufacturer at least makes all the plant both for the supply authority and for the consumer; and orders are likely to be more numerous where the rates for the supply of energy are low. Some kind of protection should be extended to those municipalities who after having acted as pioneers now find their areas surrounded or invaded by private supply companies. These power companies can, as a rule, select their consumers; naturally they will choose those that are more profitable and leave the less profitable to be supplied by the municipality. This leads to unfair comparison in the same district between the rates of charge made by the municipality and those made by the private company. The supply authority, whether private or municipal, is undoubtedly on the outlook for the large power user; but the municipal concern, which must supply every kind of demand that is made, and is excluded from certain forms of exploitation which are permitted to the private company, should, I maintain, be protected from the possibility of the private concern invading the municipal area, and securing the large power user by offering a specially low rate which, while it does not pay the company, may be an indirect means of profit. In like manner, I am also averse to a municipal concern harassing a company in this way. If, and so long as the municipal authority is giving a supply at a rate which just covers the statutory requirements in the form of interest, and sinking fund, it should not be subjected to anything like a tariff war with an outside company.

The question of depreciation and its relation to sinking fund is one that still remains undecided. Since the rate of sinking fund has been so seriously increased, any undertaking having a rate of not less than 3⅓% and a reserve fund equal to one-tenth of its capital is surely quite sound financially. It may be asked what is depreciation? I should say that: (1) Depreciation of value is met by the sums set aside for sinking fund, if such sinking fund be properly calculated upon the probable life of the plant; (2) decreased efficiency should be met by depreciation if the ordinary maintenance chargeable to revenue is not sufficient to keep the plant in its first state of efficiency; (3) obsolescence does not mean, nor does it involve depreciation. It is not true depreciation, but it is quite possible that a prudent authority, owning works, might look to the advantage which would be gained by installing present day plant, and so getting greater efficiency than would be obtained from antiquated plant. Such an authority would annually lay aside a sum for this purpose and might be found dispensing with old plant in favour of something more up-to-date, even although the latter might not have reached the end of its usefulness. Such a course, however, is not complusory under the Electric Lighting Acts. It is not legal to create a deficit by setting aside a sum either in name of depreciation or of reserve fund. Only such sums as are profits are available for this purpose.

We all believe that the metal filament lamp will do for the supply of electricity for lighting purposes what the incandescent mantle has done for gas lighting, and more also; but the immediate effect has been to cause many stations to cease putting down additional plant for a year at least. One is glad to think that no such radical change in the efficiency of motors can take place. Much could be said in favour of the supply authority providing the consumers with lamps. Frequently bad lighting is found to be entirely due to defective lamps. In premises which are rented, whether for business or dwelling in, the rule now is that the proprietor in the first instance provides lamps, but there is no definite arrangement for these lamps being either of the most efficient type or renewable at stated periods. In the end it would be for the best welfare, not only of the supply undertaking, but of the wiring contractors, if the lamps were left to the supply authority, either to be supplied and the price included in the charge per unit, or sold direct to the consumer by the supply authority. If the former method were adopted, one lamp might be given for every 100 or 200 units used, and if the latter, the price would be, at most, net cost. Very great improvements in heating and cooking appliances have been effected, and more extensive use of electricity is daily being made for these purposes.

Rapid growth of supply has brought to the front the question of rates of charge to special classes of consumers. For example, consumers with large and small demands; and extra long hour consumers. This is a question which is bristling with difficulties, but it is only by flogging at it that we can come to anything like a solution, and every time that an individual engineer boldly tackles the subject of special charges as regards small, large or long hour consumers he is helping those who find themselves faced with similar difficulties. A flat rate per unit is what is wanted by most people, and it appears to me that it may be possible to adopt this. Any flat rate adopted must be based on the maximum demand system; or in other words, on the load factor of each consumer, and, where classification is possible, on the average load lactor of any one class. For instance, in Glasgow we have a maximum demand system for both lighting and power. We might begin to charge flat rates to-morrow, but these rates would be the same as the average rate paid by each consumer during the previous year on the maximum demand system. The maximum demand would still be taken during the year and the average rate worked out. This would mean that we should have flat rates for different consumers or for various kinds of consumer, ranging from 3½d. per unit to ½d. per unit, decreasing from the former to the latter by tenths or even hundredths of a penny; but each rate would be the result of fair and just computation. A Rating Committee might be appointed, and sit once or twice a year to hear and settle cases in dispute. It is quite conceivable that such a method might lead to increased consumption of energy; for do we not find that consumers paying 3½d. per unit for the first 730 hours use of the maximum demand, and ¾d. thereafter, or an average price of, say 2d. per unit, forget about the units they have got at the ¾d. rate and grudge the price of energy when the time comes to revert to the 3½d. rate? It is quite likely that many such consumers would regard a flat rate of 2d. as a distinct boon, and would not exercise the rigid economy which is often practised in connection with 3½d. rate. The Rating Committee might be appealed to, in cases of dispute, to settle the rate of any new consumers making a large demand. The real cost is the total charge per horse-power per annum, including all material, labour depreciation, and interest on capital. The cost of electrical energy does not depend upon the number of units used, but upon the maximum rate at which the energy is demanded. That is to say, it depends upon the horse-power of plant that has to be installed to meet the demand, or the capital expenditure involved to supply the units demanded. If a consumer of electrical energy caused the supply authority to put down 1 h.p. of plant, and used only that 1 h.p. for an hour in the whole year, and this at a time when the other consumers demanded their maximum supply, such a supply would be cheap at the rate of 80s. per unit. On the other hand, if another consumer caused 1 h.p. of plant to be installed and used it twenty-four hours a day throughout the whole year, the energy could be supplied profitably at ½d. per unit. The rate per unit is not a reliable criterion as to whether the supply is cheap or dear. Four hundred units per kw. of demand per annum at 3½d. per unit is cheap, and probably is under cost, and it is certainly far from being such a profitable supply as 4,000 units per kw. per annum at ¾d. per unit. Strange to say, it is the consumer who is paying 3½d. per unit who complains that he is being overcharged to make up the deficit caused by the consumer who is paying only ¾d. Of course, it is the reverse that is true. If it were not for the consumer who gets his supply at ¾d. the 3½d. consumer would need to pay a much higher rate. The time may be approaching when, instead of charging a rate per unit we will charge so much per 10 units; this would enable us to make fractional reductions smaller than the minimum possible reduction of ¼d. per unit with the present method of charge. For instance, our rates in Glasgow vary from 3½d. to ¾d.; this would work out at 2s. 11d. per 10 units for light, and 7½d. per 10 units for power. Where a fixed rate of, say £4 or £5 per kw. per annum is charged plus a low rate of ½d. or ¼d. per unit, the fixed rate can be reduced, but when the fixed rate system was tried ten years ago in Glasgow by Mr. Chamen, we had serious complaints from lighting consumers because of their bills being as heavy in summer as in winter. It has been suggested that the municipal electricity supply undertaking should, in certain circumstances, give power supplies to large industrial concerns even at a loss, for the sake of the secondary profit that may accrue through the employment thus provided. This is not sound reasoning. The supply undertaking should see that all classes of consumers pay their due share of the standing charges on the capital expenditure necessary to provide plant to supply them. After all, municipal enterprise stands or falls according to whether or not it can justify its existence by continued financial solvency, and if the electricity supply undertaking were to sell energy at a loss for the sake of the problematical inducement held out to a manufacturer to extend his premises, one can easily see that the whole question of tariffs would, ere long, be in a state of hopeless confusion. It seems to me that it would be to our common advantage if those who have a number of large lighting or power users connected to their mains came to some agreement as to the basis upon which the rates of charge to such consumers should be founded. The present lack of uniformity in our methods of charging is a fruitful source of trouble.

A significant statement was made in 1900, and is worth quoting. Four power Bills were under consideration of a Committee of the House of Commons. The Chairman said he wished to state on behalf of the Committee that the value of electrical energy as a means of power had been amply demonstrated, and its importance to the industry of this country was admitted; the Committee felt, he said, that it was to the public advantage to facilitate machinery which would ensure a general supply of electric power to all consumers seeking to avail themselves of the economy and efficiency thus offered; the Committee, therefore, did

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not require the constant repetition of scientific evidence to prove what had already been practically demonstrated to their entire satisfaction. Every one of us, as members of this Association, can do something to maintain the satisfactory supply of electrical energy which has now become sufficiently important to be linked with, and even regarded as a measure of the wealth and prosperity of the Empire.

Alderman Smith, Sunderand, in proposing a vote of thanks to the President for his address, said that the ground which a presidential address was supposed to cover had been repeatedly gone over, and the scope of matter for such an address was therefore limited. Mr. Lackie had, however, managed to break upon fresh ground and given them food for thought. He was precluded from discussing the address, and he would only ask them to thank the President for his address.

Mr. C. H. Wordingham, Manchester, seconded.

Mr. A. C. Cramb, of Croydon, then read a paper on "Commercial Advancement of Electric Supply," and was followed by Mr. H. Collings Bishop, who read a paper entitled "Notes on the Commercial Progress of Electricity Undertakings."

Abstracts of these two papers will appear in a future issue.

The following joint discussion took place on these papers:

Mr. A. H. Seabrooke, Marylebone, said he was thoroughly in accord with the ideas contained in the papers, and his remarks would be by way of constructive criticism. He held that the system of paying bonus on business obtained and apparatus sold was not so good as a graduated bonus on the different kinds of business obtained which encouraged that class of business most desired by the engineer. He thought that two years was an ample period for hire purchase of apparatus. He agreed with the idea of hiring arc lamps to consumers; these things always kept the supply undertaking with the consumer, and kept the former conversant with changes and extensions in the premises of the latter. The collection of accounts should be carried out by those who could give consumers practical advice with regard to apparatus, etc. He did not believe in circular letters; he rather favoured specially typewritten letters signed individually. He was in favour of hiring motors, etc., even to large users. They were i n their infancy as regards commercially pushing their business: in Marylebone, after 25 years, he found they had only 40% of the premises connected, and not half of these used electricity exclusively for lighting. They could not tackle the question of wiring small properties until they got rid of the need of supplying a meter for each consumer.

Alderman Crowther, Sheffield, said they had many large power users in Sheffield, some of them paying them £3,000 and £4,000 per annum for energy. They had tried two exhibitions to push their business. One of these was on a large scale, and was visited by 30,000 people, paying 6d. a head for admission, and realised £1,200. They were only out of pocket to the extent of £105, but the result in the way of business was rather disappointing. The electric furnace was making headway for the production of steel. The energy for such furnaces was sold overall at ·6d. per unit. They tried another exhibition in 1909 on a smaller scale—in a shop rented at £18 per week for four weeks. They were more than satisfied with the result so far as extension of domestic supply was concerned. He preferred the idea of a periodical exhibition to central showrooms permanently open. He thought the bonus system was mischievous. Set a good man and pay him a good salary. In Sheffield they were threatened with gas at 11d. per 1,000 cubic feet, and the only way to meet that was to satisfy the consumer that the convenience and economy resulting from the use of electricity made the latter the preferable commodity.

Mr. Wordingham said that a plain statement of fact was the best means of advertisement. He deprecated the "Ally Sloper" type of advertisement. He thought that the innocent looking, disinterested, unsigned article, which one frequently saw in newspapers, was a good form of advertisement. A close watch should be kept on new premises. The central station engineer should cultivate the house-agents' acquaintance. He thought that in the two papers read the contractor was not treated as he should be. Instead of looking upon him as an enemy, he should be looked upon as the best friend of the central station engineer. He did not think they should poach upon the contractor's preserve at all; they ought rather to try to put work his way and not take any from him. He also thought the Borough Electrical Engineer in the smaller municipalities ought not to take on consulting work in his own district, because a genuine consulting engineer was the real friend of the local central supply. His advice to municipalities would be, "Get a good man, pay him a good salary, and trust him."

Mr. Vignoles, Grimsby, said that the canvasser should be on commission. The principal use of the canvasser was to find the most suitable time for the Chief Engineer to call on particular consumers. Side street lighting was a good form of advertisement. The Joint Committee of the London companies was doing good work in the preparation of suitable literature for probable consumers. They must, however, bear in mind that provincial undertakings were not in the same position as the London concerns. They should, therefore, keep in touch with provincial engineers to ascertain their requirements. He believed in canvassing by means of trades, *e.g.*, let the canvasser go round all the butchers and then if one put in a motor the others might be induced to do the same by way of emulation. In advertising the best results were often indirect. He thought they should have a scheme of advertising in a national way by jointly contributing to a common advertisement such as the gas people had, such advertisements to take the form of articles educating the public up to the possibilities of electrical energy.

Mr. Lingston, Hull, said that the electrical engineer must lower the price of electricity so that the working classes can take advantage of it.

Mr. Ayton, Ipswich, thought they must employ the fair sex if they were to get at the lady of the house with electrical appliances. His Corporation was one of those that did everything for the consumer. They must not consider the contractor too much: the contractor did not consider them. The contractor generally advised the consumer to put in the maximum number of lights, and the dearest fittings, and in this way often hindered the business of the central station. Their publicity work was entirely done by their sales department, which last year sold £3,043 worth of material for an expenditure in wages, etc., of £300. They did not under-quote the contractor, and their average price per lamp point was 8s. 9d. actual cost, or to the consumer 13s. 6d. exclusive of fittings. New apparatus should be brought to the notice of consumers even when it was not sold, because it helped the consumer to think "electrically."

Mr. Hoadley, Maidstone, said that every municipal undertaking should have those powers which would enable it to get business. His experience was that consumers preferred to deal direct with the Corporation. It was not a question of municipal trading, but of business.

Mr Long, Norwich, advocated a system of charging based on rateable value of premises plus 1d. per unit. As a result of a system of free wiring they had over 4,600 consumers out of a total population of 120,000. He had adopted a system of giving metal filaments in small houses on an instalment system of 1s. down and three subsequent quarterly payments of 1s. He had also hired out arc lamps at £7 per pair inclusive for shops shutting at 7 p.m. and £8 for shops shutting at 8 p.m. He was now trying a system of £5 per pair of lamps all round plus 1d. per unit.

Mr. Cramb and Mr. Collings Bishop briefly replied.

The members of the Convention and friends were then conveyed in brakes to the Glasgow City Chambers, where an excellent luncheon was served, the hosts being the Electricity and Tramways Committees of the Corporation.

The Lord Provost of Glasgow presided and proposed the toast of the Incorporated Municipal Electrical Association, to which Mr. Lackie replied. Alderman Bruce, of Sunderland, proposed the Glasgow Corporation and the Lord Provost replied. After lunch the company were driven in brakes to inspect the power stations of the Tramways and Electricity Departments at Pinkston and Port Dundas respectively. Afternoon tea was served.

A busy day was brought to a close with a largely attended reception in the City Chambers, Glasgow, in the evening.

Wednesday was spent in Edinburgh, and Thursday and Friday in Glasgow. A full report of the proceedings of these two days will appear in our next issue.

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Electricity in the Summer Time.

First Article.—Vacuum Cleaners and Ventilators.

It is in accordance with the general scheme of compensations that just at such seasons when Electric Supply Companies are beginning to feel a loss as the result of diminishing need for light and heating, a fresh demand for current arises as Summer time suggests the use of vacuum cleaners and ventilating fans. Both of these appliances, thanks to the enterprise of manufacturers, are with us in many different types; so it is easy for the contractor and dealer to meet the varying needs of users. It is good policy, both from the point of view of the current supply undertakings and contractors to make an effective display of these appliances early in the season, for they only need to be seen, to have their simplicity of action and other merits explained to gain adherents, which means business for all concerned.

Principles of Vacuum Cleaning.

The essential principle of the vacuum cleaner is sound economically and hygienically, for these machines remove, but do not raise dust into the air, as the broom and duster inevitably do. By having a machine whose principal parts consist of an exhaust pump, a hollow chamber and a removable receptacle, to which a flexible aspirating tube with properly adapted mouthpiece is attached, we can create a vacuum in the hollow chamber which will produce a powerful suction action, and then it is only necessary to move the aspirator mouthpiece over carpets or upholstery to remove all dust. And the beauty of the system is that the dust goes direct to a receptacle, where it is deposited. It is quite unnecessary to sweep twice, to dust twice, and even then feel that the work is only partially done, for in cleaning we do not fill the air with dust. This is a distinct gain from the point of view of saving labour and wear and tear, and from the sanitary aspect. For large establishments there are fixed vacuum cleaners, necessitating long lines of flexible aspirating tubes, but for general utility purposes one of the portable type is best. These machines will, given a sufficiently powerful vacuum, draw all the dust, not only out of, but from beneath carpets. Of course, the very best form of power for putting the pump in action is electricity, for it does not add dust or fumes to the atmosphere, and works the small motor noiselessly. Also, current may be taken from any source of supply—town supply, dynamos, or even accumulators. The great beauty of electricity, from the users' point of view, is that the motor, unlike engines, can be run safely by the most unexpert person. Thanks to the flexible tubes, heavy curtains can be cleaned while still hanging and upholstered furniture can also be cleaned. The machines are now even used in libraries to remove dust without disturbing books; they can clean walls covered with flock-papers, cornices, and so on. They are exceedingly useful in stables and garages, in railway and tramway car sheds for removing dust from the upholstered carriages. In fact, they are a boon all the year round, but particularly so in the dry summer months.

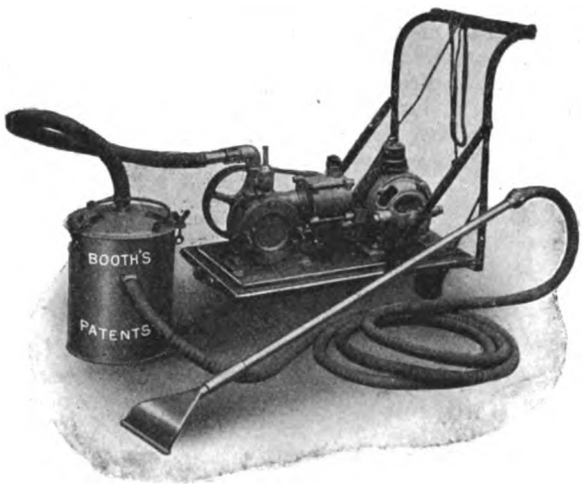
Types of Vacuum Cleaners.

The British Vacuum Cleaner Co., Ltd., Parson's Green-lane, London, S.W.

It is now over 10 years since Mr. H. C. Booth, a partner in the firm of Hitchins & Booth, civil engineers, of Westminster, took out patents for applying a vacuum for the purposes of cleaning. His ingenious contrivances were taken over by the British Vacuum Cleaner Co., who speedily obtained recognition as pioneers in a new and useful field of hygiene. It is necessary, for the sake of economy, cleanliness and health, to remove all dust and dirt thoroughly, speedily, with the least friction possible, and without such disturbance as will raise clouds of dust in the air. Now, this is just what the system introduced by Mr. Booth does. Briefly, the essentials of the system are some form of mechanism (the pump or fan) to create a vacuum in a vessel to which a flexible tube with suitable

Excelsior Ideal.

nozzle mouthpiece is attached. As soon as communication is opened between the nozzle and the vessel, suction takes place, and all dust is quickly withdrawn into the machine, where a suitable filtering bag is provided. It is evident that by such a system considerable power may be used without damage to any fabric, and yet sufficient to detach and remove all adhering dirt. While this is being done, no dust is raised, so that the dirtiest of carpets may be cleaned and yet give rise to no need for after dusting of the room. So flexible is the system that it can be applied not only to clean floors and floor coverings, but walls and wall



B.V.C. Model "R."

coverings, cornices, furniture, and so on. It is largely applied for cleaning railway and tramway cars, as well as private carriages and motor cars, and also for cleaning machines—for instance, dynamos and other large machines in electricity generating stations. At first, Mr. Booth used oil engines or gas engines for the large fixed types of machines, as motive power, but for some time past the vacuum cleaners have been most successfully driven by small electric motors. This gave the idea of constructing small machines suitable for ordinary domestic use, and driven by electricity. The British Vacuum Cleaning Co. have introduced several types of these electrical-driven

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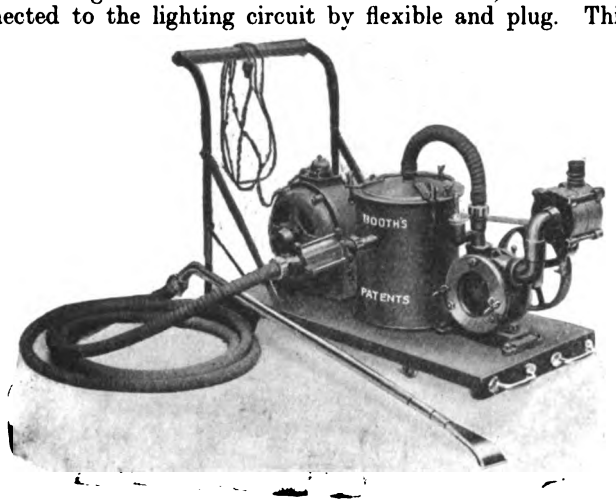
domestic appliances. In models L. and T., costing respectively from 35 to 37 guineas and 50 to 54 guineas, we have a cleaner in a compact cylinder mounted on a small, smooth-running truck, together with pump and motor, which is connected by means of a length of flexible and plug to any electric light socket. Models O. and R., costing respectively from 33 to 35 guineas and 45 to 49 guineas, the vacuum cleaner cylinder is not placed on the truck, which only bears the pump and motor, the pump being connected to the cylinder by a length of armoured hose. The electric "Excelsior" is a self-contained rectangular box, containing cleaner above and motor beneath, to be connected to the lighting circuit by flexible and plug. This



B.V.C. Model "T."

machine is fitted with double-acting bellows and patent crank shaft action. Its listed price is 18 guineas, and it will run at average lighting rates at 1d. per hour, and on average power rates at ½d. per hour. The Excelsior Ideal Electric Sweeper may be described as a "popular" machine, for while thoroughly efficient, it is small, compact, easy to carry about, and only costs £14 17s. 6d. It is self-contained, apart from the suction hose and nozzle and the flexible and plug, measuring 12 in. by 16 in. high, and weighing, complete, 32 lbs. Both of the latter are well within the reach of hotels and large households, and might even be profitably hired out by the day by contractors.

The General Electric Co., Ltd., 67, Queen Victoria-street, London, E.C.

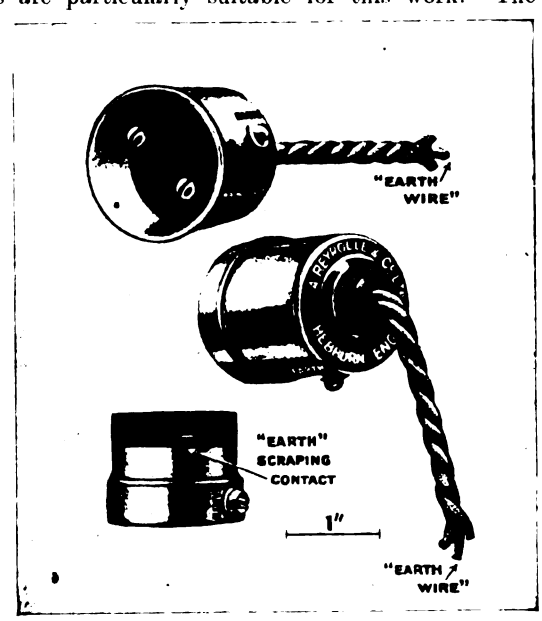
The General Electric Co.'s "Kleenall" (Arnold's System) is a thoroughly practical domestic appliance, compact, and weighing, complete, only 10 lbs. This suction sweeper comprises an electric motor, fan, brush, all mechanism and

"Kleenall."

the dust bag, are enclosed in a handy aluminium casing. Thus it is easy to move, dust cannot escape, and the working is noiseless. Power is obtained from the lighting circuit by means of a suitable plug from wall socket and a length of flexible. The dust bag, it should be mentioned, is of a special woven fabric, which allows the air to pass through, but retains the smallest particle of dust. When about to be used, the attachment plug, with its 30 ft. of flexible, is inserted in the most convenient lamp plug, the switch placed on the handle is turned over, and the sweeper gently moved over the surface of carpet, floor, portiere, furniture, etc. The nozzle acts as the mouth-piece, and owing to the electrically-driven fan, sucks in all dust and dirt. A novelty is the attached brush, which has a peculiar pounding motion of 10 to 15,000 movements per minute, thoroughly loosening all dirt; but where it is desirable to use suction only, the brush can be easily unscrewed. The stock machines work on both alternating and direct current, though the former can only work up to a periodicity of 60 cycles. However, sweepers can be speedily supplied for any voltage and periodicity required. Very little attention is necessary with these sweepers. After every 10 hours working, 5 to 10 drops of oil must be placed in two little cups fitted on the top casing. The dust bags are easily dealt with. Owing to their shape and portableness, the "Kleenall" is of universal application for domestic purposes, and also for coachhouse and garage.

Messrs. A. Reyrolle & Co., Ltd., Hebburn-on-Tyne.

While Messrs. Reyrolle are not manufacturers of vacuum cleaners, they have two notable specialities which are used in connection with them; these are their Patent Motor Starters and Wall Plugs. It must be said, however, that motor starters are not an essential part of a vacuum cleaner installation, except in the larger sizes, as the motor is, generally speaking, of small power only. But a wall plug which will enable connection to be made to the mains rapidly and with safety, is an important adjunct, and their smaller sizes are particularly suitable for this work. The type



illustrated has been designed to meet the new Home Office Regulations with regard to the earthing of portable apparatus, and while this provision is not generally of great importance in connection with housework, it is nevertheless highly important that the design of the plug be substantial, and such that there is no danger of the operator's hand being burnt owing to internal short circuit. Moreover, as the plug portion is frequently dropped on the floor, and otherwise illtreated, the pins should be protected as far as possible. All these points have been carefully considered in designing the plugs illustrated, and the various parts have been moulded into a special insulation which will withstand extremes of temperature without alteration in shape. It will, of course, be understood that these plugs are suitable and are largely used for other purposes than as attachments to vacuum cleaners.

Purification by Ozone.

It is gradually being recognised that all elaborate systems of ventilation should be accompanied by air purification. Attempts towards this have been made by various more or less efficient systems of filtration, the air drawn in by fans being passed through slag wool or other media for the elimination of moisture and dust. We have dealt above

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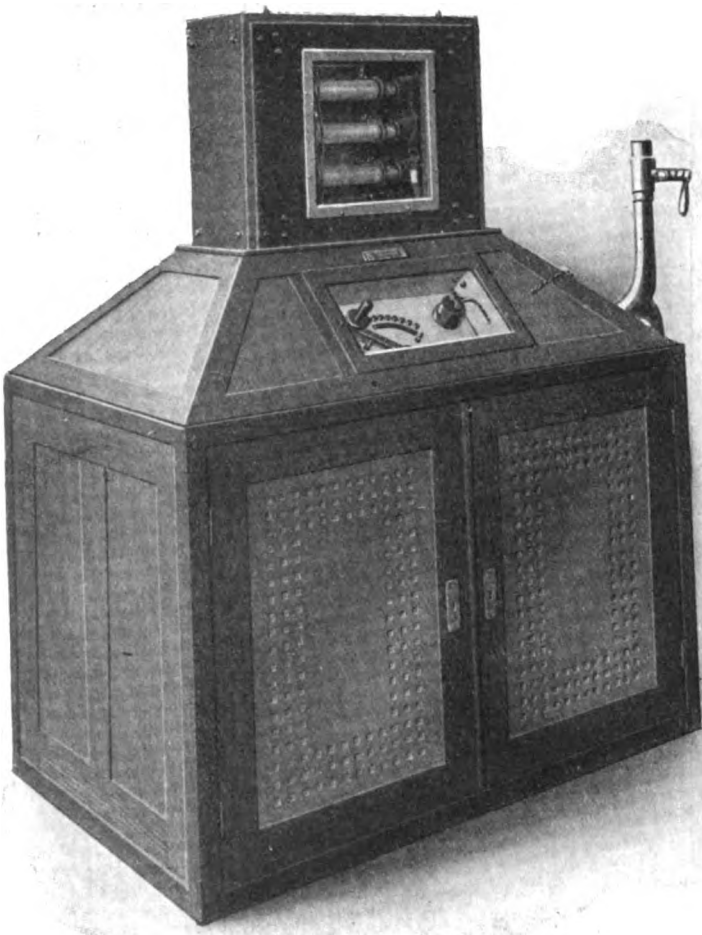

Large Ozone Apparatus.

Elsworthy-Kolle Ozone Apparatus, Type "K."

with the need of removing dust from apartments, which is made easy thanks to electrically driven vacuum cleaners. Electricity has also come in usefully in the matter of purification of air by means of ozonification. Various types of electric machines for the production of ozone from the air introduced into buildings are on the market. Two main types of apparatus are used. In one we have a series of plates, alternately metal (copper or aluminium) and metal covered with glass, or a series of metal and glass rods, the current taken from the lighting circuit is passed through a transformer to increase the tension, and is passed between the plates or rods, meanwhile air being admitted. At once the ultra-violet rays appear, and ozone is generated. This may be distributed by natural diffusion or by fan propulsion, and is usually passed through a gauze net to break up the current and produce better diffusion. Dr. Fischer, of Berlin, devised a means of producing ozone by the aid of a Nernst lamp. An electric fan drove air into a chamber with a powerful Nernst lamp, where it was raised to a temperature of 2,000 c., and then passed into a cold chamber, ozone being generated in the process; but only 4% of the oxygen is thus concentrated. In many public buildings at home and abroad this combination of ventilation with ozonification is adopted. It has the merits of destroying all bacteria and dissipating tobacco smoke and evil emanations. Several appliances have been brought forward for use in large buildings, in shops, and for private houses.

Pinching & Walton, 52, Cannon-street, London, E.C.

The Elsworthy-Kolle ozone generating appliances of this firm are quite simple, and may be used either with artificial or natural ventilation. We illustrate two types. The first is intended for a large establishment; the second is suitable, say, for a restaurant or private dwelling. We have in each case a suitable cabinet in which the transformer, battery and switches are placed. While the larger machines are permanently wired to the electric circuit, the medium and smaller sized appliances are provided with sockets, connection being made by means of plug and flexible. A small exhaust fan is used. Before working the ozone-producing part, air is blown slowly through the glass battery to remove all moisture. Then the air current is turned off and the electric switch turned on, when air is again admitted slowly. Ozone is immediately evolved, and can be easily distributed, either by general diffusion or by means of ducts with suitable openings. A very practical method of utilising the benefits of this system is to conduct the ozone to a ceiling or a desk or bracket fan. In connection with the Elsworthy-Kolle system it is to be observed that there is practically no elevation of temperature, and a total absence of oxides of nitrogen. It therefore gives a cooling, refreshing and purifying media. The large type of machine is made in four sizes, with 4, 6 and 10 tubes, and measuring respectively 3 ft. 6 in. high by 4 ft. wide, 4 ft. 3 in. by 4 ft., and 5 ft. 7 in. by 4 ft., and the price ranges from £215 to £275. The medium sizes, 1 and 2 tubes, are 5 ft. high by 2 ft. 2 in. in width, and cost respectively £95 and £145. Type "K." is only 1 ft. 8 in. high, 1 ft. 8 in. wide, and 3 ft. deep, and costs £50.

Principles of the Ventilating Fan.

Ventilating fans consist of a series of metal blades, either flat or helically shaped, fixed at an angle to a rotating hub, from which they radiate. When the hub is made to rotate at a sufficiently high velocity, the blades attract the air and create currents. Therefore, such fans, when suitably placed, may be made: (1) to introduce fresh air into a room or building from the outside; (2) to expel vitiated air from a room; (3) to produce a cooling effect by raising currents of air. Consequently, we have enormous fans for pumping fresh air into mines and others for exhausting the polluted air; less huge appliances for ventilating factories, workshops, schools, and other public buildings; and, finally, the many patterns of small fans for more domestic purposes, which more particularly concern us.

It is to be noted that when a fan is used to introduce air from the outside, that air may be purified by being drawn through a tube, protected by gauze netting, and filled with

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slag wool or other suitable filtering media, and in this process the air may at will be either dried or humified. It may, indeed, be electrically charged with purifying ozone generated in one of the ozonifiers, worked by means of current from the ordinary supply sources.

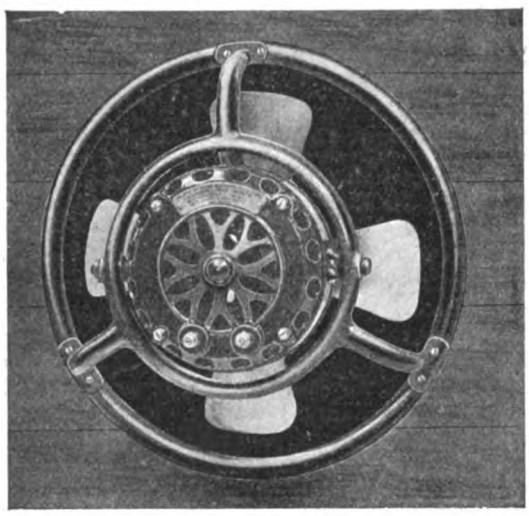
As regards the mere draught creating fans, certain learned doctors in Paris decried them because they raised a certain amount of dust, and microbes, in the air. This point may easily be exaggerated. Especially when we remember that the reasonable retort is that there should not be any dust to raise, when electrically driven vacuum cleaners are available, and may be worked quickly, with care, and at little cost, as a matter of regular routine.

Any form of power, of course, may be used for driving fans, but electricity is the best, as only small motors are required, and these are under perfect control (hence there is no waste of power), in themselves work noiselessly, and being enclosed cannot easily be damaged or get out of order. A very small expenditure of current is sufficient to drive a fan, whether a medium-sized one placed near the ceiling, a pendant from an electrolier, or one of those delightful desk diminutive air propellers.

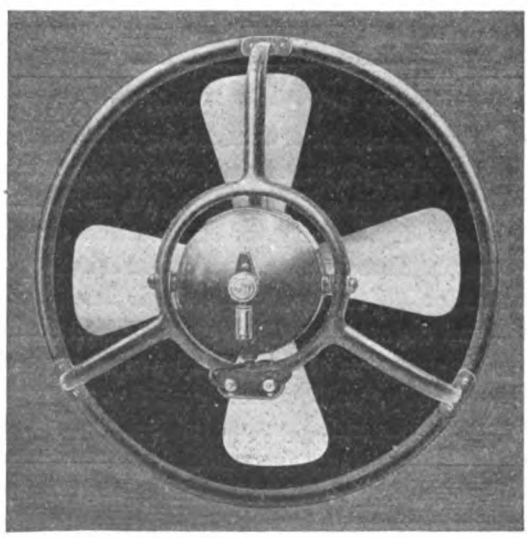
Types of Fans.

The British Thomson-Houston Co., Ltd., 83, Cannon-street, London, E.C.

Both continuous and alternating fans are turned out by this firm. They have four paddle-shaped wings, cast

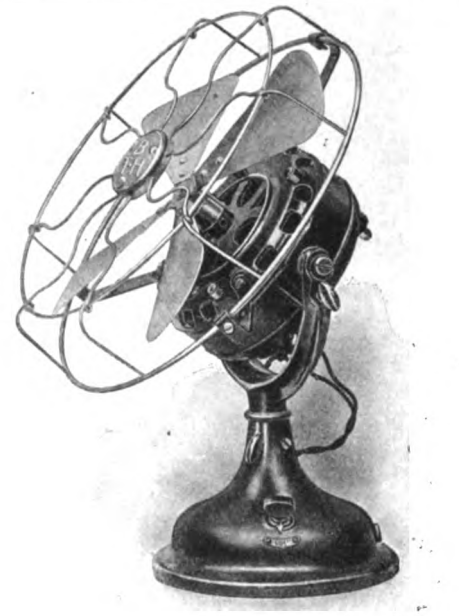


B.T-H. A.C. Exhaust Fan.



B.T-H. D.C. Exhaust Fan.

with a curve in them so as to act scoop-wise, and are set at an angle; they revolve within a copper wire cage. The motors are contained in ventilated frames, with removable shields, the brass-composition bearings are self-aligning and self-oiling. In the continuous current fans we see a universal joint used, enabling the fans not only to be adjusted horizontally and vertically, but instantly converted from a desk to a bracket fan. They range in voltage (six sizes) from 95-115 to 210-250 and in price from £2 19s. to £3 12s. 6d. The alternating current fans are fitted with motors which run satisfactorily on a circuit whose voltage or frequency may vary 5% above or below the rated voltage or frequency. They are fitted with swivel and trunnion frames to allow of adjustment horizontally

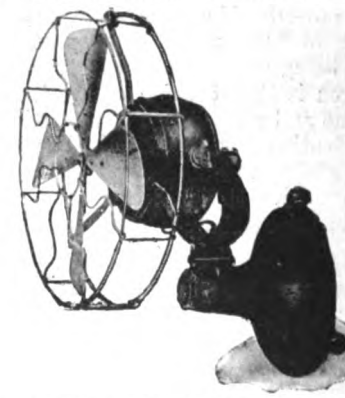


B.T-H. A.C. Swivel and Trunnion Frame Fan.

and vertically. The bracket type varies from the desk type in having an angular adaptor fitted to the motor. There are six sizes, ranging in voltage from 95-100 (50 to 100 periodicity) to 190-220 (50 to 100 periodicity), and in price from £3 5s.to £4 12s. 6d. The B.T.H. also make excellent types of continuous and alternating current exhaust fans, for large rooms, kitchens, etc. The motors are supported by tripods, the arms being placed as far away from the fan as possible in order to less vibration and noise.

The British Westinghouse Electric and Manufacturing Co., Ltd., Manchester.

The Westinghouse D.C. motors for fans are of the drum type, the cores being built of annealed sheet steel laminations and slotted to receive the windings, and the commutator bars are of hard-drawn copper. When intended for ceiling or column fans the motors are fitted with ball bearings. The A.C. motors of the induction type, have an automatic switch which cuts out the phase winding



Westinghouse Convertible Desk and Bracket Fan.

when the motor attains the full speed set. The regulators are mounted on porcelain switch base. In the D.C. type we have high resistance wires wound on the edge of the base and coated with japan; in the A.C. the choke coil consists of insulated coils with soft steel laminated magnetic circuits. In most cases the motor is swung in trunnions and by means of thumb-screw can be fixed at almost any

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angle. We illustrate a convertible swivel and trunnion desk and bracket fan, showing the general design and the well proportioned blades. Our second illustration shows

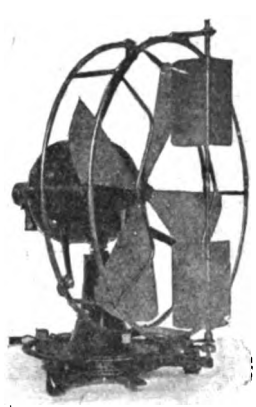
WESTINGHOUSE FANS IN RESTAURANT.

the fans in position in a restaurant. The Westinghouse ceiling fans have paddle-shaped blades with square ends, and are so fitted as to be adjustable. A novelty of this firm is the combining of ventilating with lighting. In both the cases of ceiling and column fans incandescent globes are connected to appropriate sockets in the base of the motor cases, an economical and most effective combination. Owing to the careful design and construction all these fans run lightly, with the minimum noise and at a surprisingly low consumption of power.

THE EDISON & SWAN UNITED ELECTRIC LIGHT CO., LTD., 36 and 37, Queen-street, London, E.C.

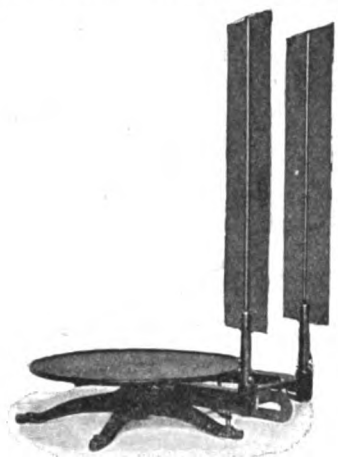
The "Ediswan" electric fans cover a wide range. The "B" type is a convertible pattern, enabling the fan to be used on a table or other stand, to be fixed as a bracket or pendant from the ceiling, being provided with swivel and trunnion movement and provided with a two-speed switch in the base. The changes of position are easily effected, there being no loose parts. They are made in two sizes, 65-110 volts and 200-250 volts, and listed at £2 2s. 6d. The same fans without swivel and trunnion movement sell at £2. The "A" pattern is the same as

OSCILLATING BASE (IMPROVED PATTERN) IN USE.



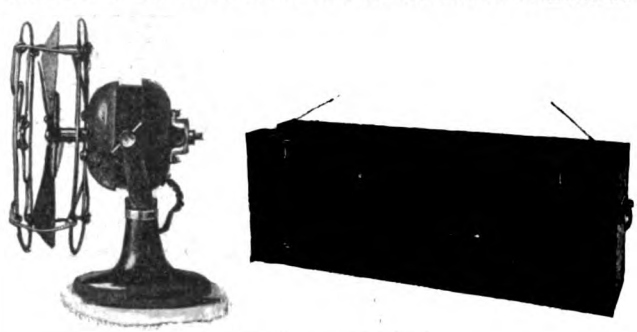
OSCILLATING OR REVOLVING DESK FAN (IMPROVED PATTERN).

the above, but has larger motor and three-speed regulator, and is made in eight sizes, ranging in price from £2 to £3 7s. 6d. Another variation is the use of induction motors at a slightly higher price. The friction gear pattern, made for both continuous and alternating current, is suitable for large rooms, offices, lounges, and so on. It has eight scoop-like blades, and a very small motor, running at its normal speed, that is, 3 to 4 times as fast as the revolution of the blade. The makers claim that this combination gives a maximum efficiency with the minimum of noise, the current consumption of a 24 in. D.C. fan being 75 watts. The table pattern D.C. fans range in voltage from 65-100 to 220 and in price from £4 10s. to £5 2s. 6d.; A.C. single-phase from 105-110 to 200-220 and £5 10s. to £6; three-phase, 105-110 to 200-220 and £5 15s. to £6 5s. The bracket patterns are the same price, but more sizes are made. An ingenious contrivance which should prove immensely popular is the oscillating base, made in two patterns and for D.C. and A.C. By the use of the bases any of the firm's fans can be given an oscillating move-



OSCILLATING BASE (IMPROVED PATTERN).

ment, from side to side, so that the current of air is better distributed. Two types of these bases are made. For use on board yachts and other ships, as well as on trains, a special swinging pendant is employed, great care being taken with the insulation to withstand high temperatures and sea water. Another innovation of considerable value is the primary battery set, an excellent three-blade fan, the stand fitted with trunnion movement, is provided with a primary battery in a substantial base, the battery being sufficient to run the fan for 150 to 200 hours without re-



PRIMARY BATTERY FAN SET.

charging. The re-charging is an easy matter, taking only a few minutes. Ceiling fans, with two, three and four long blades, are made in a great variety of styles, with long pendant rod, with motor case fixed close to the ceiling, and also with a special revolving and swinging arrangement, enabling the motor and fan to be given any inclination desired. In connection with the porthole fans (four and eight blades) "Ediswan" automatic shutters can be provided, which prevent back draught when the fans are at rest.

ERCOLE MARELLI & Co., 26, Garlick-hill, Queen Victoria-street, London, E.C.

Prominent among the many high class ventilating appliances turned out by this firm is the "Ciclone," short-winged, self-rotating ceiling fan. It will be seen from the accompanying illustration that it is quickly adjustable, and has a good sweep. This fan in standard size has a voltage of 103–150, a diameter of 12 in., a net weight of 12 lbs., a revolution of 1,450 p.m., and costs £5; that is, for the D.C. type. The A.C. "Ciclone" is made in two patterns: with brushes and commutators, about 1,370 r.p.m., costing £5 4s.; and induction type, about 1,400 r.p.m., costing £5 14s. These are well adapted for restaurants, cinematograph theatres and other places of public resort. There are many other patterns, the "Monsone" being a very useful one for cabins and low-pitched rooms, as the motor is hung close to the ceiling, and the fan, with its four curved blades, revolves horizontally. It is 12 in. in diameter, has a speed of 1,450 r.p.m., and costs £2 19s. In the convertible standard desk and bracket fan

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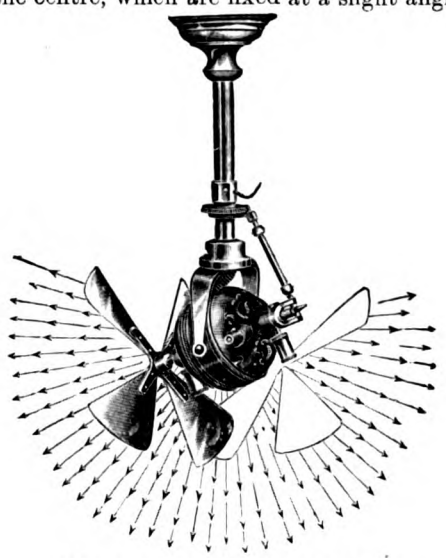
are provided swivel and trunnion fittings, a special loose joint being provided to be placed between the motor and stand when it is converted from a desk to a bracket fan. There are several types of these running from 10 in. to 16 in. in diameter, and running in price from £2 2s. to £4 7s. for D.C., and from £2 4s. to £4 19s. for A.C. machines. Messrs. Marelli are introducing neat electroliers for fitting to their long blade ceiling fans, the three lights, being just below the blades. These fittings cost, for a 54-in. fan, £1 8s., and for a 60-in. fan, £1 12s. This firm's ceiling fans have rather broad blades, tapering but slightly towards the centre, which are fixed at a slight angle. They

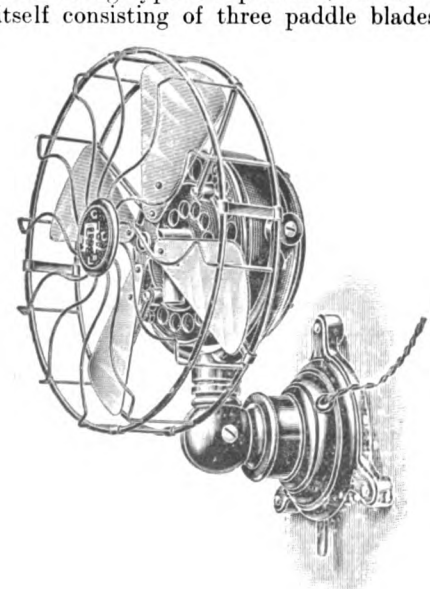


"Ciclone" Self-Rotating Fan.

are made for D.C. and also for A.C., a unique novelty being of the single-phase induction type. Blades are made of wood or of aluminium, and prices vary from £4 2s. for the 24-in. "Tempesta" (700 r.p.m.) to £11 13s. for the 60-in. "Maestrale" (210 r.p.m.) A.C. induction type. All parts are most carefully made, the motors being of excellent type. Messrs. Marelli have a reputation for their small motors for general use. The D.C. series wound motors range from 1-50th to 1-7 h.p., and in price from £1 16s. to £4 16s.; or if shunt wound, from £2 to £5 5s.; the same sizes, A.C. with brushes and commutators, range from £1 17s. to £4 19s.; induction type, from £3 4s. to £4 17s.

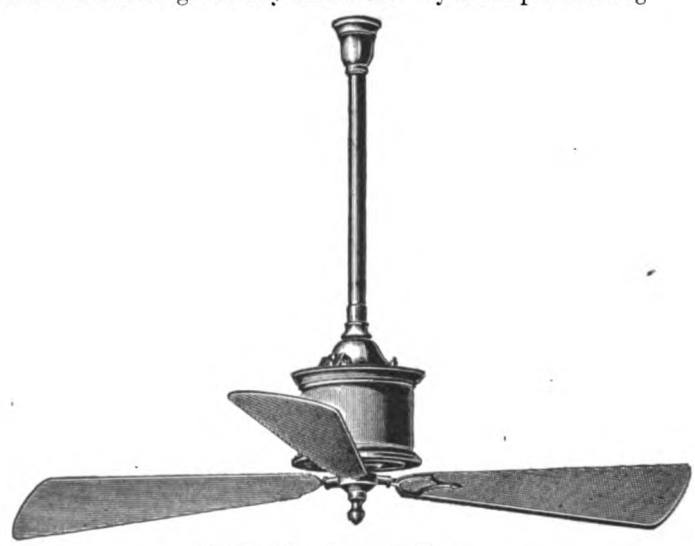
The General Electric Co., Ltd., 67, Queen Victoria-street, London, E.C.

The General Electric Co. have long made a speciality of electric fans, their "Freezors" of various types being well known. The ceiling type is a pendant, like an electrolier, the fan itself consisting of three paddle blades set at a



"Freezor" "Universal" Type Bracket Fan.

slight angle, and revolving at a comparatively slow speed, with a blade sweep of 56 inches. These blades are of wood. The motor portion is contained in a small circular box just above the fan. Insulation is perfect, so the appliance is suitable for use in large rooms at home, and also for the extremely variable hot and damp climates of the tropics and sub-tropics, effectively replacing the uncertain punkah. The "Universal" types have four short paddle blades, slightly curved and set at an angle, guarded by a cage of brass wire. They are placed on stands, are swivel jointed, and so can be placed on table, desk, or chimney, or fixed as a bracket against a wall at any desired height, and can be made to run at varying angles, so that the breeze created can be given any direction. By a simple starting



"Freezor" Ceiling Fan.

and stopping lever in the base, the speed can be regulated at will. "Freezors" are so well constructed that they run noiselessly and perfectly steadily. The "Universal" can be run, with electricity at 6d. per unit, for a farthing per hour. Ceiling fans are listed at £4; the "Universals" range from £2 2s. to £2 8s., for "The Liteweight," and £2 10s. to £3 6s. for the table fan, and £2 15s. to £3 for the bracket fan.

In our issue of July 1, this subject will be resumed, and among the firms whose fans we shall illustrate and describe are the following: Messrs. Hogan & Wardrop (makers of the "E.M.I." fans and small motors), Messrs. Siemens Bros., Ltd., The Sun Electrical Co., Ltd., Messrs. Verity, Ltd., and Messrs. Vandervelde & Co.

TECHNICAL PROBLEMS, WITH SOLUTIONS BY PRACTICAL MEN.

RULES.

Under the above heading we insert questions of a practical character relating to power stations, electrical railways and tramways, mining installations, electric power in workshops, electro-metallurgical plant, and electrical engineering work generally.

Questions.—For each suitable question we offer one shilling. Questions of a practical character stand a better chance of acceptance than those of a theoretical nature. Questions may be sent in at any time.

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Question No. 1219.—Consider the possibility of lighting train carriages by acetylene gas and compare this system with lighting by electric glow lamps. Make the comparison with special reference to general convenience, safety, simplicity, economy, influence of weather, colour of light and general operation. How does the necessity to heat cars affect the problem. Information as to the costs of various systems together with notes on electric accumulators and on, say, one constant voltage generator (axle driven) would also be appreciated.—"City."

Question No. 1220.—Compressed air, water-power and electric power are all available for a certain foundry. Which should be used to get cheapest, most reliable and most flexible supply? Please note valve and pipe troubles and remedies and the relative pipe and engine sizes for compressed air and hydraulic power. Compare compressed air and steam for cases in which fairly long pipes are required; also compare air and water pipes as regards leakages, etc. Over what distance is each system of power transmission available and what is usual best limit?—"Constant."

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THE INTERNATIONAL ELECTROTECHNICAL COMMISSION.

With the publication of the first Annual Report of the International Electrotechnical Commission it is possible to take a fairly accurate view of the progress made since June 27, 1906, when the Commission came into being. If the work actually accomplished does not bulk very largely, it must be remembered that the preliminary steps of organisation has been extremely heavy, and it is only by the untiring energy of Colonel Crompton as Honorary Secretary, of Mr. G. Le Maistre as Secretary, and of the successive presidents that the many initial difficulties have been overcome. Mr. Le Maistre apologises for the late appearance of the report, but the delay is all to the good seeing that we have presented in it a brief historical sketch of the movement and distinctly encouraging details from several of the national committees. It is well to point out here that there are now working committees in America, Belgium, Brazil, Canada, Denmark, France, Germany, Great Britain, Hungary, Italy, Japan, Mexico, Spain, Sweden and Uruguay, while others will shortly be inaugurated in Austria and Russia. In most cases the Committees have received recognition from their respective Governments, either by the appointment of official delegates, by allotment of funds, or by both these measures. Needless to say, this does not apply to our own National Committee. It is curious to observe how long misunderstanding of the aims of the movement persisted in spite of the large amount of publicity given, since the idea of international action to secure a certain amount of uniformity was first mooted by Colonel Crompton at the St. Louis Electrical Congress in 1904. As the outcome of the Colonel's eloquent plea for co-operation in nomenclature and ratings of electrical apparatus and machinery, it will be remembered, our own Institution of Electrical Engineers called a preliminary international meeting in 1906. Numerous leading foreign experts took part in the discussion as official delegates, and, as we know, several

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national committees were formed, our own among the number. But it was not until eighteen months later that the first Council meeting was held in London. No doubt it was practically the only course open that the Honorary Secretary and Secretary of the International Commission and our own National Committee should be one and the same officials. In the preliminary work this was necessary, although it has brought an undue amount of labour to these gentlemen and has unavoidably retarded some of the work. We, therefore, welcome the new departure, whereby Mr. Le Maistre is enabled to devote his whole time to the Commission, the affairs of the British Committee being left in the competent hands of Mr. Rowell, the Institution's Secretary. This is a wise step, not only on the score of the increasing work, but because it is politic that the International Commission bureau should be distinct from our own Committee. The wisdom of this is quite as apparent in the big questions as in such matters of detail as the commendable decision to accumulate a reserve fund; the excess of income over expenditure will not, at least for one year, be returned to the Committees, but will be kept as working capital for the central body, and then, if it is feasible, the subscriptions of the Committees will be reduced in a way to secure an equilibrium. Most of the Committees, on being constituted, took in hand the question of nomenclature and in many instances the work has been carried so far that lists of words from A to E have been decided upon and sent in to the Commission. That is the case with our own Committee, whose lists are now going out to the other Committees, while the letters F to J are being taken in hand. Satisfactory work has also been done in regard to the adoption of a standard candle, though a halt has been called owing to the decision come to by the German Committee, which was communicated to the Commission and transmitted to the other Committees. Meanwhile, in the United States the British proposal that the International candle = 10/9 of a hefner = 0·104 carcel = 1 bougie decimale = 1 pentane candle was adopted, although it involves a reduction of 1·6% of the unit candle-power hitherto adopted by the Federal Bureau of Standards. In Brazil the Committee devoted its attention to ascertain the influence of high atmospheric temperature (23·5 c.) on the pentane lamp. It was found that such temperature does not militate against the use of pentane. Progress as regards uniformity of symbols has been slow with us and with others, and practically this work is now being confined to the question of Ohm's law, a restricted view which is regrettable and will, we trust, soon be widened. Difficulties have, not unexpectedly, been met with in the matter of standard tests for apparatus and machines. However, the regulations existing in different countries have been collected for the information of the committees. Meanwhile, the French Committee is taking the matter up seriously, devoting its first energies to D.C. apparatus, and in order to clear the ground is having certain experiments connected with insulating materials carried out at the Laborotoire Central d'Electricité de France. It will thus be seen that all is going well. In view of the fact that the aim of the movement is to secure uniformity of action it was highly expedient to make the basis of inquiry as wide as possible, hence the necessity of devoting so much time and attention to the organising of affiliated committees in as many countries as possible. Now that this has been done we may hope for evidence of even greater advance in the next report, which, if possible, should be issued next year. The Belgian Committee, which by the way is a very powerful one, representing engineers, manufacturers and all the interested Government Departments, taking advantage of the International Exhibition at Brussels is inviting foreign delegates to two or three informal meetings, commencing on June 30. No doubt, as the Belgian Committee point out, these meetings under such pleasant auspices may prove very useful in preparing the way for the official congress of the Commission to be held at Berlin next year.

INSTITUTION OF ELECTRICAL ENGINEERS.

On and after June 23, the address of the Institution of the Electrical Engineers will be Victoria Embankment, London, E.C., the fine new premises being now practically ready for occupation. The old telegraphic address and telephone number will be retained.

CORRESPONDENCE.

All communications intended for the Editor should be addressed "The Editor, 149, Fleet Street, London, E.C." Anonymous communications will not be noticed. Letters should reach the Editor not later than Tuesday afternoon to be included in that week's issue of the Journal.

The Editor is not responsible for, nor does he necessarily endorse opinions advanced by correspondents.

LAMP LOWERING GEAR.

Sir,—Adverting to the reference to lowering gear given by your Scotch contributor on page 731 of your last issue, the problem of lowering gear for centre poles has now for some time been overcome, as you will see from the pamphlet enclosed giving illustrations of half-a-dozen out of a great number of successful installations of this class of gear in successful operation, including amongst others Oxford and Regent streets, London, which are probably the busiest thoroughfares in the world.

Having specialised on arc lamp lowering gear we have a catalogue of our 100 pages dealing exhaustively with the subject and any of your readers can have a copy of same on application.

The range we deal with include:—Contact devices, counterweight lowering gear, two-stage lowering gear, span wire lowering gear, centre pole lowering gear, inverted gear, self-sustaining winches, flexible wire rope, protector for wire rope, guide pulleys, arc lamp brackets, etc., etc.

Yours etc.,

The London Electric Firm.

George-street, Croydon.
June 8, 1910.

TUNGSTEN LAMP PATENTS.

Sir,—Reference has been made in the Press to the pending litigation between ourselves and the Osram Lamp Works, Ltd.

In the interests of the trade generally we are writing to request you to insert this letter in your next issue inviting anyone attacked to put themselves at once into communication with our solicitor, Mr. Jonathan E. Harris, of 95, Leadenhall-street, E.C., who is defending the action on our behalf with the approval of the Messrs. Phillips Metallic Glow Lamp Works, Ltd.

Yours obediently,

G. M. Boddy & Co.

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I.E.E. STUDENTS' ANNUAL VISIT.

Sir,—At the present moment there are several questions on which members from the various local students' sections would like to exchange opinions. This will be done informally during the annual visit, but such private discussion will not produce any really beneficial result for the section as a whole. If one or more special formal meetings (with a definite agenda published some time before the visit) could be arranged for the discussion of these questions, members going up, could go prepared to speak authoritatively from their local section's standpoint.

One of the questions which might well be thoroughly and formally discussed during the forthcoming visit is the matter of attendances at meetings, and means for considerably increasing them. An examination of the figures for the last few years shows that both London and Manchester attendances have a decided tendency to decrease. At Manchester, the question is, and has been, seriously engaging the attention of the local committee, and no doubt the same can be said of London. To have a general discussion on the matter, therefore, seems most opportune, and would certainly seem to be of some real value to committee-men in particular.

Then there are questions relating to the printing of papers and to the increasing of the usefulness of the section to its members, and of its members to one another. These are questions with which the London section have to deal chiefly, and it would be an excellent opportunity for the managing committee in London to ascertain exactly the views of members outside the London local section. With this end in view, the matters on the agenda could be discussed locally beforehand, and delegates appointed from local members taking part in the visit, to speak on behalf of their section and make known its views as a section. Those delegates could report the views of the other delegates on their return, and say what had been done towards a solution of the various problems.

There is just sufficient time to arrange this if members will make known their views at once regarding this suggested conference. Should the consensus of opinion be favourable, no doubt the committee in charge of the visit arrangements would arrange to hold the meetings and prepare the agenda from the suggestions of interested members. This agenda should be in the hands of the local committees and preferably in the hands of all intending visitors at least a week before the visit commences, so that local opinion can be collected by the delegates and the local committee meetings held.

I hope that members will make known their views on the subject of a conference and trust that it will be possible to hold one at Birmingham next month.

Yours etc.,

H. A. CARNEY.

Marshall Place,
Manchester, N.
June 13, 1910.

[Our columns are open to any correspondence on the subject.—ED.].

WIMBLEDON LIGHTING.

SIR,—I see in a paragraph in this week's issue of your paper I am reported to have stated that 19 London companies had a gross profit of only 1·82% on capital outlay, and 39 provincial companies only 1·75%.

This is incorrect; what I did say, in speaking of the amount for the depreciation and reserve funds, was that the average set aside for these items out of the gross profits by 19 London companies was 1·82%, and the average set aside by 39 provincial companies was 1·75%.

I shall be much obliged if you will make this correction in your next issue.

Yours, etc.,

DUDLEY STUART,
Chairman Electric Light Committee.

June 11, 1910.

NATIONAL ELECTRICAL MANUFACTURERS' ASSOCIATION.

The next Committee Meeting of the above Association will be held at the offices on Tuesday, the 21st inst., at 2.30 p.m.

TRAMWAYS CONGRESS.

The annual Congress of the Tramways and Light Railways Association was held on the 9th inst. in the *Imperial Hotel*, Sackville-street, Dublin.

Mr. William Murphy, J.P., Chairman of the Dublin United Tramways Co., offered the visitors a hearty welcome to the city of Dublin on behalf of his company. In the absence of the Hon. Arthur Stanley, he proposed Mr. James Devonshire as President of the Congress. Mr. Devonshire was known to most of them, and he was Vice-Chairman of the Council.

Mr. Devonshire then took the chair, and addressing the meeting, said he had to tender their very hearty thanks to Mr. Murphy for having arranged the Congress. He had very much pleasure, on behalf of the representatives of the Association, in tendering Mr. Murphy their very hearty thanks. He was sure they would carry that with acclamation.

Mr. A. de Turckheim, secretary, announced letters of apology from those unable to be present.

Mr. R. S. Tresilian read an interesting paper on the Dublin United Tramways, to which company he has for years efficiently discharged the duties of secretary.

TRAMWAY ECONOMICS.

Mr. J. R. Salter, A.M.I.Mech.E., in the course of a paper on "Tramway Economics," stated that the expenses of operating a tramway could be divided into two broad classes. There were, first, the "standing charges" per car mile, which were quite independent of, and which remained constant whatever the number of car miles run might be and there was what might be termed the "running expenses," which were for all practical purposes proportionate to the car mileage run. He had always thought that the relationship between the working expenses and the gross receipts in the case of a tramway expressed as a percentage was of no practical value, and gave no idea of the commercial value of the undertaking. The working expenses in most tramways varied so slightly that the percentage between these and the receipts depended entirely upon the receipts, and, as it had been shown, with an increase in the number of car miles, that the receipts can be rapidly diminished per car mile to obtain the same result, it was evident that no idea could be formed of the remunerative capacity of the undertaking from this relationship. It would seem that tramway undertakings must look rather to an increase in the gross receipts by increasing the car mileage, and thus reducing the standing charges, than to a reduction in the working expenses, to improve their financial position. Referring to the question as to the point at which, having regard to the increasing capital charges, with a reduction in the service, the construction of a tramway was justified. Mr. Salter stated that they need only for this object consider what receipts per car mile with a somewhat infrequent service were likely to be obtained. With a service of this character, and with present fares, it was unlikely, except in very special circumstances, that the receipts per car mile would exceed 11d. This being the case, it would appear that an average 17½ minutes' service was in the neighbourhood of the limit at which a tramway undertaking could be remunerative. He came to the conclusion that tramway undertakings need have no fear of being replaced by self-propelled vehicles unless the cost of operating them was reduced at least one-half, or unless, with the same operating costs, the carrying capacity could be doubled, until they arrived at a 30 minutes' service, assuming that the same fares were obtainable in each case. This conclusion might be modified by other considerations, that is, where the running of the omnibuses might obviate the necessity for changing cars, which became an important consideration, especially with an infrequent service.

The Chairman said that it was a well-know fact that the earnings of that splendid system, the Dublin Tramways, did not exceed, on the average, 9d. per car mile, and yet they paid a 6% dividend. He thought some lesson was to be learned from these figures.

Mr. Stephen Sellon, M.Inst.C.E., said he was impressed with the lines and system they had in Dublin. They had heard from Mr. Murphy what his average fare was. They knew, also, what a profitable concern the Dublin trams were. It was peculiar in this respect, that its mileage in

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regard to its population was far greater, and compared very much better with towns in England, where they made less money than in Dublin.

RAILLESS TRACTION.

Mr. Harry England submitted a paper on "Railless Traction," in the course of which he stated that the qualified success of tramways and light railways laid in public streets had practically stopped entirely extensions into suburban districts. The system of railless traction installed in Paris some 12 years ago, whatever the cause, appeared to have died a natural death, but since that time great progress had been made, and they now found that there were on the Continent three systems of railless cars working successfully both in an engineering and a commercial sense.

THE ACT OF 1870.

Mr. Fred. Coutts submitted a paper entitled "Should the 1870 Act be Revised?" He contended that the Act of Parliament made in 1870 to guide the laying down and working of street railways, however excellently it might have suited the requirements of that time, had now become so obsolete as to render them only fit to be included in the list of Parliamentary Acts which had now ceased to serve in a proper way the purposes which led to their being enacted. If the meeting came to a decision that the 1870 Act should be revised, he suggested that without further delay a committee be appointed to go very fully into it, and bring forward, with as little delay as possible, a scheme to be followed up to interest the members of Parliament in the need for such a change.

The Chairman said he was quite sympathetic with the writer of the paper as regards maintenance of tracks.

Mr. Sellon said they suffered under many disadvantages under the Tramway Act. Provided he could have a tramway passed by special Act on the terms of the 1870 Act, including the model Bill of the Lord Chancellor that was issued every year, he did not want any more.

Mr. P. S. Sheardown, Electrical Engineer, Dublin United Tramways Co., submitted a paper entitled "A few notes on the reinforced concrete lining of the steel chimney stacks at Ringsend generating station, and on reinforced concrete for chimney construction."

The members of the Congress afterwards visited the Ringsend Generating Station, tramcars being placed at their disposal by the Dublin United Tramways Co.

CONSTANTINOPLE TRAMWAYS.

The Commercial Intelligence Branch of the Board of Trade have received, through the Foreign Office, from the Turkish Embassy in London, a copy of a notice issued in connection with the concession for the construction and working in Constantinople and its suburbs of electric tramways. It may be noted that prizes to the amount of £T1,000 (£900) are to be given by the Commission of Adjudication to the best projects submitted other than that of the successful tenderer. Tenders will be received by the "Ministère Impérial Ottoman des Travaux Publics," Constantinople, up to November 10 next. A copy of the notice and of the specification) in French) may be seen by British firms at the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, London, E.C.

ELECTROLYTIC REFINING.

The Electrolytic Refining and Smelting Co. of Australia, Port Kembla, produced last year 5,851 tons of electrolytic copper, valued at £351,060, and also dore bullion, valued at £123,952, making the total value of the output £475,012. The bulk of the output was obtained from the treatment of the blister copper from the Mount Morgan mine, Queensland. The metals obtained from the ores mined in New South Wales are estimated as:—Gold, 2,599 oz., valued at £10,397; silver, 18,326 oz., valued at £1,832; and copper, 697 tons, valued at £41,034.

EDUCATIONAL.

UNIVERSITY OF LONDON.

Mr. R. E. Middleton has been re-appointed lecturer in Municipal Engineering at University College for the session 1910-11.

LIGHTING OF A VILLAGE.

Four miles out of Tamworth lies Polesworth, a mining village with a growing population. The residents not being content with the present method of illumination, some time ago held a Parish meeting to consider the situation, and it was decided to form a Committee who should receive schemes for the lighting of the place with electricity. Representatives of some firms visited Polesworth, and last week the Committee held a further meeting. Mr. Arthur Pearson, of Birmingham, the representative of Messrs. Crompton & Co., London, and Mr. J. H. Harpin, of Messrs. J. H. Harpin & Co., Birmingham, the representatives of the British Westinghouse Electric and Manufacturing Co., were present, and explained their schemes.

In Mr. Harpin's scheme it was proposed to fit new gearing and counter shaft to the existing water wheel (situate at a mill in the centre of the village), and to drive the generator by means of a belt. The distributing system for the place would be a three-wire system, which would give a supply to the lamps of 110 volts. The generator, manufactured by the Westinghouse Co. would have an output of 33 amperes at 220 to 280 volts when running at a speed of 850 revolutions a minute. A main controlling switchboard would be fixed near the generator and the battery would consist of 120 cells. The lamps are of 16 c.p. and the number of them reckoned is 742. The whole of the cables would be run overhead, along the backs of the houses. For the street lighting, 27 lamp posts are allowed for, each carrying a 40 c.p. metallic lamp. The firm's price for the whole scheme would be £1,050; for supplying and fixing one light in 300 houses, they require an additional £300.

Mr. Pearson's scheme included a dynamo suitable for supplying about 500 lamps alight at one time, a switchboard, a 19½ h.p. oil engine, overhead mains and lighting brackets, the covering figure being £670 foundations—an extra £12. Mr. Pearson explained they would want from £800 to £1,000 capital to start with. The working expenses he estimated would come to £234 per annum and the income to £477. That would allow sufficient to pay expenses, a 5% dividend on £800, and leave a balance of about £100 in hand which would go towards providing a battery which would cost £200, for the next winter's working, when more light would be required.

The Walsall Electrical Co., Ltd., had also submitted a scheme, which allowed for 350 lights. The plant they suggested consisted of a gas engine with suction gas plant, a dynamo, a battery of 55 storage cells, a Booster, and a switch board, The cost of the foregoing, with overhead cables and wooden poles, etc., would be £850; this price is exclusive of all builder's work. In all probability the cost would be somewhere about £1,500, as in addition to the £850 there would be the cost of builder's work, making foundations, cost of land, and the cost of connections from the cables in the streets to the different houses. They estimated the expenses would be £260, and the income calculating that each lamp used 20 units per annum at 8d. per unit, £338 6s. 8d. Less expenditure this would leave £78 6s. 8d.

A rough scheme sent in by Mr. C. Pullan, of Bradford, was not considered owing to the lateness of the hour. Mr. Pullan quoted £360 for the necessary foundations, repairs to gates (not including timber), repairs to wheel, generator, switchboard, overhead cables, poles, flotation expenses, and fees and services. Allowing for 50 meters, assisted wiring and a battery (if necessary) £140, making a total of £500. He estimated the working costs at £116 10s.; the revenue account for current only, if charged at 6d. per unit, would be £173 10s., in the second year £200, and increasing in proportion until the fourth year. To generally sum up, it meant a company should be formed with £1,000 capital, and call up £500 to commence. According to the figures given, for an annual expenditure of £116 10s. they would have a revenue in the first year of £173, or enough to pay 10% on the capital, and in the second year a revenue of £200 or 16%. The Committee came to no decision, and adjourned to a future date.

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Electrical Contractors' Section.

A Survey of New Things and Business Prospects.

NOTICE.

Contract and Miscellaneous Advertisements should reach this Office by Mid-day on Wednesday. For rates apply to the Manager, 149, Fleet Street, London, E.C.

CONTRACTS.

BELFAST HARBOUR.

The BELFAST HARBOUR COMMISSIONERS are Prepared to receive TENDERS for the CONSTRUCTION, DELIVERY, SETTING IN PLACE, and TESTING, in the Electric Light Station, Abercorn Basin, Belfast, of a Direct Coupled Steam Engine and Dynamo, together with all requisite accessories.

Outline Specification and Form of Tender, together with a Plan of the Station, and any further information required, may be obtained from the Harbour Engineer, Mr. W. Redfern Kelly, M.Inst.C.E.

Sealed Tenders, on the Special Forms provided for the purpose, to be addressed to the undersigned, endorsed "Tender for Electric Generating Plant," and sent in on or before Wednesday, June 22, 1910.

The Commissioners do not bind themselves to accept the lowest or any Tender, and reserve to themselves the right to apportion the contract among the parties tendering.

W. A. CURRIE,
Secretary.

Harbour Office, Belfast.
June 7, 1910.

COUNTY LUNATIC ASYLUM, LANCASTER.

The VISITING COMMITTEE of the above Asylum is desirous of RECEIVING TENDERS from persons willing to contract for SUPPLYING the following GOODS during the period specified, viz.:—For twelve months, commencing 5th July, 1910, to the 3rd July, 1911: Accessories to Laundry Machines, Castings, Electrical Goods, Glass, India Rubber Goods, Ironmongery, Machined Castings, Masonry, Machine Calico and Felt, Oils and Paint, Paint Brushes, Plaster, Plumbing, Return Water Traps, Sash Cords, Stoker Furnaces, Gun Metal Steam Taps, Steam and Gas Tubes, Timber and Wallpaper.

Printed forms of tender (none other will be accepted) may be obtained on application to the undersigned at the Asylum.

Samples may be seen at the Asylum from 9 to 5, and Saturday 9 to 12.

Tenders and samples addressed "the Chairman of the Visiting Committee," must be delivered at the Asylum not later than 17th June, 1910.

The Visiting Committee does not bind itself to accept the lowest or any tender, and reserves the right to accept the whole or any part of a tender.

J. R. WILSON,
Clerk and Steward.

Clerk's Office,
8th June, 1910.

CORPORATION OF MANCHESTER.

THE ELECTRICITY COMMITTEE of the Manchester Corporation are prepared to RECEIVE TENDERS for the SUPPLY of the following:—

(a) METERS.
(b) SERVICE CABLES.
(c) MOTORS.
(d) MOTOR STARTERS.

Particulars and forms of tender may be obtained on application to Mr. F. E. Hughes, Secretary, Electricity Department, Town Hall, Manchester.

Tenders duly endorsed and addressed to the Chairman of the Electricity Committee, must be delivered at the Town Hall not later than 10 a.m. on Wednesday, the 22nd instant.

The Corporation do not bind themselves to accept the lowest or any tender.

THOMAS HUDSON,
Town Clerk.

Town Hall, Manchester,
7th June, 1910.

BOROUGH OF HAMMERSMITH.

CABLES AND TRANSFORMER.

THE COUNCIL INVITES TENDERS for the SUPPLY of:—

(a) LOW TENSION SERVICE CABLE;

(b) AIR COOLED TRANSFORMER.

Specifications, forms of tender, and further particulars, may be obtained on application to the Borough Electrical Engineer, Electricity Works, 85, Fulham Palace-road, W.

Sealed tenders, endorsed "Tender for Cable," or "Transformer," must be delivered to the undersigned not later than 4 p.m., on Wednesday, 22nd June, 1910.

The Council does not bind itself to accept the lowest or any tender.

H. THOMPSON,
Town Clerk.

Town Hall, Hammersmith, W.
14th June, 1910.

APPOINTMENTS.

CITY OF BIRMINGHAM — ELECTRIC SUPPLY DEPARTMENT.

APPOINTMENT OF SECRETARY.

Applications are invited for the position of Secretary in the Corporation Electric Supply Department.

Applicants should have had a sound commercial training in some large mercantile or manufacturing concern. A certain amount of technical knowledge in connection with the electric supply business is also required.

The salary will be at the rate of £600 per annum.

The Officer appointed will be required to contribute to the Corporation Superannuation Scheme.

Applications for the above appointment, giving full particulars of age, previous experience and date when duties can be commenced, accompanied by copies of not more than three testimonials, must be sent to the undersigned not later than July 1, 1910.

Each application must be endorsed on the envelope "Appointment of Secretary."

Particulars of the duties in connection with the appointment can be obtained on application to the undersigned.

R. A. CHATTOCK, M.I.E.E.,
City Electrical Engineer and Manager.

14, Dale End, Birmingham.
June, 1910.

FEDERATED MALAY STATES.

CHIEF ELECTRICAL ENGINEER.

WANTED, for an Electrical Power Station in the Federated Malay States, a CHIEF ELECTRICAL ENGINEER; must be accustomed to high tension Water Turbine Generators, Transformers, Electrical Winding Plant, Ordinary Motors and Lighting.

Address, stating qualifications, to—

"BULEH" (CARE OF MESSRS. DEACON'S),
Leadenhall Street,
London, E.C.

MISCELLANEOUS.

FOR SALE.

COMPLETE VOLUMES of THE ELECTRICAL ENGINEER for years 1906-7-8, bound in neat red covers; also for 1909 (half-year), unbound, with loose cover. All in very good condition. What offers?—BOX M, 45, c/o THE ELECTRICAL ENGINEER, 149, Fleet-street, London, E.C.

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PATENTS.

S. SOKAL, Chartered Patent Agent,
AND
Certified Austrian Patent Attorney (Patentanwalt),
Specialist for German Patents and Patent Litigation.
55, CHANCERY LANE, LONDON, W.C.

THE PROPRIETOR OF THE PATENT NO. 13891 of 1907, for "Apparatus for Treating Liquids Electrolytically," is desirous of entering into arrangements by way of license and otherwise on reasonable terms for the purpose of exploiting the same and ensuring its full development and practical working in this country. All communications should be addressed in the first instance to—HASELTINE, LAKE & Co., Chartered Patent Agents and Consulting Engineers, 7 and 8, Southampton-buildings, Chancery-lane, London, W.C.

BUSINESS FOR SALE.

ELECTRICAL CONTRACTOR'S BUSINESS for Sale on South Coast; price, £150; owner returning abroad.—Box No. 44, THE ELECTRICAL ENGINEER, 149, Fleet-street, E.C.

PLANT FOR SALE.

Advertisements under this heading: Twenty-four words, 1s. per insertion; three insertions for 2s. 6d.; or each additional line of eight words, 4d.

EIGHTY MOTORS AND DYNAMOS for sale or hire.—MARTIN, 320, Witton-road, Birmingham.

ELECTRIC LIGHT PLANT: 6 h.p. Crossley gas engine No. 43,265, Tyne dynamo compound 220 volts, 15 amp.; carbon brushes, switch board, distribution board, belt set; £38; seen working.—GROVE, Cricket Bat Manufacturer, Hall-road, Peckham Rye, London.

FOR SALE, FIRST-RATE COUNTRY HOUSE ELECTRIC PLANT, to be seen running any day. 2-16 h.p. Hornsby's Oil Engine, with full accessories. Water Tanks and Blow Lamps; one 12 h.p. Dynamo; quantity of ⅝ in. Copper Rod; 55 large Glass Cells; about 6 tons of Lead Plates; 2 small Continuous Fan Motors; one 14 amp. Motor; two 9 amp. Motors; two 5 amp. Motors.—Apply PRETOR-PINNEY, Broad-oaks, West Byfleet.

PLANT WANTED.

PLATINUM UTENSILS, SCRAP, LAMP TOPS.—Best prices given by DERBY AND Co., LTD., 44, Clerkenwell-road, London, E.C. N.B.—Platinum Sold.

SITUATIONS VACANT.

WELL established firm of Engineers, Birmingham, have vacancy for young man desirous of gaining insight and experience in commercial and technical branches. No premium asked for, but highest references required from applicant, who must be willing to learn and work. Permanency offered or assistance to salaried post when qualified if satisfactory.—Address, Box 45, c/o THE ELECTRICAL ENGINEER, 149, Fleet-st., E.C.

REPRESENTATIVE WANTED in England by a leading incandescent lamp factory for the sale of their first-class carbon filament incandescent lamps. Offers should be addressed to—Z2244Q, HAASENTEIN & VOGLER, Basle.

SITUATIONS WANTED.

WIREMAN WANTS WORK, 12 years' experience; screwed conduit.—G. H., 14, Sterndale-road, West Kensington.

WIREMAN wants sit. or job power lighting telephones, bells.—E. C., 65, St. John's-hill, Clapham Junction, S.W.

ENGINEER seeks CHARGE ELECTRIC PLANT; gas or petrol engines, or Engineer in factory; lathe experience, all branches engineering; married.—ENGINEER, 28, Adelaide Road Chislehurst.

GOOD WIREMAN, Coil Winder, age 19. Four years' experience.—W. S., 51, Blackheath Hill, S.E.

ENGINEER (General) desires situation, railway and lighting experience; good draughtsman, speaks Spanish; splendid references.—H., 25, Finborough-road, South Kensington.

CONTRACTS OPEN.

HOME.

BIRMINGHAM. Corporation Tramways.—2,100 tons grooved steel girder tramway rails, together with fishplates, bolts, nuts, and tiebars. (Specification, £3 3s., General Manager, 147, Corporation-street). June 20.

BIRMINGHAM.—Corporation invite supply of general and engineering stores, including timber, brushes, ironmongery, drysaltery and electrical accessories for the electricity department from August 1, 1910, to July 31, 1911. Particulars from City Electrical Engineer. June 30.

BELFAST.—Harbour Commissioners invite tenders for delivery and setting up at the electric light station, Abercorn Basin, of a direct-coupled steam engine and dynamo, together with accessories. Particulars from Harbour Engineer. June 22.

EALING.—Borough Council invite tenders for surface condensing plant. Specification (£2) from Borough Electrical Engineer. July 4.

ERITH.—Urban Council invite tenders for supply and erection of (1) Lancashire boiler complete with mechanical stokers, superheaters and all necessary fittings to couple up to existing steam range. (2) 750 kw. impulse turbo three-phase alternator and exciter, complete with surface condenser, air and circulating pumps, etc. Particulars from Mr. A. Coveney, Electrical Engineer, Erith. June 20.

LANCASTER.—Visiting Committee of County Lunatic Asylum invite tenders for one year's supply of (3) electrical goods, (5) India rubber goods, etc. Particulars from the Clerk's Steward. June 17.

LIVERPOOL.—Corporation invite tenders for three years' supply of tramway passenger tickets from January 1, 1910. Approximate annual supply 130,000,000. Conditions from Manager. June 22.

LONDON.—County Council invite tenders for the manufacture and supply of (*a*) 250 electric tramcar bodies, (*b*) 250 sets of centre-bearing swing bolster car-trucks, (*c*) 250 complete electrical equipments for operation upon both conduit and overhead trolley systems of traction. Specifications (40s. for each section) from Cashier, County Hall, Spring-gardens, S.W. July 5.

LONDON, HAMMERSMITH.—Council invite tenders for the supply of (*a*) low tension service cable; (*b*) air cooled transformer. Particulars from Borough Electrical Engineer, Electricity Works, 85, Fulham Palace-road, W. June 22.

PONTYPRIDD.—Urban Council invite tenders for washed nuts for the electricity works. Particulars from Mr. J. T. Teasdel, A.M.I.E.E., Electrical Engineer. June 26.

PORTSMOUTH.—Corporation invite tenders for (*a*) one year's supply, (*b*) two years' supply of best Durham small and best North country screened Nut coal for the electricity department. Quantities, 10,000 to 12,000 per annum, from August next. Particulars from Town Clerk. June 22.

RAWTENSTALL.—Corporation invite tenders for labour and materials of an electric tramway: Contract No. 5, permanent way construction; No. 6, steel poles, overhead line equipment and accessories; No. 7, cables, conduits, trenching, section boxes and accessories. Particulars (£5) from Mr. C. L. E. Stewart, Borough Electrical Engineer. July 1.

SOUTHAMPTON.—County Council invite tenders for supply and erection of electric light plant, wiring for electric light, and installation of steam and hot water heating for the County Asylum, Knowle, Fareham. Specifications and plans (£5 5s.) from Mr. J. R. Wyatt, Clerk to the Committee of Visitors, Knowle. June 28.

STOCKPORT.—Borough Council invite tenders for electric tramways supplies as follows: (2) brushes (carbon), (5) ironmongery, (6) iron tubing, (7) iron chasings, (8) nuts and bolts, (9) overhead line materials, (10) oils, grease, etc., (11) paints and varnish, etc. Particulars from Borough and Tramways Electrical Engineer. June 22.

WEST HAM.—Borough Council invite tenders for electric light installation at three schools. Specification (20s.) from W. Jacques, 2, Fen-court, Fenchurch-street, E.C. June 20.

OVERSEAS.

ADELAIDE, S.A.—Postmaster-General.—Cordlesss witchboards. (Specification No. 3,381). July 6.

ADELAIDE S.A.—Deputy-Postmaster-General.—120 common battery switchboards, cordless, for private branch exchanges, four (4) line, equipped for two (2) extension and one (1) main line only; 70 common battery switchboards, cordless, for private branch exchanges, six (6) lines, fully equipped; 30 common battery switchboards, cordless, for private branch exchanges, ten (10) lines, fully equipped. (Specification No. 338). July 6.

BELGRADE.—Monopolies Administration.—One five-ton electric crane. (Dep. 20%). (Particulars, Administration Autonome des Monopoles). June 25.

MELBOURNE.—Postmaster-General.—400 telephones, wall sets, magneto, complete (specification No. 220 and pattern C. No. 11); and 200 telephones, bridging table (specification No. 221, and pattern N.S.W. 339, schedule 321). July 9.

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NIMEGEN, HOLLAND.—Steps are being taken by a committee, called "De Maaskanter," to obtain powers for extending the Nimegen-Wychen-Dreumel light railway to various districts in the vicinity of the present line. It appears, further, that, in all probability, the Nimegen Town Council will shortly take over the steam tramways at present worked by the "Nymeesche Tramwegmaatschappij," in which event arrangements will be made immediately for the substitution of electric for steam traction throughout the system.

ROME.—The Ministry of Marine, inviting tenders from Italian and foreign firms for the supply of electric lamps and lampholders to the arsenals at Spezia, Naples, Venice, and Taranto. The upset price is put at 150,000 lire, £6,000), and a deposit of 15,000 lire (£600) will be required to qualify tenders. Tenders should be addressed to "Signor Direttore Generale dei Servizi Amministrativi e della Contabilità, Ministero della Marina," Rome, by whom they will be opened at 11 a.m. on June 30. Tenderers will be required to furnish certificates of competency. Only firms whose names are on the Government list are generally allowed to tender. Personal representation is practically necessary.

ROME.—Tramway equipment required. *See* under "Business Notes: Traction—Overseas," Rome.

TENDERS ACCEPTED—Home.

EDMONTON.—The following tenders for plant in connection with the electric light and power installation of the Edmonton Union were accepted by the Guardians at the meeting last week: Specification No. 5:—For electric Motors and Accessories for laundry equipment: Messrs. G. Harland Bowden & Co. Manchester, £240, with E.C.C. motors. Specification No. 6: For Electric lift motors and fan: Messrs. R. Waygood & Co., Ltd. £293.

NEWPORT.—Corporation have accepted the tender of the General Electrical Co., Ltd., at £3,047, for the supply of a 60 kw. motor generator, two 400 kw., and one bolster.

NOTES.

Superheating.

Although fully aware of the economies that can be derived from a moderate degree of superheat, many engineers and managers hesitate to instal superheaters on account of the structural alterations necessary to their boiler setting, and the time required to shut down; but with care, this stoppage can be reduced to a minimum, and during the past few weeks, Mr. John Thompson, of Wolverhampton, under the supervision of Mr. A. L. Tester, his London representative, installed two of his bent tube superheaters at the Chemical Works of Messrs. Forbes, Abbott & Lennard, East Greenwich, one of these superheaters being for one of his 30 ft. by 9 ft. 3 in. dish end Lancashire boilers and the other for an ordinary 30 ft. by 7 ft. flat end boiler. The contract included the erection of steam pipes giving a by-pass, connecting to their existing mains, and all necessary alterations to the down-takes. These were fairly extensive, including shifting the dampers, raising the side flues of the larger boiler two courses of bricks, and rebuilding the back flues for a width equal to the two boilers. Steam was shut down on Friday evening and the boilers handed over on the following Wednesday morning at 6 a.m. with full steam up and the superheaters at work, giving 110° Fahr. and 100° Fahr. of superheat respectively. To save time these contractors had all their materials on the site before stopping, then cleared away the whole of the down-takes and back flue, erecting the piping and superheaters in position, finishing the brickwork when everything was in place.

Drawing Office Appliances.

Both for the engineer and the enterprising contractor a properly equipped drawing office is a necessity. The wise man will always avail himself of any assistance which will either facilitate or shorten his task, because this also generally brings with it greater accuracy. Messrs. W. J. Brooks & Co., of Letchworth, Herts, have now been favourably known for some years for their flexible curves, ingenious devices which the writer of this note had the pleasure in bringing before public notice in one of the leading London dailies, when the first patents were taken out. Three types of these curves are made. (A) A flexible strip of steel is provided at intervals with tabs, and by means of these tabs and the five fingers, the steel can be

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EBONITE

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Voltmeters
The Latest and Most Novel Patterns.
The Best and Cheapest in the End.
For Lists and Particulars apply to
The Leysner Electrical Instrument Coy.,
12, Lime St., LONDON, E.C.

TECHNICAL CLASSES.

ENGINEERING AND CHEMISTRY.

CITY AND GUILDS OF LONDON INSTITUTE.

There are two City and Guilds Colleges providing Courses of Instruction in Engineering and Chemistry. The **City and Guilds Central Technical College** (Exhibition Road), and the **City and Guilds Technical College, Finsbury** (Leonard Street, E.C.). The Entrance Examinations to both Colleges are held in September, and the Sessions commence in October. Particulars of the Entrance Examinations, Scholarships and Courses of Study, may be obtained from the respective Colleges, or from the Head Office of the Institute, Gresham College, Basinghall Street, E.C.

CITY AND GUILDS CENTRAL TECHNICAL COLLEGE.
(EXHIBITION ROAD, S.W.)

A College for higher Technical Instruction for Day Students not under 16 preparing to become Civil, Mechanical, or Electrical Engineers, Chemical and other Manufacturers, and Teachers. The College is a "*School of the University of London*," and also forms the *Engineering Section of the Imperial College of Science and Technology*. The Entrance Examination includes the subjects of Mathematics, Mechanical Drawing, Physics, Chemistry, English Composition, and French or German Translation, and the Courses of Study for the Associateship of the Institute cover a period of three years. Fees, £36 per Session. Professors:—

Civil and Mechanical Engineering	W. E. DALBY, M.A., B.Sc., M.Inst.C.E., (Dean for the Session).
Electrical Engineering	T. MATHER, Wh. Sch., F.R.S.
Chemistry	H. E. ARMSTRONG, Ph.D., LL.D., F.R.S
Mechanics and Mathematics	O. HENRICI, Ph.D., LL.D., F.R.S.

CITY AND GUILDS TECHNICAL COLLEGE, FINSBURY.
(LEONARD STREET, CITY ROAD, E.C.)

A College for Day Students preparing to enter Engineering and Chemical Industries, and for those who have already served an apprenticeship, and also for Evening Students. The subjects of the Entrance Examination are Mathematics, and English Composition and Precis Writing. The Day Courses in Mechanical or Electrical Engineering cover a period of two years, and those in Chemistry three years. Fees, £20 per Session. Professors:—

Physics and Electrical Engineering	SILVANUS P. THOMPSON, D.Sc. F.R.S., Prin. of the College
Mechanical Engineering and Mathematics	E. G. COKER, M.A., D.Sc. F.R.S.E., M.Inst.M.E.
Chemistry	R. MELDOLA, F.R.S., F.I.C.

City and Guilds of London Institute,
Gresham College, Basinghall Street, E.C.

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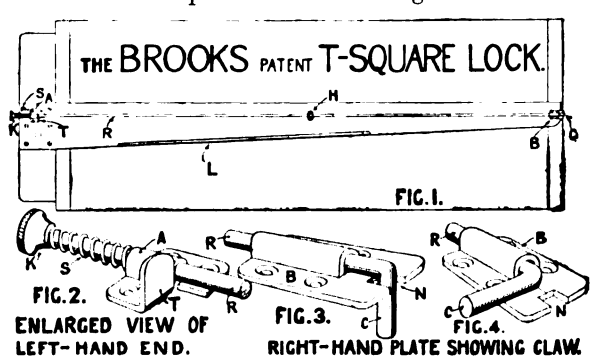
made to take any curve desired. (B) The steel strip is provided with stiff-hinged linkwork, somewhat on the principle of "lazy-tongs," which are self-clamping as soon as the desired curve has been adjusted. (C) These are for steel strips, a foot or upwards in length. In these light wooden cross-bars are dinged to the tabs and slide through brass spring-clamps, so being held friction-tight against a wooden bar running the whole length of the curve. By merely pushing the cross-bars up as required any kind of curve can be adjusted and maintained during work. Messrs. Brooks also make a series of mathematical curves, cut out of transparent celluloid. The corner curve for machine drawing is a circular disc of transparent celluloid, 2 in. in diameter and having circular notches of varying sizes on its edge and provided with a handle at the centre, and thereby small and large curves for different parts of a machine can be quickly drawn. These are all very useful inventions.

T-Square Lock and "Pinro."

Two novelties introduced by Messrs. Brooks are illustrated herewith. The patent T-square lock can be quickly screwed on in any position to a vertical drawing board, to lock the square in position, thus leaving both hands free. Fig. 1 shows the device in position, holding the T-square. Figs. 2, 3 and 4 show details. These enable one to follow the manipulation of the thing. The rod R has



a bent or claw end C, to fit over an edge of the board, and a knob K with spring at the other for adjustment. By merely pressing the knob, the claw is pushed away from the board, and the T-square can then be pushed forward or backwards with the left hand, and when the knob is released locking at once takes place. The clamping and screw arrangements will be easily understood. The other patent, "Pinro," is one of those simple things that "any child" might have thought out, but did not. It has many applications besides that for which it is chiefly intended, namely, to pin down a drawing or tracing paper. It will be readily understood that adjustment is made much easier, there is equal pressure on the paper or cloth all along, and there is less obstruction offered to T-square or drawing instruments.

"PINRO."

New London Agent.

Mr. E. C. Spear, of 16 and 17, Devonshire-square, London, E.C., late manager of Herr Brouckmann's Electrical Department, has been appointed by Herr F. W. Busch, manufacturer of electrical machinery, of Ludenscheid, as his sole agent in the United Kingdom.

Foster Metallic Lamps.

Messrs. the Foster Arc Lamp & Engineering Co., Ltd., recently sent a large consignment of their metallic lamps to a customer abroad, and they report that not a single lamp arrived broken, which certainly speaks very well for the method of packing employed. This is an important point for shippers and contractors overseas. The manufacturers inform us that they are keeping big stocks of these lamps for both high and low voltage, so are in a position to give prompt delivery. A recent introucdtion of theirs is a train lighting lamp. This is very strong mechanically, and is well calculated to withstand considerable vibration.

CONTRACTS WORTH WATCHING:—

Below is a list of contracts recently given or tenders invited. Although we have no means of ascertaining whether in all these cases electricity is to be used, it is presumed, from the nature of the cases that this will be so.

Bacup.—H.M. Office of Works, Westminster. Post Office.

Belfast.—City Surveyor. Disinfecting Station.

Brecon.—Best & Sons, surveyors, 3, Bulwark, Brecon. Addition to Chemical Laboratory and Lecture Room and two new class rooms at County School for Girls.

Chester.—Town Clerk. Fire Station.

East Ham.—Mr. A. H. Campbell, Town Hall. Additions to Town Hall.

Galway.—Mr. W. A. Scott, architect, 45, Mountjoy-square, Dublin. College.

Knowle.—Mr. W. J. Taylor, County Surveyor, Winchester, Work-room block and alterations at Knowle Asylum.

London, Holloway.—H.M. Office of Works, Westminster. Money Order Department Building.

London, Stoke Newington.—H.M. Office of Works, Westminster. Erection of Sorting Office.

Merthyr.—Mr. H. S. Berry, Victoria-street, Merthyr. Buildings for the Merthyr Central Laundry Co., Ltd.

New Hey.—Mr. H. E. Clare, County Office, Preston. School for 350 children at New Hey, near Rochdale.

Oswaldwistle.—Mr. A. Wade, Secretary, Higher Education Committee, Oswaldwistle. Higher Grade School.

Shrewsbury.—A. E. Williams, County-chambers, Shrewsbury. Public Abattoirs.

Swansea.—W. B. Rees, architect, Dumfries-place, Cardiff. Schools.

Windsor.—Edgington & Spink, 15, High-street, Windsor. Additions to Boys' and Girls' Schools.

LEGAL.

Electric Fittings and Municipalities.

In the Chancery Division, before Mr. Justice Neville, the case of the Attorney-General *v.* The Mayor and Corporation of Leicester was commenced on Monday.

In this case the Attorney-General, acting at the instance of a Mr. Ultey, ratepayer, brought an action to obtain a declaration that the Corporation were not entitled to carry on business as electrical contractors, and also a declaration that they are not entitled to expend their funds for the purpose, and for an injunction to restrain them from so doing, and for consequential relief.

A report of the case will be given in due course.

MOROCCO AND ELECTRICITY.

It appears that the Sultan of Morocco, acting through his representative at Tangiers, will shortly call for tenders for the installation of telephone and electric lighting services in various towns of the Empire.

ELECTRICAL ENGINEERS TERRITORIALS (London Division).—Orders for week ending June 25:—Monday, June 20, "A" Co., Technical Drill, 7 to 9.30 p.m.; Rating Examination for those who have been warned. Tuesday, June 21, "B" Co., Recruits' Infantry Drill, 6.30 to 7.30 p.m.; Technical Drill, 7.30 to 9.30 p.m.; any N.C.O. or man who has not yet performed his qualifying drills is reminded that they should be performed before Camp. Wednesday, June 22, Gymnasium, 6.30 to 9.30 p.m. Thursday, June 23, "C" Co., Examination for ratings for all N.C.O.'s and men who have been warned. Friday, June 24, "D" Co., Examination for ratings for all N.C.O.'s and men who have been warned.—(Signed) P. H. Campbell, Capt. R.E., Adjutant.

OSRAM·LAMPS

Electrical Progress at Home & Abroad.

A Review by our Special Correspondents.

TYNESIDE.

NEWCASTLE-ON-TYNE.

Curiously enough, just at the present time the greatest signs of life in the electrical industry of this area appear to come from the electric tramway undertakings. Some notes on these were given last week, and this week three further items of news may be of interest. The first is that the Newcastle Corporation Tramways Committee is, according to the *North Mail*, seriously considering the question of making a charge for the carriage of parcels on the cars. This is within their authority, but such powers have not hitherto been exercised. As the result of a census it has been found that an average per week of about 25,000 parcels—using the term in a wide sense to cover even the mail cart—are carried on the cars, while tradesmen are in the habit of sending their boys on the cars with parcels of merchandise. It is now suggested that a charge of one penny shall be made for such parcels, which should benefit the income of the tramways by about £100 per week. A second note is that there is a possibility of the tramway service from Whitley Bay being extended to Blyth, some distance up the Northumbrian coast, calling at some of the colliery villages on the way. A motion has been passed at the Blyth Council meeting inviting the Whitley Council to co-operate in inaugurating such a service of cars. Thirdly, the Tynemouth and District Electric Traction Co., Ltd., having been in negotiation with the Tynemouth Town Council with the object of obtaining a Provisional Order for extension purposes in the area between Tynemouth and North Shields. Certain conditions have been laid down by the parties which appear to be in a fair way of adjustment.

Mining Matters.

During the past week some important developments have taken place in mining matters which are certain to have a direct or indirect bearing on electrical affairs. The first is the general meeting of the North of England Mining and Mechanical Engineers where, after the usual formal proceedings, the meeting had an excellent demonstration at Armstrong College, given by Dr. Thornton, on the ignition of coal dust by single electric flashes. This was followed by a complete and able paper on the theory of the matter, embodying the results of the tests, and written by Dr. Thornton and Mr. E. Bowden, B.Sc. The local Press has given details of a most important scheme for a central rescue station for the Northumberland and Durham coal fields, staffed by sixty-eight trained men, and equipped with the most complete apparatus for fire fighting and rescue work. The cost of this work is to be borne by the Coal Owners Associations of the two counties; the location is to be at Elswick, owing to an offer made by Messrs. W. G. Armstrong & Co., Ltd. Another development is that the new pit at Dipton—a note concerning which was given some time ago in these columns—has now been opened by its owners, Messrs. Bowes & Partners, Ltd.; while it is given out that the Wingate Grange Colliery estate has been purchased by Messrs. Furness, Withy & Co., Ltd.

Messrs. Ernest Scott & Mountain, Ltd.

One of the notable exceptions to slack trade in this area is the works of Messrs. Ernest Scott & Mountain, Ltd., which appears to be doing very brisk business. A large amount of work in pumps, haulage gears, etc., is at present passing through the shops, some very important orders being now in course of execution. Among these may be mentioned an extension equipment of the Caledonian Coal Co., of Australia, which has been running its various pits for some time past from isolated direct current plants. As a further step, however, a unification scheme has been adopted, with a central generating station where three-phase currents at 3,000 volts and 50 frequency are produced and transmitted to motor generators at each pit. A considerable number of these motor generators giving 500 volts direct current are being made, of from 200 to 250 kw. capacity each, while generating plant is also on order. The existing steam plant is being largely used, but as an extension a compound high speed vertical engine and three-phase alternator set of 250 kw. capacity is now on the test bed. Among other plant which this firm is producing is a large number of portable pumps and haulages, which in the smaller sizes are kept in stock, while important developments may be looked for in the near future.

THE MIDLANDS.

BIRMINGHAM.

The showroom, which is to be opened by the Birmingham Corporation Electric Supply Department at the offices in Dale End, is now being fitted up, and will be available for the public in a fortnight or three weeks. The room, which is on the ground floor and fronting the street, has been tastefully decorated with a view to showing to the best advantage the lighting appliances which will be on view. A bay forming the rear portion of the room will be devoted to power appliances specially interesting to manufacturers. There will be a small model rolling mill and a shears plant actuated by three-phase alternating current motors, 110 volts, one of 5 h.p. for the rolling mill and one of 3 h.p. for the shears. There will also be an electric welder by the British Insulated & Helsby Cables, Ltd., working at 110 volts single-phase and developing 7½ h.p. A Thwaite's blower will be driven by a Phœnix motor 220 volts D.C., 3 h.p., and one of Archdale's drills by a B.T.H. motor of 1 h.p. The general display will include demonstrations of various forms of A.C. lighting, with a great variety of fittings, also illustrations of heating, cooking, ironing, ventilating, and other domestic applications of electricity.

Colliery Equipment.

The new collieries of the Earl of Dudley at Baggeridge near Himley which have been in course of development for fifteen years, and for which coal is expected to be drawn in a few months' time, will have an extensive electrical equipment. The winding machinery and the principal fans will be steam driven, but the haulage, coal cutting, ventilating and other machinery below ground will be driven by electricity. Four generating sets of 500 kw. each will be installed in the Central power house. The Baggeridge Collieries when in full operation will be the largest in the world and is expected to give employment ultimately to 2,000 or 3,000 men.

Local Works at Full Pressure.

The works of Siemens Bros., Ltd., at Stafford, are still working at very high pressure to cope with the business that is coming in. There are 35 turbo-generators or turbo-alternators going through the shops, and in spite of the fact that the firm is now stocking some 200 D.C. machines of their latest class F.C. type, it is still found that the demand exceeds the supply. There are a number of big contracts coming up in the Birmingham district which Siemens Bros. are hopeful of securing. Their new 1-watt lamp is going very well and some most interesting life tests of it are being conducted by supply engineers and others all over the country. This lamp which is of 100 c.p., has a drawn tungsten filament instead of the ordinary squirted filament, and the firm is making on the same principle. Its battery lamps for pocket, mining and other portable uses are being made on the same principle.

Local Fixtures.

An inspection of the Electricity Works formed part of the programme of the Midland Junior Gas Engineering Association, which has its headquarters in Birmingham,

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on the occasion of a visit to Malvern on Saturday. The visitors were entertained to tea at the *Imperial Hotel* by Mr. F. A. Moerschell, chairman of the Gas and Electricity Committee of the Malvern Council. Among the fixtures of electrical interest for next week is a visit to the works of the Rugby Lamp Co. by the Birmingham and District Electric Club, and one to the works of the Electric Construction Co., at Wolverhampton, by the Staffordshire and Warwickshire Branch of the Institution of Mining Electrical Engineers. A paper on "The Electrification of Railways" was to have been read before the Birmingham Summer Meeting of the Institution of Mechanical Engineers by Mr. George Westinghouse (President of the American Society of Mechanical Engineers). Mr. Westinghouse, however, has been obliged to cancel this engagement, as he will not be able to attend the meeting.

LANCASHIRE.

MANCHESTER.

The improvement in the volume of business being done is being maintained in a satisfactory manner. Much of the material being ordered appears to be for replenishing customers' stocks, which during the period of bad trade were allowed to run out. The result is that now everything is wanted at once. The willingness to buy, however, is a satisfactory sign. As far as local observation goes, the firms who suffered most during the passing period of depression were those large firms who pride themselves on being able to supply anything and everything electrical and consequently are obliged to have a large works, etc., entailing a complicated organisation, which in lean years becomes a heavy financial burden. This was so, too, in all the other trades here; for instance, during the past year practically all the cotton mills have worked half-time only, but several mills spinning certain special counts have been so busy during the past two years that they have had to work continuously *night and day* during the whole of that time, and even then have had to increase their plant capacity, sometimes to the advantage of the station engineer.

"Branding" as a Means of Salvation.

In many manufacturing businesses, especially of such things as eatables, cloth and the like, "branding," that is, the establishment of some speciality and its development, has brought the firm from a very insecure position in the market to a position of command which made it practically independent of fluctuations in the state of trade. This principle of branding has been successfully applied to businesses where at first sight it seemed entirely unapplicable. It can be applied to a very great extent in the electrical business if only the firms will set themselves the task. If each firm would strike a line for itself and try to make the wanted article, which the other man does not make, and not rush in to make the article which he does make, each firm would be doing something to improve its own trade and position and at the same time reducing instead of increasing the amount of home competition. The branded article would also command a readier sale abroad; it is the well-developed speciality which passes through tariff walls almost without effort, not the thing which everyone makes. Branding has saved thousands of firms in all lines in the past; it can save the electrical trade of this country. If firms would drop some of those lines in which competition is keenest and take up a line or two in which they had some chance of becoming the leading makers—either from their greater technical skill or through having first brought out the idea. Competition in the various lines would automatically lessen considerably, and owing to such of the firms as did compete in one line, each getting a larger share of available orders than at present, production would be cheaper and consequently lower prices to the consumer more compatible with a profit; while, owing to there being fewer firms in direct competition, working arrangements for preventing excessive price cutting would be much easier to bring about than they are in the present confusion, when the hundreds of large and small firms are all competing in the same markets. The phrase, quoted in an advertisement of one of those institutions which help to produce a glut in technical knowledge, applies to the electrical business and it is the only hope for many firms: "leave the rut."

Items.

Oldham which at present has only a D.C. supply will very probably put in A.C. extensions—when these become necessary—with a view to taking the power load. Exhaust steam turbines will very likely be used, and it is probable that the extensions will be needed in two years' time as the load is growing rapidly.

On the trams between the Ashton and Oldham boundaries an interesting development in "parcels" carrying has been working successfully since last August. For 1d. it is possible to despatch a dinner to a person anywhere on the system. The dinner will be dealt with in one of several ways. It will be delivered to a person at a specified stopping place, or taken to a tram office to be called for, etc. As the district is a "working class" one, the idea has been much appreciated.

SCOTLAND.

GLASGOW.

Up here we feel that a caustic contemporary rather goes "over the score" when in a recent issue it conjures up a fearful vision of hostility existing between municipal engineers and electrical contractors. So far as Glasgow is concerned the said vision is as unsubstantial as the proverbial shadow of a dream. The electrical contractors in Glasgow and district know that they have no better friend than Mr. Lackie. He not only leaves them unmolested to pursue their own business of wiring and fitting up installations in consumers' premises, but whenever possible he hands over to them all such work in Corporation property. The paragraph in question only shows the unwisdom of writing without sufficient knowledge. It speaks of Mr. Lackie as "making use of the outside worker, rather than exerting himself (*sic*) to push his local tradesmen from off the face of the globe." The meaning is not quite clear, but the intention is as evident as it is uncalled for. What the rest of the paragraph exactly means can only be dimly guessed, but it may interest our friend to know that the number of electrical contractors in Glasgow is not forty but about four times forty. Mr. Lackie has frequently stated in public when speaking in favour of the contractors, that they in seeking business for themselves are helping the Electricity Department, but he has never in the slightest degree sought to exploit the contractor to boost his Department, far less to economise along the line of personal exertion.

Order for Scottish Firm.

At a recent meeting of the London County Council it was agreed to accept the tenders of Messrs. Hurst, Nelson & Co., Ltd., Motherwell, for 39 double deck car bodies with roof covers and 40 centre bearing four-wheeled bolster trucks. The price for the car bodies is £10,040 and for the bolster trucks, £4,980. The United Electric Car Co., Preston, quoted £4,880 for the trucks, but the Motherwell concern's tender was preferred on the score of quicker delivery. The Brush Electrical Co.'s tender for the roof covers was £14,469, the United Electric Car Co.'s £14,742, and the Metropolitan Amalgamated Railway Carriage and Wagon Co.'s £13,366.

Gas in a Manhole.

A serious explosion took place last week in connection with the Motherwell Electricity Supply. A gas main pipe burst and the gas travelled along the pipe to an electric manhole, where unfortunately a jointer named Aylott was engaged at work with a blow lamp. The blow lamp ignited the gas, an explosion ensued, and Aylott was badly burned, being rescued only with difficulty from the manhole. In the meantime the flames were issuing in great volumes from the manhole and a good deal of cable was destroyed. The current was cut off from the consumers in the upper end of the burgh and considerable inconvenience has resulted. The flames were extinguished by filling the manhole with clay.

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A New Transforming Station.

On June 9 at [the Glasgow Dean of Guild Court, the Glasgow Corporation Tramways Department were granted lining for the erection of a sub-station in New Bridge station to take the place of the sub-station in Hayburn-street, which has been found too small. The new sub-station will get power direct from the main power house at Pinkston and will transform the current as required for the tramways in the district. The estimated cost of the buildings is £7,000.

Opening of Edinburgh Electric Tramway.

Edinburgh, so progressive in some things and so very conservative in others, has stuck by cable cars long after many a smaller town in Scotland had introduced electric traction. Even Edinburgh, however, has at last got its first instalment of electric cars in operation. The new tramway from Ardmillar Terrace to the new markets at Gorgie was opened on June 9, when Councillor Rusk, Convener of the Tramway Committee and a number of the officials went over the route. The power is being taken from the Electricity Department. The route extends to a mile and a quarter and sufficient provision has been made for the passing of the cars by loop lines. Which is all very characteristically cautious and is in wonderful contrast to the excellent encouragement which the Edinburgh Corporation have always given to the use of electricity for lighting purposes especially in connection with street lighting.

City Rates and the Common Good Fund.

The Glasgow Corporation are encountering vigorous opposition to their proposal to subsidise the rates by a contribution from the Common Good Fund, which is partly made up from the surplus of the Tramway Department's income. Deputations were received last at the Council meeting with regard to this matter and it was decided to hold it over till next meeting. Those who profess to know, seem to be of the unanimous opinion that to devote the surplusage of a municipal trading department to the relief of rates is simply to juggle with other people's money, with a view to relieving the rates of those who can best afford to pay them.

GERMANY.

BERLIN.

Special interest is aroused among German electrical engineers by an ambitious project of the Vereinigte Kander & Hagnekwerke Aktiengesellschaft, of Berne, which is much discussed. Its chief feature is the construction of a reservoir reaching from the Grimsel Lakes to a dam near the foot of the Unteraar glacier, to hold 10,000 million gallons. It is also in contemplation to convert lakes known as the Gelmersee and the Engstelensee into reservoirs, thereby increasing the stock of water by 4,200 million gallons. The following plants are to be laid down: 1. Oberes Aarwerk, fed from the big reservoir of the Gelmersee with an effective head of about 800 yards, and giving 36,000 h.p. 2. Unteres Aarwerk, fed by the outflow from No. 1, and by sundry water-courses. Effective head, 440 yards, 81,000 h.p. 3. Engstelenseewerk, fed by the lake. Effective head, 840 yards, 6,000 h.p. 4. Gadmenwerk, fed by the Gadmen river. Its overflow passes through the Engstelenseewerk to the Unteraarwerk. Effective head, 650 yards, 9,000 h.p 5. Uhrbachwerk, fed by the natural streams of the Ohrbach valley, collected above Pfenger. Effective head, 170 yards, 6,000 h.p. This place will be built first, and supply the power required in building the others. The whole plant will yield 138,000 h.p., and supply 430 kw. hours per annum. The total expense is put at 32 million marks.

German Street Railways.

More than 80% of the trams in Germany are now electrically driven. Some statistics will no doubt be of interest. The total length of the 251 street railways is 2,500 miles. Only 21 of the number are worked by horses, and only 14 by steam locomotives. More than 10,000 electric cars are in use in Berlin, where in 1908, the last complete year for which the figures are available, nearly 400 million passengers were carried. The journeys amounted altogether to more than 50 million miles. Frankfort-on-the-Main exceeds every other German town in the number of tram trips made in proportion to population, 220 journeys per head having been made in 1908. The biggest tram dividend paid in Germany for 1908 was 20%. Out of 154 Prussian street railways, 19 made no net profit in 1908.

Iron Electric Furnaces.

The use of the Heroult furnaces is rapidly increasing. The present statistics are as follows. Sixteen types of furnace are now in use.

In use	Disused	Building
..67	.. 11	..36
Heroult ..17	Heroult .. 0	Heroult ..12

Of the total of 114 furnaces, 35 are on the induction principle, 77 work with the arc, and two combine both systems.

Electric Spinning.

Some highly interesting results in this direction are reported from the mills of L. Schilling & Co., established at Turin. It was found advisable not to use a separate motor for each machine, chiefly to enable the motors to be kept in a separate room away from the damp and fluff-laden atmosphere of the spinning sheds. At first four rotary current motors, totalling 350 h.p. and driving a common shaft by means of belts, were used. These have been replaced by a 3,000 volt 50 period slip-ring induction motor giving 600 h.p. at 300 r.p.m., and giving 92% efficiency at full load. The working expenses have thus been lowered by nearly 10%, and the work of the self-actors has been greatly improved.

Blast Furnace Cases for Electric Power.

Great economy is secured by using blast furnace waste gas on the spot for gas engines driving dynamos. In one case the fuel cost was only half that of coal at 14 marks per ton, the ton giving 7,000 kw. Even when the current was carried from 12 to 30 miles, the gas worked more cheaply than coal. Great economy is also secured in driving electric motors for rolling mills, the current then costing from ·235d. to ·293d. per kw. hour. It is only when the price rises from ·4d. to ·6d. that steam may be cheaper. The following data will be of interest. In a rolling mill where 40 tons were turned out per shift, say, 24,000 tons a year, the cost of the plant is 145,000 marks with steam drive and 23,000 marks with electric drive. Taking the consumption of electric energy at 180 kw. hours per ton, we have a working expense of 9·34 marks per ton, as against 8·2 marks with steam, *i.e.*, a saving of 26,000 marks per annum. As, however, the increased demand put upon the generating station enables the kilowatt to be supplied at a lower rate, the saving is actually 65,000 marks, which pays the cost of the electric installation in two years.

Municipality Sharing in Electrical Undertakings.

In the Bavarian Landgtag the Government and also private members have called attention in discussing the capitalisation of centres concerned with different authorities, to the necessity of making large undertakings of the kind take the form of share companies, in which all the municipalities interested take a share, the object being to prevent monopolisation. Whether this is practicable or not remains to be seen. In the meantime it must be remembered that the Amperwerke Elektricitatsgesellschaft of Munich founded in 1908, in co-operation with the gesellschaft fur elektrische Unternehmungen in Berlin, introduced a sort of participation with the municipalities, in the shape of allowing the latter to share the profits in consideration of granting exclusive concessions. In the agreements with the municipalities on the right bank of the Isar, the public bodies receive a share of all net profits exceeding 7% in return for concessions. By net profits is understood the excess of receipts for the sale of light and power over all expenses whatsoever. If the net profit is between 7 and 8%, the municipalities get 20% of what is left when the 7% has been reserved for the company; if it is between 8 and 9%, 25% of what is left; and if it is over 9%, 30% of whatever is over. Such a system is more likely to create an interest in the welfare of the undertaking on the part of the municipality than allotting shares to it.

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Berlin Street Trams.

A new electric line is to run from Lubecker Strasse, in Moabit, to the corner of Christianastrasse and Prinzenallee, which will fulfil a long felt want. The work is to start at once, and will cost 1,175,000 marks. Besides, a syndicate has been formed to bring lines from Moabit and Gesundbrunnen to Rixdorf. They are to meet at Donhoffplatz, and thence proceed to Rixdorf through a tunnel. The Donhoffplatz will then have an underground station, and form a central point in the electric tram traffic between the north and south of the city.

New High Frequency Machine.

A. Hartmann-Kempf has built a machine giving 500 watts and 5,000 pole changes. The magnetic ring and the armature revolve in opposite directions at 3,000 r.p.m. The motion is transmitted by belting, or, better, in regard to the high speed required, by direct coupling. The machine weighs only 60 kg., and is specially suitable for measuring capacities, self-induction, etc.

Company Notice.

The Oesterreichische Siemens-Schuckert Werke, Berlin, made a gross profit in 1909 of 9,687,631 k., and a net profit of 1,290,911 k. The dividend will be 6%. In the year, the factory, in addition to smaller items, supplied the whole plant for seven electric stations and five electric railways, besides extending 53 stations and eight railways.

UNITED STATES.

NEW YORK.

The principal event of the week has been the thirty-third Convention of the National Electric Light Association at St. Louis, which was one of the most successful gatherings of this Association on record. The papers read reached a high standard of usefulness, and the programme of business was excellently arranged. A noteworthy contribution by Mr. C. F. Scott dealt with a new form of tungsten lamp, the wire type lamp made by the Westinghouse Company. Mr. Scott pointed out that the great handicap of the tungsten lamp has been its fragility. This is because the tungsten filament is similar to glass in many respects. Besides this, the ordinary method of mounting it is to take four or five hairpin shaped loops, secure their ends rigidly by fusing to the leading-in or connecting wires, and anchoring the bent parts. This has been necessary because it has been impossible to make and mount single filaments of 30 in. or such length for 110-volt lamps. The resulting construction has been shown to be weak because most breakages occur near the fused ends. To overcome these difficulties the ideal way seemed to be to employ a single filament and to mount it without rigidly fastening it to its supports. This has been achieved by a new method of manufacturing the filament by which it is produced in long lengths. A few turns near each end are wound in the form of a spiral spring around the leading-in wires to which the ends are fused, thus securing an elastic connection between the body of the filament and its terminals. Intermediate supports are provided for loosely holding the folds of the filament. The single continuous filament insures a perfect uniformity of the filament throughout its length. In the ordinary form, with four or five hairpins in series, a slight inequality in current capacity of the different loops results in a greatly diminished life for the overloaded loop, and, therefore, an early burnout of the lamp. To avoid this, careful sorting of the filaments by electrical measurements is necessary. In the new " wire type " lamp this is eliminated. The mechanical excellence of this lamp has been proven by a series of tests, which showed that it was much less liable to injury than the fused-type of lamp when subjected to blows similar to those to be expected in actual service.

The Grounding of Secondaries.

The report of the Committee on grounding of secondaries was presented to the Convention by Mr. W. H. Blood, who said that the committee sent out a list of 12 questions, to which 285 companies replied, or 36% of the companies then in the association. Of these, 135 ground the secondaries, while 150 do not. In connection with use of polyphase circuits, 40 out of 58 companies report that they ground at the neutral point. A few ground one leg on delta-connected circuits, so that the potential between line and ground is, in some cases, 220 or 440 volts. As to methods of grounding, driven pipes or rods are most popular, but water piping systems give best results, and the committee recommends this method. Sixty-four fatalities and 42 severe shocks are reported by the 285 companies. Of these, 76 were due to crosses with high potential lines or transformer breakdowns, 10 were on circuits carrying 150 volts or less, and 20 on 230-volt circuits. Of the 190 companies reporting " no fires," 98 do not ground their secondaries, 92 do. There is a wide variation of opinion as to the limiting voltage for circuits which should be grounded, but the majority of answers place it between 220 and 300 volts. The committee recommends a rule which should make it mandatory to ground secondaries on all lines which have not more than 150 volts between line and ground. This includes grounding middle wire of three-wire systems up to 300 volts. They do not recommend it for higher voltages. The efficiency of all grounds should be tested, and only grounds of sufficiently low resistance to blow a 10-ampere fuse on 150 volts should be considered adequate. With transformers larger than 20 kw., the fuse should be of a size representing one-tenth of the kilowatt capacity.

A New Rotary Engine.

A semi-public demonstration has been made here of the application of a principle by means of which it will be possible, it is claimed, to construct rotary engines to occupy a place between the reciprocating engine and the turbine. The inventor is Mr. G. P. Herrick, and the chief feature of the engine is the method of balancing the radial thrust, due to concentrated load on the rotary. The engine consists essentially of two rotors of the same diameter and in rolling contact with each other, one of which carries a projection fitting closely in a casing and registering with a notch in the other rotor. The projection on the lower rotor provides the working surface which corresponds to the piston in the reciprocating engine. When this projection passes through the point of contact with the upper rotor, the notch in the upper rotor uncovers the steam inlet back of the projection, and admits a given amount of steam in the space between the contact line of the two rotors and the projection. After cut-off this steam expands and pushes the lower rotor around until the exhaust port is reached, where the steam leaves the engine. The balancing is accomplished by the use of specially constructed flanged plug on each side of the rotor. This plug contains a number of shallow recesses in the surface presented to the under side of the working rotor, into which steam under pressure is admitted in such a way as to act in opposition to the working pressure, and in proportion thereto at all times. The result claimed is that the load, instead of being carried on a metallic surface, is sustained by a film of steam, the friction being that between steam and metal, rather than that between metals. Tests on this engine showed a steam consumption of about 50 lb. per b.h.p. hour, with a steam pressure of 145 lb. per sq. in. and atmospheric exhaust. With a steam pressure of 115 lb. per sq. in. and 18·4 in. vacuum, the engine required about 44 lb. of steam per b.h.p. hour. The Herrick Engine Company has built a 100 h.p. engine, which is now installed in the laboratory of the Stevens Institute of Technology.

Ductile Tungsten.

A further contribution to the literature of tungsten was made by Dr. W. D. Coolidge, in the shape of a paper read at the recent New York meeting of the A.I.E.E. Describing the experiments made by the General Electric Company, Dr. Coolidge said that at the outset the problem of making a ductile form of tungsten for filament use seemed very baffling. Mechanical working and chemical purity were known to have a beneficial effect in rendering other elements more ductile, so attention was directed in those lines. This led to work on tungsten alloys, one of the most promising containing cadmium, bismuth and mercury, to which, when heated, powdered tungsten was added. After drawing this successfully into a wire, it was found that the ductility disappeared with the removal of the auxiliary metals. Similar experiments with other alloyed

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metals proved equally unavailing. Subsequently, it was found that an ordinary, dense, well sintered, tungsten filament can be easily bent and put into various forms at temperatures below redness and before oxidation takes place. The removal of the last traces of certain impurities greatly improved the resulting product. A certain micrographic structure in the metal before the drawing process was began was found conducive to enhanced ductility. As the mechanical difficulties diminished, improvement was also made in the chemical purity of the metal with which the operations began. The final product of the various lines of research was a pure tungsten that could be mechanically worked without more difficulty than attends the manipulation of any very fine wire. The perfectly pliable and ductile wire formed has a tensile strength like that of steel. The resulting filaments retain their ductility throughout the life of the lamp. Filaments of a diameter of 0·005 in. have a tensile strength of 490,000 lbs. per sq. in., while 0·0015 in. diameter gives even 600,000 lbs. The electrical resistivity in microhms per centimetre cube is 6·2 for the hard-drawn wire, and 5·0 for the same annealed. The temperature co-efficient of resistance between 0 and 170° C. is 0·0051.

The Chicago Railways Company.

As the sequel to an action brought by the Westinghouse Company, it is probable that the Consolidated Traction Company's system will undergo reorganization and be merged with the Chicago Railways Company, which already operates the most important electric surface lines on the north and west sides of Chicago. The action brought by the Westinghouse Company was a friendly one to recover a sum of $69,514, which the company was unable to pay owing to a judgment against for $1,344,685 on account of the Consolidated Traction Company, for whose bonds, it is held, the Chicago Railways Company is liable. But as the Railways Company is already mortgaged for its full value, no recovery of the Westinghouse claim was possible, so the Judge, as the simplest way out of the difficulty, placed the Chicago Railways Company in the hands of receivers, appointing to that office Mr. Henry A. Blair, the Chairman, and Mr. J. M. Roose, the President. Thus, as both the Consolidated and the Railways Company are in the hands of the High Court, it will be a comparatively simple matter to unify them.

New Power Projects.

The great Edison power plant for San Francisco will be located on a 10-acre site to the west of Long Beach Harbour. The first unit to be built will cost $2,000,000, and it will develop 40,000 h.p. The Pacific Light and Power Company's plant at Redondo is undergoing alterations and improvements that will enable it to produce fully 65,000 h.p. with its overload. The immediate cost of construction will approximate $2,000,000, with later developments at additional cost. The Los Angeles Dock and Terminal Company will fill in the land at once, while the Salt Lake will put in the spur tracks. The first building will be of sufficient size to contain two turbine generating units with a total output capacity of 40,000 h.p., and the building will be arranged so that additional generators can be added from time to time without great additional structural outlay. The power plant of the Mill Creek Power Company, near Midvale, Idaho, is rapidly nearing completion, and the prospects are that in the near future the new plant will be sending out 2,600 h.p. to the mines and smelters of the valley. The water will develop sufficient power to run two 1,300 h.p. generators.

Central Stations and Ozone.

In the course of an editorial on some new types of electric ozonizers, the *Electrical Review* of Chicago points out that in the production of ozone for water purifying and other purposes, central stations have available a steady and profitable source of income. The writer observes that it is only in the last few years that the peculiar properties of ozone have been applied commercially, the chief obstacle to its exploitation hitherto having been the difficulty of making the gas in a pure form and in sufficient quantities for practical use. Ozone is now produced commercially by a cold silent discharge of high-tension electricity. There have been many types of electric ozonizers recently invented. Several of these are already in successful commercial use for various purposes. In some ozonizers the air is compressed to facilitate the production of the ozone, inasmuch as the latter occupies only two-thirds of the bulk of the same weight of oxygen under the same conditions of pressure and temperature. The presence of silicon fluoride tends to promote the generation of the gas, as does also water vapour in small quantities. The formation or presence of nitrous oxides is deleterious to the process, and should be avoided. Excess moisture in the air to be ozonized is commonly removed by refrigeration of the air, and this further retards the formation of the objectionable nitrous compounds. Even without taking any of these special precautions, however, a silent discharge of high-tension current will produce ozone of remarkable purity, one certain make of ozonizer for use in regenerating the air in public halls, large living rooms, hospitals, etc., being guaranteed to generate the gas with a purity of 98·5%. Besides revitalizing and deodorizing the air in inclosed public spaces and rooms, ozone has been largely applied in hospitals for sterilizing instruments, bandages, etc., in breweries and distilleries for sterilizing vaults, barrels, casks and for ageing wine, in refrigerators for aiding in the preservation of perishable goods for human consumption, and in other ways for purifying, bleaching, or as a bactericide. One of the most important uses of ozone is the purifying of water on a large scale for drinking purposes, and it is in this direction probably that its most material benefits will be effected. There are many cities and towns, for instance, that are situated near a water supply that is too much polluted for human consumption. Such places have often to build large and expensive waterworks at some considerable distance away, and pipe the water many miles to the point where it is used. If some way of treating the more or less polluted water supply which is near at hand were available, a great capital outlay would be avoided. Again, many municipalities have perforce to use a contaminated water because none other is available. In each of these cases the use of ozone for purifying the water would prove of inestimable benefit: in the first on the score of economy, and in the second case by reason of the improvement from a sanitary and hygienic standpoint as well. The *Review* also looks forward to the time when small ozonizers for use in connection with the domestic water supply and other purposes will still further popularise electricity in the home.

BRITISH ELECTRIC TRACTION.

The report of the directors for the year ended March 31, is as follows:—

Capital and Reserve Accounts.—The subscribed share and Debenture capital of the company at March 31, 1910, was: £1,333,010 in Ordinary shares of £10 each; £1,614,370 in 6% Cumulative Preference shares of £10 each; £1,470,653 in 5% Perpetual Debenture Stock; £475,730 in 4½% Second Debenture stock.

The directors have purchased in the market £3,000 5% Perpetual Debenture stock, and £53,206 4½% Second Debenture stock of the company. The issued Debenture stocks have been reduced by those amounts, and the difference of £16,383 11s. 3d. between the purchase price and the nominal value has been transferred to the reserve. The amount of reserve at March 31, 1909, was £602,420 7s. 11d. This account has since been credited with the profit of £10,397 18s. 10d. made on sale of investments during the past year, and debited with various losses, and at March 31, stood at £618,581 17s. 3d. It will be further increased by the sum of £15,000 proposed to be transferred to reserve out of the profits of last year. In addition, reserves amounting to £58,752 2s. 3d. have been made from time to time out of profits against loss and depreciation of specific assets. The various associated companies have created depreciation and reserve funds of their own, which amounted at December 31, 1909, (including balances carried forward), to £1,175,997.

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Creditors.—The total amount at March 31, 1910, was £10,887 8s. 11d. and in addition £46,623 0s. 3d. Debenture interest had accrued at that date and has since been paid.

Investments and Undertakings.—This item stands at £4,997,845 17s. 4d., and consists of shares and Debentures in associated tramway, electricity supply, manufacturing and other companies, consols, and sundry securities and undertakings. It is made up as follows:

	£ s. d.	£ s. d.
Consols of the par value of	200,000 0 0	
Standing in the books at		196,373 18 5
Debentures in various Companies of the par value of	428,181 0 0	
Standing in the books at		408,033 18 6
Shares in various Companies of the par value of	4,411,497 5 0	
Standing in the books at		4,254,680 4 4
		4,859,088 1 3
Capital expended at Barrow, Brighton and Mumbles, less Reserve of £15,500		138,757 16 1
		4,997,845 17 4

Debtors.—The amount of sundry debtors and debit balances stands at £447,947 11s. 9d., and shows a reduction on the amount at March 31, 1909. Details of this item are given in Schedule V. on page 17.

Buildings and Land.—The expenditure on and in connection with the new building in Kingsway amounts to £42,036 18s. 4d. It has been arranged to grant a lease of this building to the British Electrical Federation for a period of 21 years. The account also includes a sum of £2,775 15s. in respect of other buildings and land.

Expenditure on Acts of Parliament, etc.—This item has been increased by the expenditure during the year, and now stands at £26,783 16s. 3d. It is being written down annually by 20%.

Profit and Loss Account.—The net profit after reserving £12,500 against depreciation of undertakings worked by the company, buildings and freehold land, doubtful debts and expenditure on undertakings not proceeded with, and after transferring to reserve the profit of £10,397 18s. 10d. on sales of investments, is £130,564 5s., to which must be added the sum of £20,203 10s. 10d. brought forward from last account, making a total of £150,767 15s. 10d.

After deducting the interest on the 5% Perpetual Debenture stock and the 4½% Second Debenture stock for the year, amounting to £97,484 15s. 4d., there remains a balance of £53,283 0s. 6d., out of which it is proposed to pay a dividend of 3s. per share on the Preference shares amounting to £24,215 11s. and to transfer a sum of £15,000 to reserve, leaving a net balance of £14,067 9s. 6d., which the directors propose should be carried forward. This dividend will bring the payment of the full dividend on the 6% Cumulative Preference shares of the company to June 30, 1908, and the reserve will be increased from £618,581 17s. 3d. to £633,581 17s. 3d. The yield for the past year on the total investments and undertakings standing in the books at £4,997,845 was 2·63% as compared with 2·5% for the preceding year on £5,037,095.

General.—For some years past the directors have made every effort by increasing fares, eliminating unremunerative services and by similar means to increase the profits of the tramway undertakings, and they have been successful in arresting the steady decline in the receipts per passenger. The directors feeling that other measures were necessary in order to obtain a positive improvement of the profits, have during the past year given much time and attention to the examination of various schemes for increasing the net profit on the working of tramways, keeping in view the importance of not increasing the fares to an extent likely to deter traffic. As a result the "Fair Fare" system has been devised. Many of the federated companies have adopted this system, which has been explained in a pamphlet circulated among the shareholders. The directors are glad to be able to say that during the past few months there has been a marked improvement in the traffic receipts on the tramway undertakings, but there has not yet been sufficient experience of the "Fair Fare" system to enable them to say definitely to what extent the improvement is the result of the adoption of this system or is due to better weather conditions and improved trade. The various lighting undertakings in which the company is interested show steady improvement, but owing to the introduction of metallic filament lamps the advance in net profits has to some extent been checked.

The electrical manufacturing industry is still in a very unsatisfactory condition, and the accounts of the Brush Electrical Engineering Co. for the past year show a loss. With regard to the other branches of the company's operations and particularly the development of new electrical enterprises, the directors feel that opportunities for promoting new tramway and lighting undertakings in this country with a prospect of reasonable profit are rare. This is undoubtedly a matter for general regret, especially when it is admitted by the Light Railway Commissioners that the construction of many much needed lines could be effected by the amendment of some of the provisions of the Light Railways Act, 1896.

Having regard to the general position of the company the policy by which the directors are guided may be stated as follows:—

To meet depreciation, the associated companies have made various reserves which amount to £1,175,997; moreover, the B.E.T. Co. itself has a reserve of £633,581 17s. 3d. which is also available to meet depreciation. The increase of these reserves is a matter to which the attention of the directors is constantly given, and while they recognise that the depreciation of assets which has occurred may be in excess of the existing reserves, they consider that it would be incorrect under the existing conditions to make any valuation based upon the present market quotations of the company's own shares and Debenture stocks, which in the opinion of the directors show an unduly exaggerated depreciation. They propose for the immediate future to deal with the depreciation as and when its amount is ascertained, and so long as such depreciation continues to transfer to reserve any profits or losses (other than accrued dividends or interest) made by realisation of present investments. The accounts for the year are made up on this principle. They recommend also an annual addition to reserve out of net profits. With regard to the management of the associated companies, an efficient organisation for the administration and working of the various undertakings has been established by means of the British Electrical Federation, and the results show that compared with other enterprises of a similar kind, the associated undertakings are being economically worked.

It is satisfactory to state that the company has control of large financial resources, which are available either for the development of existing undertakings, or for employment in new enterprises. The cash in hand and Consols alone represent a large sum, and there are other investments which could be realised either without loss, or at a profit, whenever opportunities for the employment of capital in more profitable directions present themselves. Although the directors are of opinion that the scope for safe and profitable expansion in this country is at present very restricted, they believe that opportunities will occur for granting financial aid to existing electrical undertakings on profitable terms. The directors have recently met with some success in their endeavours to secure participations in electrical enterprises abroad, and they are giving their attention to several other promising schemes. They have also acquired interests in some new branches of enterprise which, although not strictly electrical, can be worked conveniently and profitably with the company's existing organisations. In these ways the directors hope not only to increase the financial resources of the company, but also to find profitable employment for them, and to gradually increase the net profits.

DIARY.

WEDNESDAY, JUNE 22.

ASSOCIATION OF ELECTRICAL ENGINEERING STUDENTS (L.C.C School of Engineering).—At the School, Poplar, E., at 7.30 debate on "Gas *versus* Electricity."

INSTITUTION OF CIVIL ENGINEERS (Great George-street, Westminster).—At 8 p.m., "Recent Developments of Telegraphy and Telephony," by Sir John Gavey, C.B.

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Business Notes and News.

LIGHTING AND GENERAL—Home.

ACTON.—After a heated and prolonged controversy the Urban Council have, by a vote of 12 to 10, handed over their electricity undertaking to the Metropolitan Electric Supply Co. The undertaking drew its supply in bulk from the company. The terms of the lease are: duration for a period of thirty-seven years, the company agreeing to pay all loan instalments and interest, and hand back the concern to the council at the end of the time in good order, the council then to re-imburse the company with a percentage of the cost incurred by laying new mains, etc., in extending the business.

BELFAST.—The profits of the electricity and tramway department, announced in our issue of June 3, have been allocated as follows: £5,000 in aid of rates, £6,040 to the renewals account. No reductions in the price of current is to be made for the present.

BLACKBURN.—Mr. P. P. Wheelwright is able to give a most favourable report to his council. The increase of the electricity department was £36,716, nearly £1,800 more than the previous year, while the expenditure was reduced to £17,142, a saving of over £1,140. As a result, £2,000 has been able to be placed to depreciation and a heavier carry-over realised.

BURY.—A notable feature of Mr. S. J. Watson's report to the Council is the very substantial increase of 541,372 units for power purposes. It appears that there are actually 74 hired motors—678½ h.p., and 240 owners' motors—1,827½ h.p., connected with the mains. This is good. Of the profits earned last year, £1,000 has gone in aid of rates, and £2,568 placed to reserve.

COVENTRY.—Application has been made to the Local Government Board for permission to borrow £43,108 for extensions, etc., at the electricity works. It is proposed to spend £54,200, but of this £4,403 will be provided by the sale of old plant, and £6,688 contributed out of profits. At the inquiry, the Inspector suggested that the amount should be further reduced by £15,000, the Corporation to avail themselves of the power already granted, but not exercised, to borrow £14,000 for main extensions outside the city, and at present not required.

DOVER.—A proposal is before the council to lay an extension cable along Alkham-road, Ewell, at a cost of £247.

DUBLIN.—The report furnished by the Lighting Committee regarding the staffs of the electricity and gas departments of the Corporation states: "The Committee are unanimously of opinion, as the result of the investigations of the sub-committee, that the staffs of the electricity department at Fleet-street and the Pigeon House, and of the public lighting department, Tara-street, are not in the slightest degree overmanned. As regards the electricity department, the staffs appear to have always been kept down to the limit at which efficiency could be maintained, and only increased from year to year sufficiently to meet the necessary requirements involved in the rapid extension of the system."

DUDLEY.—In view of the fact that the electricity credit balance of £123 of 1909 has been converted into a debit balance of £600, the Town Council have decided to discontinue the 5% discount to tradespeople.

EASTBOURNE.—The Corporation electricity works made a profit of £2,200 last year. Since the works were taken over from the old company, the cost of production has been reduced by Mr. J. Kempe Brydges from 4·28d. per unit to 1·92d. The Council will shortly take into consideration a proposal to reduce prices.

FROME.—By ten votes to four the Urban Council have decided to transfer the electricity works to the contractors, Messrs. Edmondsons. The town found the money, originally estimated at £20,000, but subsequently over £43,000 have been spent on the works, which have been run by Messrs. Edmondsons on an agreement.

HEREFORD.—A Local Government Board has been held into an application to borrow £3,000 for purposes of electric lighting. After hearing evidence, the Inspector suggested that the amount of the loan being asked for should be increased, and if the Council liked to forward a resolution asking for an additional £500 it could be sanctioned without further inquiry. As a matter of fact the charge on the rates for the works had only been 1¼d. in the £ in 11 years. That was not altogether unsatisfactory considering all the circumstances in a new undertaking, and they had every reason to expect a revenue in the future.

LEITH.—The Town Council are asking Messrs. Preece & Cardew, consulting electrical engineers, to decide as to the best course for the extension of the electricity works. Mr. A. P. Rutherford, borough electrical engineer, favours the laying down of a 600 kw. dynamo with reciprocating engine at a cost of £3,000. The Sub-Committee desire to lay down a 500 kw. mixed turbine set, with cooling tower, to partly absorb exhaust steam from the existing engine. It is claimed that by this alternative a saving of £224 a year would be effected, but the capital outlay would be about £6,000.

MARKET HARBOROUGH.—The Electric Light Provisional Order would expire on June 22 in the absence of any further steps being taken with regard to it. Mr. Douglas said the Board of Trade intimated pretty plainly when it was renewed last year that it would not be again renewed. They had had the Order continued from year to year for several years. After considerable discussion it was resolved to ask the Board of Trade to renew the Electric Lighting Provisional Order for another year.

NORTHAMPTON.—The Northampton Electric Light and Power Co., has posted a circular to its shareholders announcing the issue of 15,000 B shares of £1 each. The shares are offered at 2½% premium; and it is at the option of the applicants to accept them as either ordinary or as 5% preference shares. The authorised share capital of the company is £100,000, and up to the present £71,654 shares have been issued. In addition the company carries £50,750 debentures.

NORTH BERWICK.—Messrs. Crompton & Co.'s scheme for the supply of electricity to the borough has been approved in principle, and an agreement is shortly to be brought up for ratification. The borough seeks powers to purchase the undertaking after a period of 12 years.

ROCHDALE.—A Local Government Board has been held into an application to borrow £13,941 for extension of the electricity undertaking. This includes new buildings, costing £2,950 on additional land leased for 999 years, new accumulators, etc.

STAFFORD.—With a gross revenue of £4,343 and an expenditure of £1,865, the electricity works have made a net profit of £473. Out of this, £350 has been transferred to depreciation account, and the balance has been distributed as a 7·9% bonus on the salaries and wages of the employés.

ST. HELENS.—Application has been made to the Local Government Board for powers to borrow £10,230 for purposes of the electricity undertaking. Of this, £6,300 is required to equip the power station with plant to supply high tension current to Peasley Cross and beyond. It is proposed to instal a turbo-alternator, with condenser and switchgear, and switchgear and transformers in the Sutton sub-stations.

WARRINGTON.—At a Local Government Board inquiry into the application for powers to borrow £7,420 for extensions at the electricity works, considerable opposition was shown. Extension however, is necessary to meet the increased demand and also to provide against any possible breakdown.

WEDNESBURY.—The Local Government has sanctioned the raising of a loan of £2,858 for electricity works extension, but application is to be made for powers to raise another £4,600 for the same purpose. This is due to the rapid increase in the demand for electricity both for lighting and power purposes.

LIGHTING AND GENERAL—Overseas.

BUENOS AIRES.—The Argentine Government has issued a decree approving contract and plans submitted by Messrs. Otto Franke & Co., relative to the construction in Buenos Aires of an underground electric railway, which will run from the border of the Riachuelo, by way of the Avenida Vélez Sársfield, Entre Ríos and Callao to the Retiro station, and through the Calle Brasil to the Plaza Constitución, thence effecting a connection with the lines at the Buenos Aires and La Plata harbours.

DURBAN.—Negotiations are proceeding between the Government and the Durban Corporation relative to the latter taking over the Farmers' Electric Power Station. There is every prospect of an agreement being arrived at.

ORTIZ.—The Paraguayan Government have granted to J. M. Meza Landaeta permission to construct a telephone line between Ortiz and Parapara.

THE HAGUE.—The Posts and Telegraph Department are having a double line of telegraph run between Arun and Franeker, with branch lines, the work being carried out by contract.

TORONTO.—The municipal system organised by the Ontario Government for the distribution of electric energy generated at Nigara Falls, will deliver power at Toronto in October, and at London and St. Thomas, 100 miles west of the Falls, by the end of the year.

WAIKINO, NEW ZEALAND.—Preparations are now in progress for the commencement of work in connection with the scheme whereby electrical power will be conveyed a distance of 53 miles from the Hora Hora Falls to the Waihi Gold Mining Co.'s mine at Waihi, and to its battery at Waikino. The scheme will take upon two years to complete, and it will provide about 5,000 h.p. to work the shafts at Waihi and Waikino.

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WELLINGTON, NEW ZEALAND.—The profit of the municipal electric light department for the past year amounted to £2,228, as compared with £4,272 for the previous year, the decrease amounting to about 48%, being attributed to the very general use of metallic filament lamps.

TRACTION—Home.

BOURNEMOUTH.—The Town Council have referred to a committee of the whole Council a recommendation from the Tramways Committee that, subject to the approval of the Board of Trade, the present conduit system of tramways through the centre of the borough be abandoned and the overhead system substituted. Mr. C. W. Hill, tramways manager, in his report suggesting the change, estimates that a saving of £3,000 per annum would be effected.

LINCOLN.—The expenditure on the Municipal tramways ("G.B." surface contract system) rose from £3,648 in 1908-9 to £3,900 in 1909-10, and thus in spite of the fact that a saving was effected both in cost of manufacture and power expenses. Mr. Stanley Clegg adds: "Turning to the cost of the 'G.B.' equipment, it would at first sight seem that there is a reduction on last year's expenses; last year, however, there were various special items included in the £147 which reduced the direct revenue expenditure to £82. This year there is only £28 to be deducted, being £18 for up-keep of feeders, and £10 for special improvements, and therefore the total amount to be charged against upkeep is £112, or an increase of about £30. For the first time we have exceeded the 'G.B.' Co.'s guaranteed figure of £90 per annum, and I have had the costs taken out for the past four complete years—including the one under examination—and find it works out at a total of £276, or an average of £69 per annum."

WARRINGTON.—Out of the profits of the Municipal tramways £1,000 has been paid over in relief of rates and £1,750 transferred to reserve fund, which now stands at £84,371.

YORK.—The two last sections of the tramway, those between Holgate Bridge and Acomb, and between Lendal Bridge and Haxby-road, have been passed by the Board of Trade.

TRACTION—Overseas.

MADRID.—The Ministry of Public Works have issued decrees granting (1) to the "Sociedad Anonima Tranvia de Cádiz á San Fernando y Carraca" a concession for the construction of an electric tramway from Fernando and Carraca; and (2) to the "Sociedad Nueva Montaña" of Santander a concession for the construction and working of an electric tramway in the vicinity of Santander.

ROME.—Tenders are invited by the Commissione Consultative dei Tramvia Elettrici Municipali, Piazza SS. Apostoli, 49, Rome, for the supply of the following material: 50,000 metres of three-phase cable, 30,000 insulators, supplies for the equipment of generating and transformer stations, alternators, transformers, water turbines, etc., 500 standards of reinforced concrete, iron standards, about 138 miles of copper conducting wire, and about 4,000 insulators to withstand 30,000 volts. No date is given for the receipt of tenders, which, it is stated, are open to international competition.

STOCKHOLM.—With reference to the notice on page 740, relating to the proposed establishment of an electric power station at the Porjus waterfall and electrification of the State frontier railway in the north of Sweden, H.M. Minister at Stockholm now reports that the Government's proposals in this connection have been agreed to by both Chambers of the legislature. An electric power station is to be set up at Porjus, a railway constructed from Porjus to Mount Gellivara, and the frontier railway electrified, at a total estimated cost of 21,500,000 kronor (about £1,194,500).

VALPARAISO.—The Department of Public Works have arrived at the conclusion that it will be advantageous to substitute electric for steam traction on the first section, *i.e.*, from Valparaiso to Santiago and Los Andes, of the Chilian State Railways, and tenders have now been invited for this work, and will be received at the "Ministerio de Obras Publicas," Santiago, up to July 15.

COMPANIES' MEETINGS AND REPORTS.

R. WAYGOOD & CO.

The report for the year ending March 31 states that the profits earned by the company, including £3,159 10s. 8d. brought forward from last year, amount to £23,755 8s. 6d. The directors recommend that a further dividend be declared at the rate of 7% per annum for the six months ending March 31, 1910, making, with the interim dividend already paid, 6% for the year on the Ordinary shares, which will require £4,725, leaving a balance of £2,665 5s. 6d. to carry forward.

COMPANIES REGISTERED.

ELECTRICAL TRUST.—£2,500, in 2,000 Ordinary shares of £1 each and 10,000 Founders' shares of 1s. each. Business: That of electrical, telegraph, telephone and mechanical engineers, etc. Private company. Office, 9 and 10, Pancras-lane, E.C.

ELECTRO CHLORINATION SYNDICATE.—£50,000 (48,000 £1 preferred ordinary and 40,000 1s. deferred ordinary). To acquire and lay down a working plant for the reduction of ores and the refinement of metals by new processes in chlorination and electrolysis, and to adopt an agreement with H. W. Couzens. Minimum subscription, £2,000. First directors (not less than three nor more than seven) to be appointed by signatories. £100 each per annum (chairman £150). 39, Victoria-street, Westminster.

EXPRESS CABLE INVENTIONS.—Capital £50,000, in £1 shares. Business: To acquire from H. Knudsen his patents and other rights in certain inventions for transmitting and receiving photographs and printed and typewritten messages by wireless telegraphy and over cables and land lines, etc. Minimum cash subscription, £100. First directors (to number not less than two nor more than 10), are Colonel H. S. Fitzgerald, C.B., H. C. Hall and T. E. L. Oakley (all permanent). Qualification, 10 shares. Remuneration (except managing director, if any), £500 per annum, divisible. Office: 29a, Charing Cross-road, W.C.

PERSONAL.

The Hampstead Borough Council have granted the following increase of salaries as from April 1: Mr. George H. Cottam, chief electrical engineer, from £775 to £825 per annum; Egerton Sayer, chief assistant engineer, from £365 to £390 per annum; and John Leadbeater, chief indoor assistant engineer, from £325 to £360 per annum. This was approved.

Mr. T. H. Matthews, formerly connected with the Shrewsbury Corporation Electricity Works, and who then went out to South Africa to join the staff of the Randfontein Central Power Station, Johannesburg, has been appointed shift engineer at the Port Elizabeth Municipal Electricity Works at a commencing salary of £225 per annum.

Professor Henry Adams (Henry Adams & Son) has consented to act as one of the jurors in the Engineering Sections of the Japan-British Exhibition.

Mr. George Nicolson, assistant engineer, Weymouth and Melcombe Regis Electricity Works, was awarded the Cecil Medal and Prize for 1909-10 by the Dorset Field Club for his essay on "Electricity as a Motive Power for the Purposes of Aviation, Navigation and Motor Traction on Land, in view of Recent Developments."

THE CALCUTTA ELECTRIC SUPPLY CORPORATION, LTD., announce that the number of units delivered to consumers during the four weeks ended April 29, 1910, were 780,512 compared with 573,738 units in the corresponding four weeks of 1909.

PATENTS.

Dynamos and Motors.

2959.—1909. E. TURNER, Trafford Park. The invention provides an armature for use in direct current dynamo electric machines composed of two sets of stampings with projections which screen certain portions of the armature coils to convey the magnetic flux from the poles to the housing and thence to the other pole so arranged that the length of the magnetic circuit and hence its resistance, is constant for any position of the inductor field. Air resistances are arranged for decreasing the resistance of the armatures. The armature inductors may be joined in different combinations to give a wide speed range.

Electrical Transmission of Power and Speed Regulation for Vehicles, etc.

6758.—1909. W. D. DURTNALL, Herne Bay. This is a system of propelling a vehicle or driving other machinery by means of polyphase alternating current generator and motor, in which the primary or secondary member of the motor is mechanically driven by the prime mover, and regulation of the speed is obtained by causing the magnetic field of the motor to rotate relatively to the field magnet structure.

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Starting Electric Motors.

10680.—1909. W. D. KILROY, Chiswick. The invention consists in starting electric motors by utilising a series of resistances which are cut out or varied by means dependent on the change and fall of current or voltage produced as the motor speeds up after contact has been made with any particular resistance.

Electric Switches.

10757.—1909. E. P. ELIESON, London, E.C. The object is to enable the local switches in public buildings, etc., to be automatically opened from a distant position by the operation of a main switch. The arrangement is such that when the main switch is opened all the local switches are opened, and if the main switch is again instantly closed all the local switches remain open, but where the lights are required the switches can be closed again by hand and will remain closed until opened automatically or by hand.

Electric Heating Devices.

11172.—1909.—BRITISH THOMSON-HOUSTON CO., London. The heater comprises concentric rings of insulating material and a number of independent resistance conductors wound on the rings from a common terminal. One of the conductors is wound first on the inner ring and then on the outer, while the other conductor is wound first on the outer and then on the inner ring.

Apparatus for Use in Distributing Electricity.

11201.—1909. E. W. LUCAS & W. WALMSLEY, Higher Broughton. The object is to economise current. The lamps are fed with a current of higher potential than they are adapted to take under normal conditions, by passing the current through the lamp in spurts instead of constantly. The interruptions are so rapid that thei ncandescence of the filament is not visibly affected. When 25 or 30 lamps are in use the current passes through each in rotation so that it is only for one twenty-fifth or one thirtieth time that euch lamp receives current instead of all the time.

Electrical Transmission of Signals.

11295.—1909. H. C. LEAKE, Altrincham. This improved apparatus for transmitting signals electrically comprises a multiphase generator, a receiver having a stator and rotor connected by wires to the transmitting station, and a transmitter switch adapted to connect desired phases of the generator to the receiver wires.

Electric Controllers for Railway Service.

11302.—1909. T. V. ZWIEGBERGK, Southport. This invention provided means for moving the reversing barrel longitudinally to cut out different motors. In combination with collars on the barrel is a rotary spindle which projects through the controller casing and carries a crank pin which engages between the collars so that the longitudinal movement of the barrel may be effected from outside the casing.

11303.—1909. T. VON ZWIEGBERGK, Southport. The regulator of the electric controller comprises the combination with a bracket on the controller shaft a frame pivoted thereon operatively connected to the regulating handle. The frame carries a movable pawl which engages a ratchet member to limit the movement of the handle. A bell crank lever and spring control the pawl to release and advance it at the end of the movement, and upon release of the handle allows a further limited movement.

Prepayment Electricity Meters.

11402.—1909. W. N. GODDARD, Windsor. In this electrolytic prepayment electricity meter the desired quantity of liquid is introduced into the electrolytic cell from time to time, by variations of the relative levels between one end of a liquid delivery tube and the liquid in an adjacent reservoir to which the other end of the tube is connected.

Electric Arc Lamps.

11482.—1909. W. J. DAVY, East Croydon. This is an improvement in flame arc lamps, and the object is to prevent the deposit of ash on the inside of the globe. For this purpose a shield is arranged with its lower edge in close proximity to the intensifier so as to leave a perfectly unobstructed space below the arc which allows direct access of air. An annular outlet surrounds the free space near the arc level. The hot gases pass through the annular space and a direct current is given across the arc.

Rectifying Apparatus for Electric Current.

11539.—1909. BRITISH THOMSON-HOUSTON CO., London, E.C. This vapour electric rectifying device has an exhausted metal envelope provided with a lining so disposed as to provide an annular condensing chamber between it and the fall of the envelope. A current supplying conductor passes through the envelope from which it is separated by an insulating tube. A cap provided with passages for the circulation of a cooling fluid is secured to the supply conductor. Insulating rings are placed above and below the cap, and, with the cap, are held in position by a spring.

Electric Meters.

12689.—1909. BRITISH THOMSON-HOUSTON CO., London. This is an improvement in the class of meter in which the movable element is a mass in liquid, such as mercury. The object is to provide an effective device for sealing the mercury chamber during transport of the meter. A number of segmental spring jaws surround the spindle of the meter and are adapted to be moved longitudinally to cause their segments to engage with a co-operating seat which forces the jaws into contact with the spindle and with each other, and thus prevents the escape of mercury from the meter.

Electric Controller and Switches.

15151—1909. R. C. LYNESS, Sunderland. A contact finger is provided which can be easily attached to the contact base of the controller. The tip of the finger has wings which can be fitted when the tip requires replacing or reversing.

Electric Arc Lamps.

16904.—1909. SIEMENS SCHUCKERTWERKE, G.M.B.H., Berlin. This is a fume intercepting arc lamp, the fume chamber and partition of which are of conical shape instead of cylindrical. The gases flow from the centre of the chamber to the circumference and back again. Lips may be arranged in the path of the fumes to serve to promote the settlement of solid matters in the fumes.

Electric Arc Lamps.

22926.—1909. S. SZUBERT, Pankow. The electrodes are suspended from the lower ends of crossed pivoted levers, and slope towards one another. The cross levers are guided on the one hand at the pivot by the electro-magnetically operated member which drives the electrode up and down, and on the other hand only at one pair of ends.

Transmitting Apparatus for Electric Signalling.

25190.—1909. P. D. PEDERSEN, Copenhagen. The apparatus has two contact devices arranged in series. The controlling contacts control the emission of the signals, while the other contacts effect the transmission proper. The controlling contacts are closed immediately before the closing of the signalling contacts, and opened immediately after the opening of the latter so as to avoid sparking when large currents are flowing.

Electrodes for Arc Lamps.

29239.—1909. A. GRAVIUS, Nurnberg. The electrodes are impregnated with lime or metal oxides and are provided with a central perforation lined with the same substance through which oxygen can be supplied.

Apparatus for Automatically Recording Intervals of Time Between the Passing of Trains on a Track and Their Speed.

376.—1910. SIEMENS & HALSKE, A.G., Berlin. This is a device of the kind in which there is a rail contact at each end of the section of the track. By the combined action of a uniformly driven recording drum and a style moved at right angles to the direction of the drum and operated by a device actuated so long as the train is in the section of the track between the two contacts, a series of approximately straight lines are traced which show by their position on the recording strip the time of day and intervals of time between the trains and, by their length, the time occupied by the train passing over the section.

Telephone Receiver.

466—1910. SIEMENS BROS. & CO., Westminster. The receiver is mounted on a small box, the cover of which is the diaphragm of the receiver. Contacts are on the base of the box in the form of a ring and stud. These receivers can be attached and removed by unskilled persons should occasion arise.

Frequency Meters.

2726.—1910. SIEMENS & HALSKE, A.G., Berlin. In this frequency meter, for measuring the speed of vehicles simultaneous use is made of two electro-magnets traversed by alternating currents, of which one is polarised and serves at the main exciter of the field, while the other acts as an auxiliary.

Switches.

3926.—1910. A. P., G. C., AND P. A. LUNDBERG, Islington. The switch is mounted on an adjustable carrier which in turn is mounted on brackets disposed in the box for the switch in such manner that the carrier and switch can be adjusted thereon relatively to the bottom of the box.

Distribution of Electric Energy.

7019.—1910. A. E. TANNER AND E. A. CLAREMONT, Old Trafford. The invention consists in connecting induction coils between the main conductors and the pressure distributing conductors so proportioned that when under the prescribed alternating pressure distributing conductors, they provide the capacity current required to be fed on to the pressure distributing conductors and thus minimise the demand for such current on the device supplying pressure to such conductors and the necessity of transmitting such current over the whole length of line as the case may be.

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TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns per week. Ending	1909-10.	1908-9.	Increase or decrease. Week.	Current year.	Miles of track open. 1909.	1908.	Accounts for past year. Ending	Total receipts.	Passengers carried.	Car miles run.	Receipts per Passenger.	Receipts per Car mile.	Receipts per Mile of track
		£	£	£	£				£					
Aberdeen Corporation	June 8	1,890	1,769	+ 30	—	27½	27½	May 31	71,930	17,517,304	1,556,119	·98	11·02	4,1
Ayr Corporation	Sept. 18	671	562	+ 108	—	8	8	—	—	—	—	—	—	—
Baker Street and Waterloo Ry.	Nov.	8,141	6,070	+2,071	—	4·25	—	—	—	—	—	—	—	—
Birkenhead Corporation	June 5	1,204	1,235	— 31	— 105	24·003	13·52	—	—	—	—	—	—	—
Birmingham Corporation	June 4	6,532	7,435	— 903	—	56·792	58·52	—	—	—	—	—	—	—
Blackburn Corporation	Oct. 6	1,100	1,293	— 173	— 1,036	24·53	28·3	—	—	—	—	—	—	—
Blackpool Corporation	Aug. 26	2,152	2,050	+ 102	+ 732	—	—	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams	,, 8	2,304	2,309	— 24	—	—	—	—	—	—	—	—	—	—
Bolton Corporation	Oct 10	2,416	2,337	+ 79	— 259	42	42	Mar. 31	117,799	25,492,902	2,492,147	1·1	11·34	2,8
Bournemouth Corporation	July 21	1,681	1,723	— 42	— 23	29½	29½	,, 31	86,225	13,991,328	1,766,068	1·47	11·71	2,9
Bradford Corporation	June 4	4,992	5,977	— 985	— 263	98	54·81	,, 31	235,258	47,839,569	5,331,007	1·17	10·59	2,3
Brighton Corporation	June 12	969	892	+ 77	— 607	9·5	—	—	—	—	—	—	—	—
Bristol Tramway Company	June 10	5,964	5,236	— 728	—	57	51½	Dec. 31	265,362	46,652,389	5,756,842	—	—	—
Burnley Corporation	June 11	1,275	1,227	+ 48	—	19½	19½	Mar. 31	64,261	12,355,958	1,202,330	1·23	12·83	4,9
Burton Corporation	June 12	271	244	+ 27	— 33	6½	6½	,, 31	14,918	3,221,595	430,913	1·04	8·30	1,4
Cardiff Corporation	April 3	2,000	1,957	+ 43	—	—	—	,, 31	109,979	25,058,146	2,497,169	—	10·57	—
Carlisle Tramways Company	June 19	170	175	— 5	— 89	—	—	—	—	—	—	—	—	—
Central London Railway	June 11	5,940	5,861	+ 79	+ 2,394	6·32	6·32	Dec. 31	350,150	41,898,373	1,456,781	2·01	9·769	55,4
Charing X, Euston, & Hamp. Ry.	Nov.	6 822	6,092	+ 730	—	7·75	—	—	—	—	—	—	—	—
City and South London Railway	June 12	3,101	3,202	— 101	— 294	7·26	7·26	—	—	—	—	—	—	—
Colchester Corporation	July 14	200	219	— 39	—	8	—	Mar. 31	10,983	2,308,721	349,539	1·09	7·74	1,4
Cork E. T. and L. Company	June 9	566	496	+ 70	+ 1,687	9·89	9·89	Dec. 31	24,044	5,737,478	896,945	—	6·43	—
Croydon Corporation	May 20	2,506	1,416	+ 1,090	+ 1,230	11½	—	Mar. 31	74,132	16,277,418	1,884,137	1·06	9·56	3,7
Darwen Corporation	Oct. 1	239	256	— 17	— 201	7·23	7·23	,, 31	13,899	2,557,654	245,584	1·30	13·68	1,9
Dover Corporation	Sept. 18	230	252	— 22	— 395	7	—	,, 31	11,593	2,697,672	316,754	·98	8·78	—
Dublin and Lucan Electric Ry.	June 10	146	158	— 12	+ 17	7	7	—	—	—	—	—	—	—
Dublin U.T.	June 10	5,490	5,408	+ 82	+ 3,613	54½	54½	—	—	—	—	—	—	—
Dundee City Tramways	Oct. 6	1,332	1,305	— 27	— 569	—	26½	May 15	60,573	16,367,911	1,281,552	·875	1·9	2,3
East Ham Corporation	June 11	1,068	926	+ 142	+ 70	15	15	Mar. 31	47,430	15,355,703	1,091,586	·73	10·26	—
Glasgow Corporation	June 4	18,423	18,126	+ 297	+ 1,936	194½	189	May 31	907,494	226,948,290	20,766,722	·96	10·49	4,6
Gloucester Corporation	Oct. 6	395	425	— 30	+ 535	15	—	—	—	—	—	—	—	—
G.N., Piccadilly and Brompton	Nov.	13,429	9,354	+ 4,075	—	9·25	—	—	—	—	—	—	—	—
Halifax Corporation	—	—	—	—	—	52·574	37	Mar. 31	81,872	20,378,672	1,786,390	11·40	11·13	1,5
Huddersfield Corporation	Dec. 4	1,613	1,357	+ 256	+ 2,663	28	28½	,, 31	84,704	16,200,020	1,960,329	1·29	10·37	2,4
Hull Corporation	June 11	2,678	2,322	+ 355	+ 1,373	29	26	,, 31	128,722	30,964,254	3,022,844	1·	10·22	—
Ilford Corporation	Feb. 12	451	391	+ 60	+ 1,969	10	10½	,, 31	25,328	6,385,466	634,446	·87	9·58	2,0
Ilkeston Corporation	June 8	122	114	+ 8	— 85	4	4	,, 31	7,214	1,968,850	198,415	9·1	7·9	1,8
Kirkcaldy Corporation	Sept. 8	259	266	— 7	—	7½	7½	May 15	14,993	4,874,199	459,066	·711	7·838	1,5
Lancashire United Tramways	June 8	1,284	1,453	— 169	+ 72	39	39	Dec. 31	68,904	12,554,593	2,244,344	—	—	—
Leeds Corporation	Sept. 18	6,896	6,624	+ 272	+ 3,662	108·	96½	Mar. 31	340,368	75,734,083	7,694,989	1·06	10·62	3,1
Leicester Corporation	Sept. 11	2,162	2,130	+ 32	—	—	—	—	—	—	—	—	—	—
Liverpool Corporation	Nov. 19	10,803	10,687	+ 116	— 1 977	109	104	Dec. 31	572,822	124,043,239	12,231,799	1·108	11·24	5,5
Liverpool Overhead Railway	June 5	1,343	1,537	— 194	+ 595	6·65	2·40	June 30	79,004	11,171,515	1,106,386	—	—	—
London County Council	May 28	42,070	36,603	+ 5,467	+ 49,835	132½	123½	Mar. 31	1,274,660	279 166,461	25,591,028	1·08	11·74	—
Lowestoft Corporation	Dec. 11	155	150	+ 5	+ 30	3½	—	Sept. 30	11,399	2,645,206	370,320	1·03	7·36	2,2
Maidstone Corporation	Mar. 6	157	100	+ 57	—	7·4	—	—	—	—	—	—	—	—
Manchester Corporation	Sept. 11	15,631	15,297	+ 334	— 2,871	183	181	—	—	—	—	—	—	—
Metropolitan District Railway	June 4	10,778	10,331	+ 447	+ 23,424	24	24	—	—	—	—	—	—	—
Metropolitan Railway	June 12	17,935	17,622	+ 313	+ 12,957	24½	24½	June 30	680,357	99,846,735	—	1·46	—	—
Nelson Corporation	Oct. 16	151	131	+ 20	+ 7	2½	2½	Mar. 31	7,362	2,060,712	204,740	·85	8·63	1,9
Newcastle-on-Tyne Corporation	June 4	3,824	4,170	— 346	— 1,973	60½	59½	,, 31	211,085	46,208,164	4,411,745	1·10	11·48	3,5
Newport (Mon.) Corporation	Oct. 9	663	638	+ 25	— 311	14½	14½	,, 31	35,531	8,174,003	798,029	1·04	9·89	2,4
Oldham Corporation	Jan. 24	1,778	1,516	+ 262	— 386	—	—	—	—	—	—	—	—	—
Portsmouth Corporation	Oct. 10	2,046	1,809	+ 237	—	28½	28½	Mar. 31	97,741	21,247,048	2,309,439	1·10	10·15	—
Reading Corporation	May 19	764	558	+ 206	— 5	13½	13½	,, 31	32,769	7,933,572	915,481	—	8·93	—
Rochdale Corporation	Dec. 26	1,240	1,126	+ 114	+ 746	20·9	20·93	,, 31	56,558	10,196,148	1,252,925	1·32	10·83	2,6
Rotherham Corporation	Feb. 4	555	587	— 32	—	—	—	—	—	—	—	—	—	—
Salford Corporation	Sept. 27	4,096	4,662	— 66	— 3,326	78	74½	Mar. 31	244,065	45,771,611	5,486,150	1·25	10·67	3,1
Scarborough Tramways Co.	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Sheffield Corporation	June 5	5,763	6,324	+ 561	+ 2,899	39½	39	Mar. 25	289,745	17,568,686	7,065,380	·896	9·842	4,2
Southampton Corporation	June 1	1,083	1,336	— 253	+ 200	18	18	,, 25	52,647	10,121,887	1,157,451	1·25	11·33	—
Southend-on-Sea Corporation	Aug 21	995	557	+ 438	+ 1,483	—	—	—	—	—	—	—	—	—
Stockport Corporation	—	—	—	—	—	25	25	Mar. 31	52,004	9,155,172	1,335,911	1·34	9·342	1,9
Sunderland Corporation	Jan. 27	1,310	1,336	— 26	— 7,984	—	—	—	—	—	—	—	—	—
Swindon Corporation	June 1	126	158	— 32	—	—	—	—	—	—	—	—	—	—
Torquay Tramways	Aug. 26	630	647	— 30	—	8·41	—	Dec. 31	15,065	2,880,420	353,297	1·40	1·023	—
Wallasey U.D.C.	June 11	978	900	+ 78	— 481	12·68	12·45	Mar. 31	43,823	8,331,038	891,540	1·2	11·79	3,4
Warrington Corporation	—	—	—	—	—	—	—	—	—	—	—	—	—	—
West Ham Corporation	June 2	2,415	2,983	— 567	— 49	27	14·7	Mar. 31	122,881	35,502,836	2,556,854	·789	10·96	4,4
Wolverhampton Corporation	Nov. 3	841	823	+ 18	— 206	21½	—	,, 31	44,432	9,440,369	975,714	—	10·929	2,1

a Train Miles. h Half-year's figures.

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THE
Electrical Engineer.
An Illustrated Record and Review of Electrical Progress.
WITH WHICH IS INCORPORATED "ELECTRIC LIGHT."

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LONDON, JUNE 24, 1910.

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NOTES.

Electricity in the Summer.

While we are publishing a series of articles of the uses of electricity in summer-time as an aid to making life more bearable—by means of breeze compelling fans and heat conserving cooking appliances—the same brilliant idea has occurred to others. The Electric Supply Publicity Committee of London and District have issued a little four-page folder on "Electricity and Pure Air," describing and illustrating the merits of electrically driven fans, while the Borough of St. Marylebone is following suit by issuing a pamphlet on the merits of the fans in domestic and business arrangements.

Electricity and the Medical Man.

In this week's German Notes it will be seen that our Berlin correspondent refers to an interesting electrical combination for therapeutical purposes advocated by a local doctor. On our side Dr. Goodall and Mr. Mackenzie Wallis, lecturer on "Chemical Physiology" in University College, Cardiff, have been experimenting with the electric bath in the treatment of the insane, with markedly encouraging results. Of 108 cases treated, 62, or 57·4%, either recovered or showed signs of great mental improvement. On the other hand, 16 control cases, practically the same as regards mental state, treated exactly alike in the matter of diet and so on, but only given warm water baths, gave only two improvements, or 12·5%. The sinusoidal current was used in the electric treatment, and apparently brought about a healthier condition of life functions. Dr. Goodall says that is far more used in therapeutics on the Continent than it is with us, and attributes this mainly to a lack of convenient methods of application available here. What our manufacturers have to say to this would be interesting to hear.

Electric Lamps for Mines.

Mr. William Brace, M.P., after a careful inspection of miners' electric lamps in London, has come to the conclusion that they are a vast improvement on oil lamps. As he points out to miners, these lamps can be turned about in any direction without fear, so that it is easy to examine roofs. But with an oil lamp, unless it is held straight, the flame is liable either to break the glass or to go out. With an electric lamp this cannot be done, and if the glass is, by any accident, broken, the light goes out automatically, and cannot be rekindled except after a visit to the stores. The great drawback to the electric lamp, according to Mr. Brace, is that it is not a detector of gas. This is true enough, and in this lies its safety. But as we explained in these columns some time ago, a simple electrical gas detector has been invented. At the time we referred to an Italian device, but we have reason to know that an English appliance even more simple in construction is available for use with the miners' lamps. So that Mr. Brace's one drawback has really been overcome.

Illuminating Engineering.

A remarkable series of thirty-six lectures on the science and art of the illuminating engineer are to be delivered in the John Hopkins University, Baltimore, during the coming October and November. Of late we have been paying some attention to this subject, but certainly not one of our educational establishments have ventured on anything so elaborate as this. It is, however, typical of the trend of American thought to-day, for in the States a great deal of attention is being given to illumination, from the art, economical and hygienic points of view. It is an extremely complex study, for very different rules apply to the science when used for street or indoor lighting and again for domestic or industrial purposes. Hitherto it has been largely a matter of æsthetics first and economy in the second place, comfort and efficiency coming in bad thirds and fourths. This is not as it should be. Study of the subject should be encouraged and certainly electricity has nothing to fear from such study. Rather the contrary. Indeed, the high brilliancy of the metallic filament lamp makes the study of application and distribution all the more necessary.

The Lectures.

The titles of the lectures are a most useful guide as to the wide scope of the subject and the relative importance attached to various phases in America. The physicists have a prominent say in the matter. There will be three lectures on the physical basis of the production of light; two on the physical characteristics of luminous sources; one on the chemistry of luminous sources. Then the chief sources are to be considered; two lectures by Dr. C. P. Steinmetz, will be devoted to electricity as an illuminant, and two by Professor J. B. Whitehead on the generation and distribution of electricity; while there will be one lecture each on gas and oil illuminants and two on the manufacture of gas. Then we come to application. One lecture will be devoted to photometric units and standards, and two to the measurement of light. The architectural aspects of illuminating engineering will be considered in two lectures, while the decorative aspects are to be dismissed in one. Next come the doctors, three lectures being given on the physiological aspects by two leading medical men. Practical questions in relation to application naturally figure very largely. There will be six lectures on the principles and design of interior illumination, three on the principles and design of exterior illumination. Shades, reflectors and diffusing media will be considered in one lecture, and lighting fixtures in another. Finally, the commercial aspects of electric lighting, dealt with in one lecture, will be in the competent hands of Mr. J. W. Lieb, a vice-president of the New York Edison Co., and a past president of the American Institution of Electrical Engineers, while the commercial aspects of gas lighting will be treated by Mr. Walton Clark. It is altogether a remarkable syllabus, giving an epitome of the science.

ELECTRICAL STEEL IN THE STATES.

H.M. Consul-General at Chicago says in a report on the trade of that district in 1909, which will shortly be issued: During 1909 the Illinois Steel Co., at South Chicago, Illinois, installed the first Heroult electric furnace of large capacity that has been built in the United States. This furnace has been producing electrically refined steel at the rate of about 3,000 tons per month. The hot metal is taken from the Bessemer converter, and refined in the furnace to reduce the percentage of phosphorus, sulphur, and other impurities. Experimental lots of rails made under this process have been supplied to some of the Western railways, and, so far as can be seen at present, they are likely to prove a success, as they show remarkable ability to resist hard usage.

The cost of this electrically refined steel is stated to be higher than that of steel made by the ordinary process, and this will probably prevent for some time its general adoption for rail-making purposes; in other products which have a higher cost apart from that of the steel used in them its more general use may be expected.

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Electricity in the Summer Time.

Some Special Points for Householders with Regard to Electric Cooking Appliances.

Second Article.

If electrical manufacturers have not yet reached the highest point of development in respect of electrically operated appliances for purely domestic purposes, they have at any rate travelled a very great distance along the evolutionary highway. The laboratory work which has been accomplished in regard to heating elements during the last year or so constitutes so marked an advance that it is a little difficult, speaking broadly, to forecast in what direction further improvements may be made. Efficiency is already at almost its highest pitch; economy of manufacture has gone nearly as far as it can reasonably be expected to go; and permanency of material has been carried to a point where the cost of renewals has become practically insignificant. Doubtless further economies may be effected in the matter of outer construction, and there may be some slight additional simplification in the respect of various accessories, but on the whole it may fairly be assumed that the latest specifications of leading manufacturers represent a standard of economical production beyond which (pending some epoch-making discovery of which there is as yet no foreshadowing) it would not be safe to go.

Old Misconceptions.

But with all this it may reasonably be questioned whether the consumer, in the shape of the average householder, has been kept as fully posted as he might have been with regard to these developments. There is still an idea abroad that the electric cooking stove is the luxury of the rich rather than the necessity of every class of the community. Until quite recent years practically the same impression prevailed with regard to electric lighting. The feeling of the average householder was that he would be only too glad to adopt electric lighting "if it were not so expensive." He was keen to realise (and the housewife was still keener) the advantage of a system of lighting which caused no blackening of ceilings, no damage to pictures, curtains, hangings, books, furniture, flowers, involved no risk of fire or explosion, and needed neither matches nor tapers, nor that recklessly expensive luxury, the by-pass. But he was still obsessed with the idea of the costliness of electricity. It took a long period of missionary effort to eliminate that misconception, but in spite of the efforts of the gas companies to foster it, the error, in the end, went the way of all fundamental fallacies, and electric lighting began to come into its own. The householder realises now that in the majority of districts, light for light, electricity is a good deal cheaper than gas, and that even where the bare cost of the two systems is equal, the balance of advantage, when cleanliness and handiness and the absence of deadly fumes and still deadlier risks of danger are taken into consideration, is transcendently in favour of electricity.

Economy and Efficiency.

What has already happened with regard to electric lighting is now in process of growth with regard to electric cooking. In a constantly increasing degree it is being realised that in point of economy and efficiency the application of electricity to culinary matters offers advantages which it is no longer possible to ignore. Take, for instance, the small matter of boiling a pint of water (*a*) by coal fire, (*b*) by gas, and (*c*) by electricity. Actual tests give the following figures:—

	Heat utilised.	Heat wasted.
Coal	2%	98%
Gas	25%	75%
Electricity	90%	10%

In certain makes of electric cookers an even greater efficiency than 90% is claimed; and, in fact, the waste is practically an altogether negligable quantity. When concrete facts of this kind are placed before the housewife she should find it very difficult to resist them, no matter how specious and plausible may be the arguments accumulated against them by the gas companies or range-makers.

But there are other points which also have their special appeal. In the case of a coal fire some hours of stoking have necessarily to elapse before the oven is sufficiently hot to do its work effectively, and after the cooking is done, the fire has to be allowed to burn out to waste. In the hot summer months the kitchen is not only like a Turkish bath, but, roughly speaking, tenpennyworth out of every shillingsworth of coal consumed is consumed to no purpose, and there are all the attendant nuisances of dirt, smoke and dust, involving various processes of sweeping, cleaning and dusting, apart from the "getting in" of the coals, and wood, and laying the fire, and the subsequent raking out of ashes and repolishing of the stove.

With the electric cooker there is no nuisance of any kind and no waste. There is no need to wait for the fire to burn up or any uncertainty as to whether or not the required amount of heat has been generated in the oven. The electric heat is at full strength in a few moments and can be regulated to a nicety. Unlike that of the coal oven, the electric heat can be increased or reduced at will, and when the cooking is finished it can be immediately turned off. The housewife will also appreciate the matter of portability. The electric cooking apparatus can be moved about at will, or can be placed on a table at a convenient height so that there is none of that "stooping and stewing over a big fire" which is found so trying in the case of the coal range. No soot or dirt accumulates on cooking utensils, and deterioration is reduced to a minimum.

The Claims of the Gas Stove.

With regard to the gas stove it would appear, at first sight, that the bulk of the more aggressively objectionable features of the coal fire had been eliminated. A little reflection, however, makes it clear that if gas is more economical than a coal fire for cooking, the gas-stove has many highly unpleasant features which are peculiarly its own, and two, at any rate, that are worse than any of those of the coal fire. The most apparent of these is the danger of explosion, but as that is a risk attendant upon the use of gas for any purpose it may be passed over with nothing more than a glancing reference to that section of the recent report of the Metropolitan Fire Brigade which details the great loss of life and damage to property which had their origin in this form of disaster. More insidious, if less conspicuously deadly, is the generation of those odours which are the necessary accompaniment of the combustion of coal gas. Moreover, even in the best of gas stoves there is, as has been shown, a great waste of heat and there is also, as an examination of the flue will reveal, a large deposition of refuse matter. These products of the combustion of coal gas permeate the whole of the heated air by means of which the cooking of a joint is effected, and they must of necessity permeate to some degree the joint itself.

Every housewife knows that a joint cooked in a gas oven has none of the delicacy of flavour of one cooked in a coal oven; and she is learning, too, that the only method by which that delicacy of flavour can be retained and the waste of heat be avoided, is by the use of the electric oven, the heat in which is pure hot air and hot air only, with no admixture of fumes of any kind whatever. What housewife does not know and recoil from that fierce gust of suffocating and scorching odour which bursts from the gas oven when the door is opened? What housewife does not know and dread that inequality of gas heat which sometimes burns up the outside of a joint and leaves the inside almost raw, which sometimes cooks a pie in 10 minutes and sometimes takes half an hour? Then, again, the quality of the gas supplied varies in an extraordinary degree, not only district by district, but even in the same district, hour by hour, both quality and pressure often showing so much variation that all the canons of the culinary art are upset.

Pure Heat.

In the electric oven the heat is always of the same perfectly pure quality, varying only in degree according to the

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manipulation of the switches which give maximum heat, three quarter-heat, half-heat, or quarter-heat at will. There is no pulling out of one damper or shutting another and half shutting a third, or opening or closing a ventilator—all equally uncertain and incalculable in their operation. The change is effected with no more trouble than is involved in the pressing of a key.

To sum up in a sentence or two, there is no variation in pressure as in the case of gas, or of potentiality as in the case of coal. There is no waste, no smoke, no smell, no dirt, no dust, no delay, no danger, no flame to be blown out by a casual gust of wind, no "back-fire" as in a gas ring, and no uncertainty of operation. The electric stove needs no watching and in cleanliness, efficiency and economy it stands supreme.

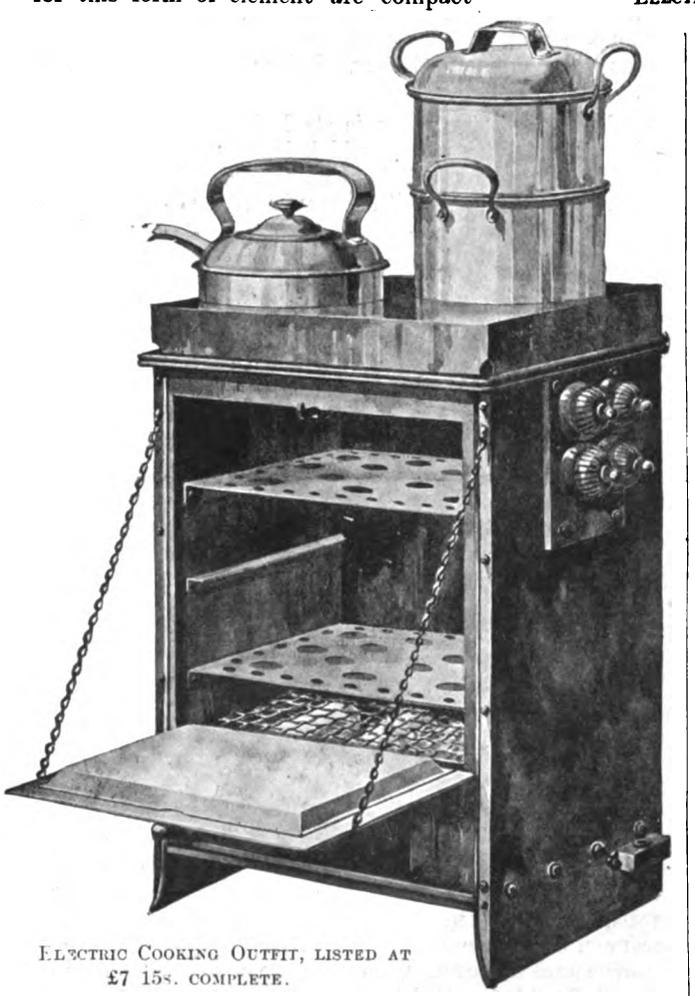
The Electric Cooker.

Practically all the great electrical manufacturing houses are now devoting expert attention to the design and equipment of electric cooking appliances, including ovens, hot-cupboards, hot-plates, kettles, saucepans, chafing dishes, frying-pans, toasters, grillers, egg-boilers, etc., both with self-contained heating elements or as ordinary utensils for utilisation in conjunction with separate electrical heating appliances. Herewith we illustrate or describe some of the latest specialities of leading manufacturers.

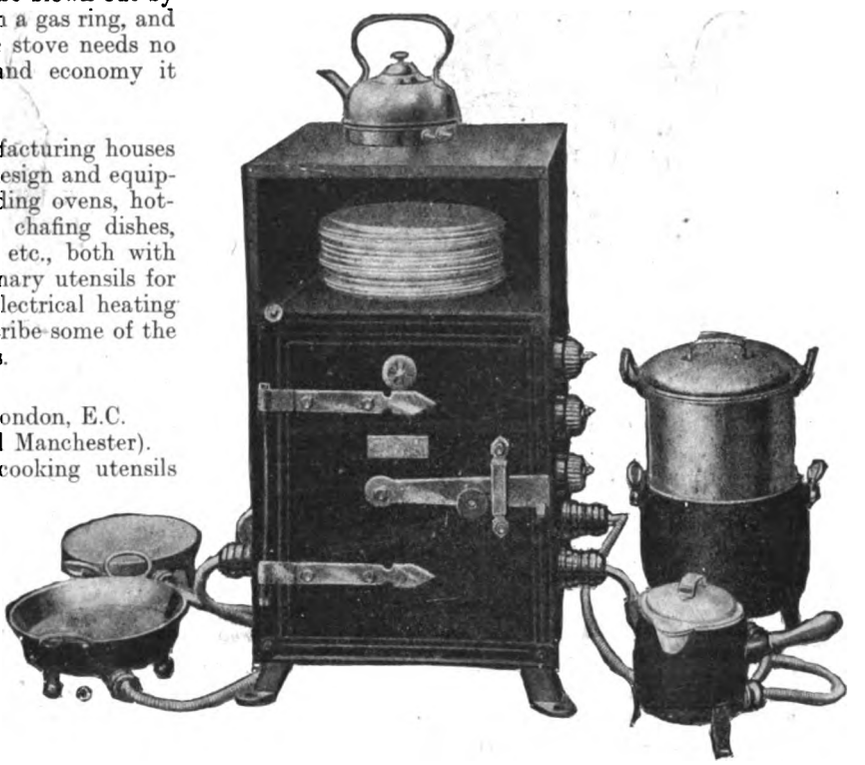
The General Electric Co., Ltd.,

71, Queen Victoria-street, London, E.C.
(and at Witton, Birmingham and Manchester).

Both for stability and efficiency the cooking utensils manufactured by the General Electric Co. enjoy a high and well-deserved reputation. The heating element in most of the General Electric Co. appliances is constructed on the well-known Archer system in which fine wires of high resistance and special composition are imposed on a layer of semi-refractory coating fused into an iron base and fused into a mass after three coatings of enamel. The special advantages claimed for this form of element are compactness, the most complete protection for the resistance wire, and the greatest possible concentration of heat. Oxidation, short-circuiting, and mechanical damage are risks that practically are altogether eliminated. The various appliances are supplied for any pressure from 50 to 250 volts, but apparatus for lower voltages is also manufactured to order. With nearly all these utensils a twelve months' guarantee is given, while in the case of apparatus for cooking or heating water a patent fusible cut-out is fitted which prevents damage in the event of the utensil being put on the circuit empty or being allowed to boil dry. Listed at £7 15s. complete with kettle, saucepan, steamer and fry-pan with two hot plates, the General Electric Co's.



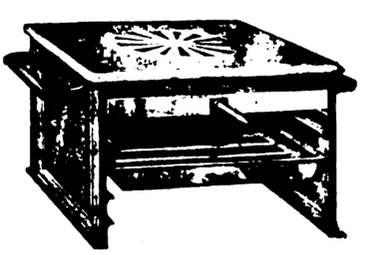
Electric Cooking Outfit, listed at £7 15s. complete.



Electric Cooking Outfit, listed at £18 10s. complete.

electric oven No. H. 3,709 affords a cooking space measuring 14 by 13 by 15 inches. It is constructed of rigid steel, double-cased and heavily lagged so that heat losses are reduced to a minimum. The oven is fitted with three open coil heaters in the base, each consuming 500 volts, and all heaters are controlled by separate switches.

A specially attractive line is No. H3,714 (illustrated herewith) which consists of an oven with plate-heating hot-chamber, and a complete set of electrically self-heated utensils by means of which a dinner for eight persons can be cooked. The oven, including the hot-chamber for plates is 31 in. high, 17 in. wide and 20 in. deep, and the utensils include a copper kettle, hot-plate, fry-pan, saucepan, six-quart stewpan, and six-quart steamer, all fitted with the necessary flexible connections, etc. The whole outfit is listed at £18 10s., or it can be supplied with such omissions or additions as may be desired. Frying and omelette pans, self-heated, are listed at 27s. and upwards according to size.

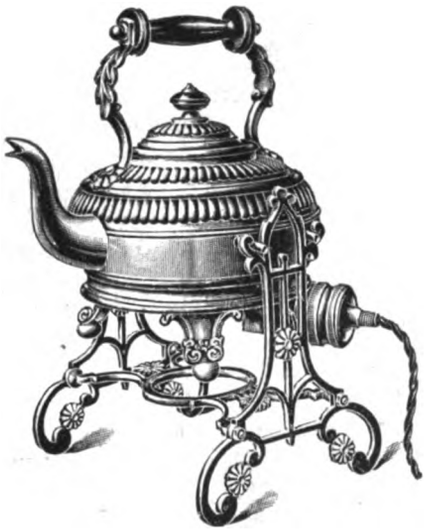


Combined Grill Toaster and Hot-plate, listed at 35s.

The General Electric Co. also supply several varieties of water heaters, constructed of rolled and polished copper, thickly tinned internally and of capacities varying from three to eight gallons. Of these two special types are connected up to the water supply.

Of electrically self-heated kettles the General Electric Co. stock a very large variety at prices ranging from 10s. to 70s. according to material, finish and capacity. These also can be had nickel-plated in varieties retailing at from

38s. to 65s., or silver-plated from 50s. to 87s. 6d. The capacities range from one pint to six pints, and current consumption varies between 500 and 1,400 watts. In all these articles the heating is effected on the Archer system. Of the higher-priced kettles the finish is of superb quality,



2-PINT KETTLE ON POLISHED ROCKER AND STAND.

and especial attention may be directed to one fitted with polished copper rocker and stand, listed at 67s. 6d., which is of exceptionally handsome design.

Copper saucepans of high finish and substantial construction are listed at from 30s. to 85s., and there is also a fine range of urns, coffee machines, *café au lait* outfits, and hot-water jugs, chafing dishes and toasters, at extremely moderate prices. Among these may be instanced a very neat water-boiler at 13s. 6d., and a combined griller and toaster, which can also be used as a hot plate, which is listed at the very low price of 35s.

THE BRITISH PROMETHEUS CO., LTD.,
Salop-street Works, Highgate, Birmingham, and
9, Newman-street, Oxford-street.

An admirably varied assortment of domestic electric utensils is manufactured by the British Prometheus Co., and can be inspected at their new London showrooms in Newman-street, Oxford-street, in the heart of the West End shopping centre. The Prometheus heating elements are made of gold and platinum and other costly metals, and a breakdown through oxidization is, therefore, practically impossible. The films or resistance strips are also constructed in such a manner that there is little or no risk of uneven heating, while self-induction is to all intents and purposes non-existent. The elements are kept in close contact with the surfaces which it is desired to heat by means of press-plates, and they do useful work immediately they are on circuit. Their durability has been proved by extended experience and many tests, and it is claimed that in many cases an over-all efficiency of approximately 97% can be obtained; but even with an efficiency of 92% the cost of operating is extremely small. With electricity at 1d. per unit, for instance, the cost of boiling a pint of water comes out at a fraction under one-tenth of a penny.

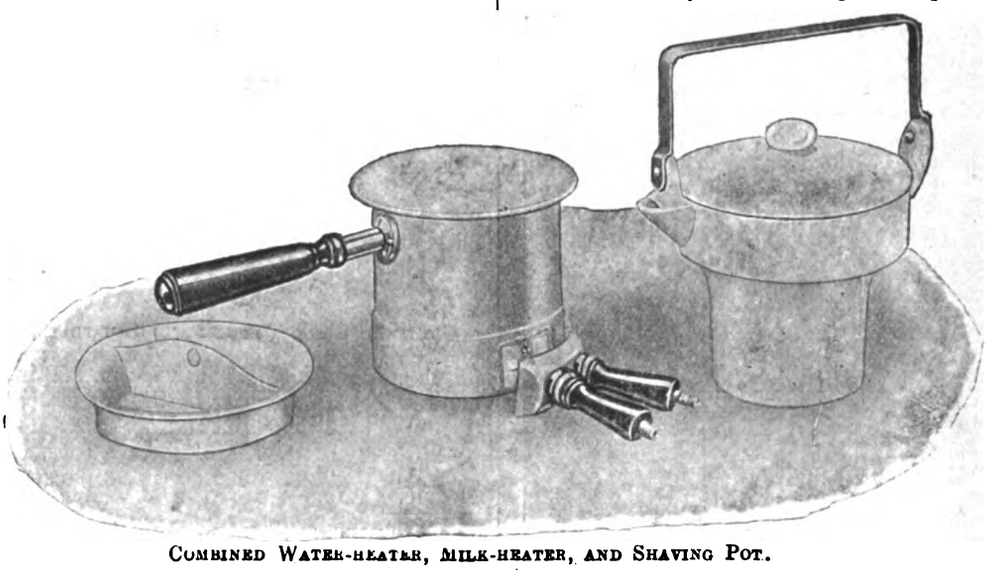
A special feature among the Prometheus manufactures is the hot-cupboard, which can be supplied in sizes varying from 16 in. by 12½ in. by 10½ in. at 47s. 6d. to one 5 ft. in height, 2½ ft. in breath and 17½ in. in depth, listed at

2-PINT TIN-PLATE KETTLE AT 10/6.

£33. One design made in various capacities is of wired steel with nickel facings, and others are externally cased in basswood and polished mahogany. These, it will be noted, are not adapted for cooking purposes, but only for maintaining food at a temperature suitable for the table, and the loadings of course are correspondingly low. The steel cupboards, however, can be effectively utilised for heating up cold dishes, and the heating of each shelf can be separately controlled. As a rule, it is only necessary to turn on the full heat for 10 or 15 min. after which the two-thirds or one-third switch can be utilised.

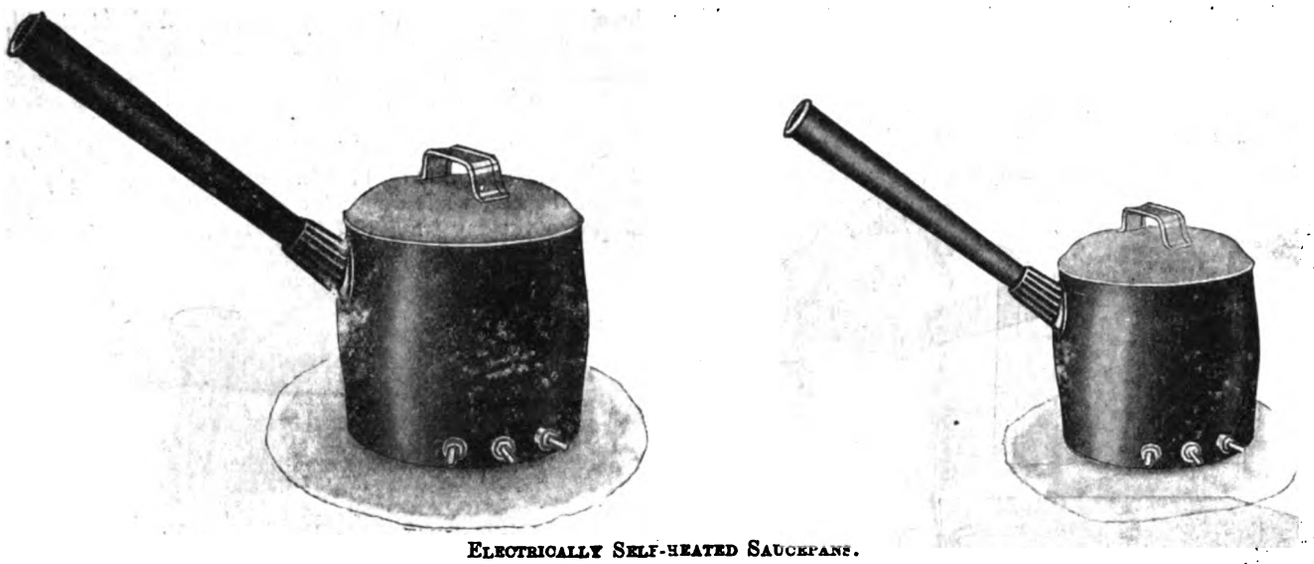
An extremely handy contrivance is that which is illustrated herewith, a liquid-heater, which can be used either for water or milk, or as a shaving-pot. In this apparatus (which is listed at 22s. 6d.) the heating element is fitted directly on the outside of the vessel and can be worked at a very low wattage per unit area. The illustration shows the milk-heater and the separate attachment for use as a shaving-pot. Other varieties run from 14s. 6d. to 50s.

Of kettles, a large range is stocked from the tin-plate 2-pint utensil (illustrated), which is listed at 10s. 6d. to a 4-pint silver-plated article at £8 17s. 6d., which is richly hand-chased and fitted with ebony handle. Other varieties are fitted with handsome brass, bronzed or oxidized silver stands of notably artistic design and splendid finish. Hot water jugs are stocked in similarly wide variety to suit every pocket. Special reference may be made to one of beaten copper, listed at 42s., which is a particularly fine specimen of the copper-workers' art.



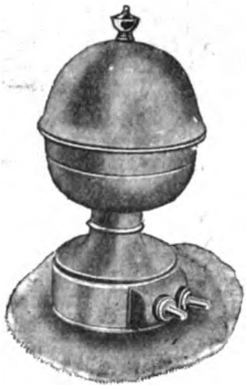
COMBINED WATER-HEATER, MILK-HEATER, AND SHAVING POT.

Coffee and tea-urns, both separate and combined, run from £3 7s. 6d. to £15 12s. 6d., according to capacity and material, and a very attractive utensil is a *café au lait*, set at £7 10s. A coffee-making machine, on the Russian



ELECTRICALLY SELF-HEATED SAUCEPANS.

principle, made in nickel, and listed at 37s. 6d., is a very popular utensil, well-finished and extremely useful. Our illustration shows a necessary adjunct to every breakfast table—an egg-boiler with a capacity for four eggs, which can be had in brass for 24s. 6d., or in nickel for 27s. 6d. Of saucepans, steamers, frying-pans and porringers, a

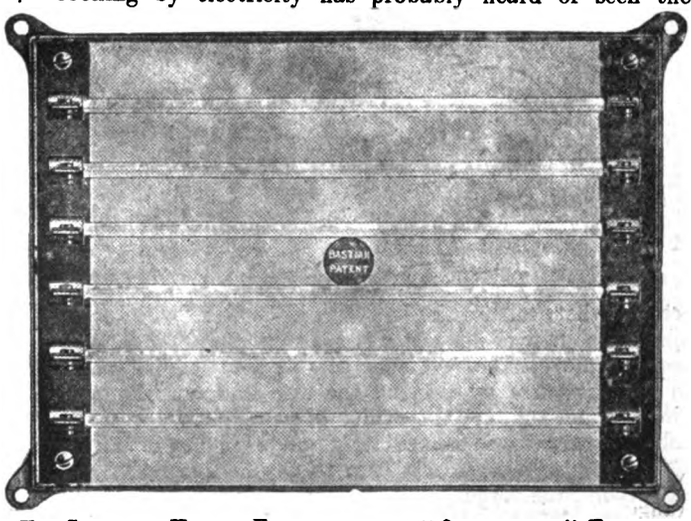


AN INDISPENSABLE ADJUNCT TO THE BREAKFAST TABLE.

large variety can be seen at Newman-street. The capacity of those illustrated ranges from 2 pints to 12 pints, the list prices running from 22s. 6d. to 40s. Most of the appliances mentioned are fitted with automatic cut-outs and with the Prometheus Co.'s new outer ring elements. The company also supplies an instantaneous water boiler or geyser, at prices ranging from £10 10s. to £37 10s., according to capacity, etc.

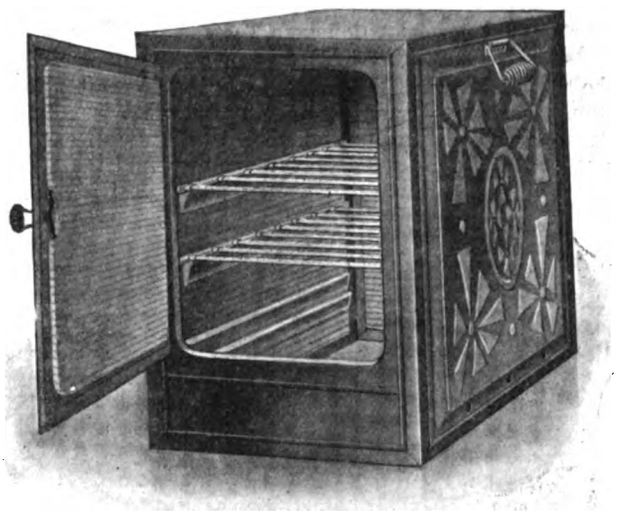
THE BASTIAN PATENTS,
The Bastian Electric Heating Syndicate, Ltd.,
Palmerston House, E.C.

Everybody interested in the question of heating and cooking by electricity has probably heard or seen the



THE STANDARD HEATER FRAME, SHOWING "QUARTZALITE" TUBES.

mystic word "Quartzalite." It represents the basic principle of the Bastian system of applying electrically generated heat to domestic purposes through the medium of quartz, one of the most stable substances known to chemists, and one which cannot be melted by any ordinary means and does not expand to any appreciable extent under the influence of heat. The heating elements, or glowers, of the Bastian system, are open-ended tubes of quartz with a metal terminal at each end and a spiral of nickel alloy or other suitable material running from one terminal to the other inside the quartz tube, which is raised



THE DETACHABLE OVEN.

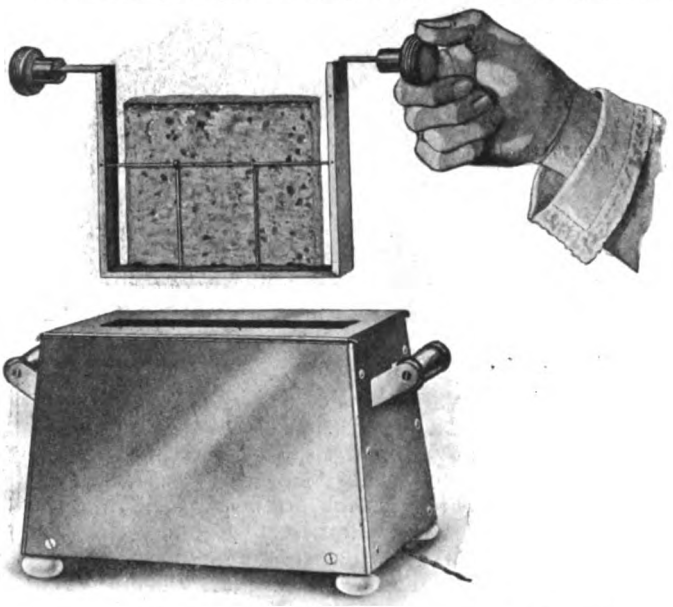
to a red-heat almost directly the current is switched on. The quartz tube is permanent, and wire spirals can be renewed at any time at a practically nominal cost. The Quartzalite principle can be applied to any form of electrical cooking or heating device, can be used on either alternating or direct current at all usual pressures between 100 and 250 volts, and is intended for application, not to special forms of apparatus, but to any variety of existing utensil. It is

THE ELECTRIC STOVE.

claimed that the principle is destined to effect the same revolution in the field of electric heating as the metal filament has achieved in the case of electric lighting.

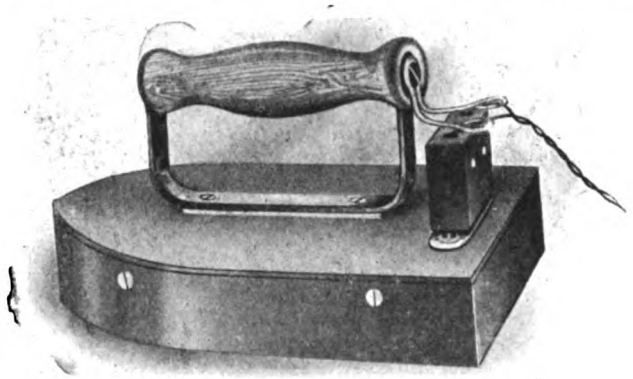
The accompanying illustration shows the Quartzalite No. 1 oven and No. 1 hot-plate, a combination which has proved extremely popular, and is sold at a very low price. The hot-plate is made in two forms, one consuming 400 to 750 watts, listed at £3, and the other 400 to 1,500 watts, listed at £3 10s. The oven is made of thin sheet metal and measures externally 18 by 12 by 13½ in., and when used with the 1,500-watt hot-plate is large enough to

cook a 6 lb. joint or negotiate any roasting or baking operation adapted to its size. The price of the oven is 15s. only. The hot-plate, which weighs about 10 lbs. is mounted on a strong cast-iron base, and when the oven is not in use it can be utilised for frying or stewpan, saucepan or kettles, or for grilling or toasting. It is fitted for three heats, the grid is easily renewable if necessary, and



THE TABLE HEATER. A COMBINED TOASTER, EGG BOILER, KETTLE BOILER AND FOOD HEATER.

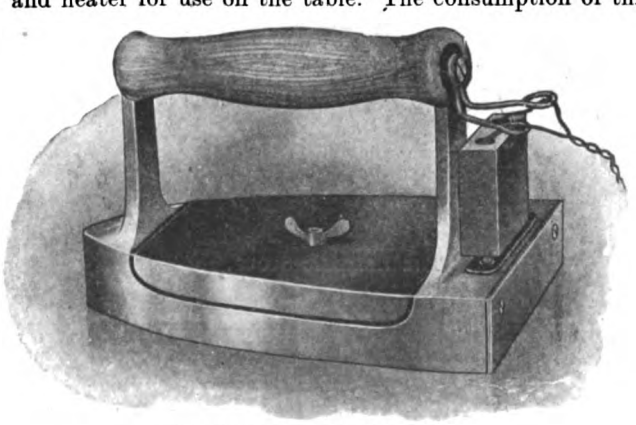
the apparatus can be cleaned with the greatest possible ease. The arrangement of the quartz tubes is indicated on the third illustration, which also affords an excellent idea of the simplicity of the arrangement and the accessibility of the working parts. No special skill is required



6-LB IRON.

in fixing a new spiral; and indeed the beauty of the whole system is its extreme simplicity.

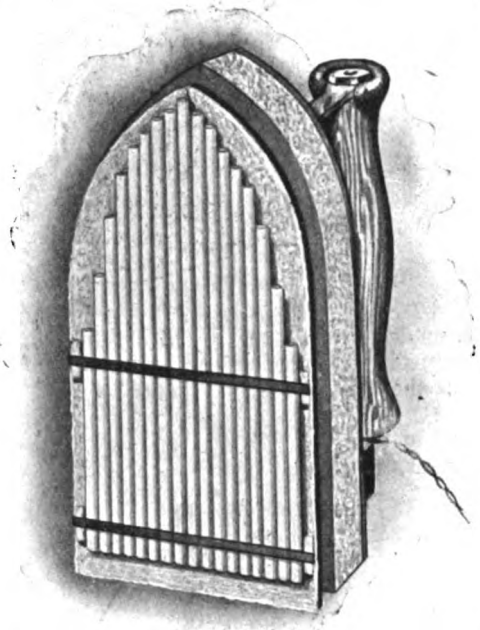
Our fourth illustration shows an ingenious application of the Bastian system in the form of a combined toaster and heater for use on the table. The consumption of this



THE "CONVERTIBLE" IRON.

form of apparatus is 450 watts per hour, and it will toast a slice of bread, keep a kettle boiling, keep bacon hot, or boil eggs at so small an outlay that it can be connected with the electric lighting wires in the dining room or breakfast room or drawing room and moved about at will, no special heating circuit being necessary. Made in polished aluminium, each heater is supplied with 9 ft. of flexible and a carrier for toasting, and is listed at the low price of 35s.

A hot-water urn in polished copper with a capacity of 2 gallons comes out at £7 10s., or with a capacity of 4 gallons at £10, while apparatus for heating alone is listed at prices varying from 16s. to £5 10s., according to size

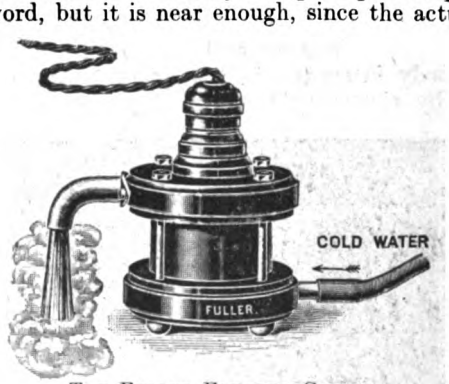


ARRANGEMENT OF HEATING TUBES IN THE BASTIAN IRON.

and finish. The same principle is applied to flat-irons, one of which, a 6 lb. iron, consuming 325 watts per hour and listed at 22s. 6d. is here illustrated. A cheaper form of the same weight is supplied at 15s., while at 17s. 6d. an iron is supplied which can be converted instantaneously from a 5 lb. to a 3 lb iron. The method of adjustment is shown in the illustration, where the upper portion can be released and removed by a mere turn of the thumbscrew.

JOHN C. FULLER & SON,
Woodland Works, Bow, London, E.

Though not strictly a cooking appliance, the Fuller Electric Geyser has so many claims upon the domestic side of electricity that a brief description of the apparatus may fairly be included in this section. The illustration shows very clearly the method of use. Attached to an ordinary water tap, it instantly converts cold water into hot by allowing it to pass through a series of electrically heated chambers. "Instantly" is perhaps not quite the correct word, but it is near enough, since the actual time



THE FULLER ELECTRIC GEYSER

occupied between turning on the cold tap and the beginning of the flow of hot water is not more than 3 secs., and temperature can be regulated at will from boiling point to lukewarmness by varying the rate of flow. For the kitchen and scullery, the utility of the Fuller Geyser for culinary purposes is immediately apparent, but it can be adapted with the greatest ease to the bedroom and the bath-room, the surgery and the operating theatre. Prices range from £3 10s. for a tap-geyser giving an output of 1 pint per minute and consuming current at the rate of 750 watts per hour, to £7 for the form giving 1 gallon per minute and taking current at the rate of 6 units per hour.

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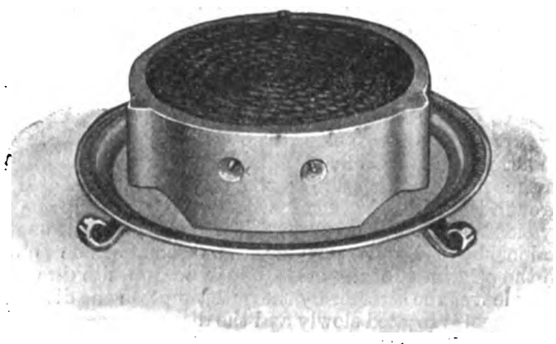
The dimensions of the geyser are approximately 5 in. in diameter by 6 in. high, and it can be used on either direct or alternating current. It is made in two series, one suitable for circuits of 100 to 150 volts, and the other for circuits of 200 to 250 volts.

The geyser can also be adapted for bedroom use where no water supply is laid on. The apparatus consists of a lead-lined water tank with a capacity of 3 gallons, mounted in a framework of polished mahogany or walnut. The geyser supplies hot water at the rate of just under half a gallon per minute, at a consumption of 2 units per hour, and is listed at £4 10s., while the tank in its framework complete with switch and connecting wire costs £3 5s.

F. A. WILKINSON & PARTNERS, LTD.,
Harpenden, Herts.

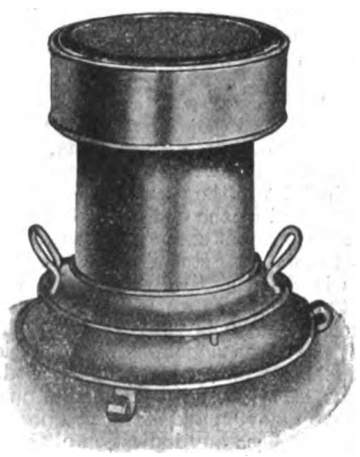
To Messrs. Wilkinson & Partners, Ltd., belongs the credit of producing what is probably, for small users, the cheapest electric cooker on the market. This consists of an oven 14 in. high, 12 in. wide and 12 in. deep, which consumes only one unit per hour, can be used on direct or alternating currents, and for any pressure from 100 to 250 volts, and is listed at 39s. 6d.

The apparatus shown in our illustration is perhaps, in its way, an even cheaper article. It is specially adapted for ordinary non-electrical household utensils, such as



THE ECONOMIC ELECTRIC STOVE.

kettles, saucepans, frying-pans, and chafing dishes, and it can also be used for toasting or for heating an iron. It consists of a stoneware body containing the heating element, which works at a bright red heat, and has a long life, with an expanded metal top, and an aluminium carrying tray. The consumption is 700 watts, and the list price is 19s. 6d., with 3s. 6d. extra for the aluminium tray, the purchase of which is entirely optional. In the second illustration the Wilkinson stove is shown in the form of



ECONOMIC ELECTRIC STOVE AS RADIATOR.

a combined stove and radiator, in aluminium, in which form it is listed at 34s. 6d. The special advantages claimed for these stoves are low first cost, high efficiency, cheap and easy renewability of the heating element, and the fact that the body of the apparatus is constructed of insulating material.

The same firm also manufacture an electric oven, which is especially adapted for combined cooking and hot-water supply for bath and general domestic purposes. The material is cast-iron, and the oven is 20 in. high by 13 in. wide, and 13½ in. deep. As the element works at bright red heat, the oven can be used for toasting and grilling, as well as for roasting, and a very high efficiency is claimed for it. The list price is £7, and for £2 extra it can be fitted with a hot-water boiler of liberal capacity.

THE WILKINSON NEW ELECTRICAL APPLIANCE FOR ORDINARY UTENSILS.

Our other illustration shows Messrs. Wilkinson's new patent electrical device for instantly converting large saucepans, frying-pans, and other domestic utensils into electrically heated utensils. Here again low price is combined with high efficiency and long life, and these advantages are linked with a device of extreme simplicity and great convenience.

BOLIVIAN ELECTRIC RAILWAY.

A prospectus has been issued which shows that the Electric Light & Power Co. of Cochabamba is now engaged in constructing an electric railway from Cochabamba to Quillacollo in Bolivia, a distance of 15 kilos., and the Government have arranged with the company for the construction of a second electric railway from Quillacollo to Arani, a distance of 30 kilos., with branches to Caraza and Vinto, and for the erection of factories for the generation and supply of electric power. The Government has authorised the company, in pursuance of the laws of the Republic of January 6, 1910, and February 15, 1910, to issue bonds of the nominal value of £300,000, and unconditionally guarantees the payment of the amount of £24,000 per annum required for the service of the bonds. The bonds will be to bearer of £100 and £20 each, and will be redeemed within 25 years by means of an accumulative sinking fund of 2% per annum, which will be applied in yearly drawings at par, or in purchase in the open market if the price of the bonds be at or below par. The redemption of the bonds by the application of the sinking fund will commence on June 15, 1911. The company reserves the right to pay off any outstanding bonds at any time on giving six months' notice. It is estimated that almost from the start the railway will earn more than sufficient to pay the amount required for the service of the present issue of bonds.

PERSONAL.

We are glad to record that Mr. George R. Drummond, Electrical Engineer to his Highness the Maharaja of Bikanar, Rajputana, India, has received the silver medal of the Royal Humane Society for his gallantry in saving one man and attempting to save two others, rendered unconscious in a well 320 ft. deep.

Mr. C. H. Yeaman, chief electrical engineer under the Hanley Corporation, has been recommended as chief electrical engineer to the new County Borough of Stoke-on-Trent.

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Municipal Electrical Association.

Annual Convention, Glasgow.

The proceedings of the annual Convention were continued on Wednesday, when the members visited Edinburgh and were welcomed at the place of meeting by the Lord Provost of that city. Councillor Stevenson, Edinburgh, who seconded the remarks of the Lord Provost, said that since the last visit of the Convention to Edinburgh the consumers of electricity in there had increased 50%, and the revenue of the electricity department had risen from £112,000 to £127,000. Mr. W. W. Lackie, President, returned thanks on behalf of the Association. Mr. F. A. Newington, Chief Engineer of the Electricity Department Edinburgh, then read a paper on "Exhaust Steam Turbines and Condensing Plant," and a paper by Mr. Ashton Bremner, Chief Engineer of Burslem, on "Mixed Pressure Turbines," was read in Mr. Bremner's absence by Mr. Faraday Proctor.

EXHAUST STEAM TURBINES AND CONDENSING PLANT AT McDONALD ROAD STATION.

By FRANK A. NEWINGTON, Chief Electrical Engineer, Edinburgh.

The plant described in this paper consists of exhaust steam turbines connected to direct current dynamos and condensing apparatus. When McDonald-road Station was designed the intention was to use towers for cooling the circulating water for condensation, but this scheme had to be give up, as it was thought the towers would be unsightly and might cause a nuisance from the steam issuing from the tops of the towers condensing and falling to the ground in the form of rain. Several other methods of getting a sufficient supply of water from a distance were considered, but were found to be prohibitive on account of the cost. In 1907, the water of Leith main sewer, which crosses under McDonald-road about 180 yards from the generating station, was brought to our notice, and on investigation, it was found that an average flow of about 750,000 gallons per hour could be obtained. It was, therefore, decided to utilise the sewer for condensing, and to extend the generating plant by means of exhaust steam turbines.

The sewer is 6 ft. 6 in. inside in diameter, and 22 ft. below the level of the road. A shaft, 26 ft. in diameter, formed of cast iron segments bolted together was sunk down until the top of the sewer was reached and a ring of brickwork, of the same diameter as the cast iron shaft, was continued downwards for about another 9 ft., that is, to the bottom of the sewer. Four suction pipes, each 18 in. in diameter, and one discharge pipe, 26 in. in diameter, are laid from the shaft to the station. Straining screens are fixed in the shaft just in front of the suction pit. The end of the discharge pipe in the sewer is water sealed so that a syphon action is maintained. Four 14-in. motor driven centrifugal circulating pumps, each with a capacity of 182,400 gallons per hour, are placed in the basement of the boiler house, each pump having a separate suction pipe from the shaft. The pumps deliver into a common pipe 26 in. in diameter, to which is connected a Bailey & Jackson rotary strainer. From this the circulating water passes through the four condensers back through the rotary strainer, and then is returned to the sewer. The centrifugal pumps are 16 ft. above the average level of the water in the sewer, and the highest point of the pipe system is 30 ft. above the pumps or 46 ft. above the sewer water level, but on account of the pipes forming a closed system, the average head against which the pumps work is 15 lbs., that is, 8 lbs. suction head, and 7 lbs. delivery head.

As there is a very considerable quantity of air in the water, two air extracting pumps have been provided: one extracts the air on the suction side of the pumps, the other the air on the delivery side. By this means the syphon action is maintained, and the pressure at the highest point of the pipe system averages about 20 in. of vacuum.

Four surface condensers of the Contraflo type are used, each having a cooling surface of 3,750 sq. ft. The air pumps are of the Edwards type with three throw cranks, The feed water force pump is also driven off the same shaft. At first the air pumps were intended to work on the dry system, but as there was some difficulty in getting the force pumps to work properly, one line of each air pump was altered so that it now delivers the condensed steam to the force pump, the other two lines working dry.

Each condenser and air pump will deal with 45,600 lbs. of steam per hour with the circulating water entering the condenser at 60° Fahr., and leaving at 90° Fahr., with a guaranteed vacuum of 28 in. with the barometer at 30 in. The ratio of the weight of circulating water to condensed steam being 40 to 1. The air pumps are driven by motors geared through Reynolds chains.

At first the idea of using sewage for condensing does not sound very promising, but at Edinburgh it has proved thoroughly successful. The quantity of water is not as large as one would wish, but is sufficient for a maximum output of about 10,000 kw. Unfortunately, about 5 p.m., that is, at the time of the top load in winter, the flow is considerably reduced in consequence of paper works and other industries stopping for the day. The chief troubles are efficient straining and getting rid of the air in the water. The straining arrangements in the shaft consist of three iron grids each 5 ft. high and 3 ft. 6 in. wide, with vertical bars spaced ⅜ in. apart. These are kept clean by scrapers automatically worked by a small motor. This arrangement answers fairly well, but a certain amount of scraping by hand is necessary at the time of top load. Probably it will be possible to devise some more efficient method of cleaning the grids, and so do away with hand labour, Further straining is done by the Bailey & Jackson rotary strainer which is placed between the pumps and the condensers. This consists of a cast iron wheel, 9 ft. in diameter, and 12 in. wide with 12 spokes. Between the spokes are fitted grids formed of brass strips built up very much in the form of honeycomb, that is, full of small holes and about 4 in. deep, the holes being about ·12 of a sq. in. in area. The wheel is surrounded by a cast iron casing which is divided vertically into two portions, which form the delivery and discharge chambers. The vertical partition is wide enough to cover the space between two adjacent spokes of the wheel. The casing has four pipes connected to it, inlet and outlet pipes on the delivery side, and the same on the discharge side. The water enters the strainer by the inlet pipe on the delivery side, passes through half of the grids in the wheel and deposits on them everything that will not pass through the holes. It then leaves by the outlet pipe on the delivery side. After passing through the condensers it re-enters the strainer by the inlet pipe on the discharge side, passes through the other half of the grids, but in an opposite direction, and finally leaves the strainer by the outlet pipe on the discharge side. The wheel is rotated slowly and the discharge water washes off from the grids everything that had been deposited on them on the delivery side, and carries it back to the sewer. The idea of the discharge water cleansing the grids is extremely ingenious. The leakage of water from the inlet chamber to the outlet chamber is considerable. It has only been possible to measure this with one pump in use, the quantity being from 10% to 12% of the total. Probably this amount will not be very much increased with four pumps running, but with a limited quantity of water, this is rather serious. It also means larger pumps and motors and a larger quantity of electricity used for pumping.

The temperature of the water in the sewer averages about 60° Fahr. in the winter and 70° Fahr. in the summer. As we are prohibited from returning the water to the sewer above 90° Fahr., the range of temperature for condensation is small, and so the quantity of circulating water required per pound of steam condensed is large. At present only two exhaust steam turbo generators have been installed, but there is sufficient steam from the reciprocating engines for two more exhaust turbines, and these will be added as soon as the increase in output requires them. The turbines are of the Rateau type running at 1,250 r.p.m. The guaranteed output of each set is 1,200 kw., about 2,200 amperes, and 560 volts, with 45,600 lbs. of steam per hour at a pressure at the inlet to the turbine not exceeding 14·7 lbs. per sq. in. absolute, and at the exhaust 1·3 lbs. absolute, say, 27¼ in. vacuum. This output is easily obtained in everyday work. This means that the exhaust steam from two of the 780 kw. reciprocating sets is sufficient to give an output of 1,200 kw. from one of the turbo-generators. Live steam is connected to each turbine through a reducing valve in case the supply of exhaust steam at any time should not be sufficient. These machines will give 25% overload for a short period. The rotor of each turbine has 11 wheels with 265 blades on each wheel. The clearance between moving and stationary parts is considerable, and there has not been any indication of stripping.

Besides the usual governor there is an emergency governor which comes into action if the speed exceeds 10% of the ordinary running speed, and also acts if the pressure of the lubricating oil falls.

The dynamos were built by Brown Boveri & Co. They are four-pole machines, and are separately excited by a small dynamo at the end of the shaft. Copper brushes are in use on one machine. The commutator of the other machine has been altered to give increased ventilation, and carbon brushes are fitted. There was some little trouble at first with commutation, but this has been overcome, and both machines are now running well, especially the one fitted with carbon brushes. This commutator keeps very cool, being only 42° Fahr. above the tem-

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perature of the air after a six hours full load run. Each commutator has 100 bars giving a pressure of about 22 volts per bar. At first there was a considerable amount of vibration on these machines, but this was caused by the turbine and dynamo shafts not being quite in line, and by the type of flexible coupling employed. Since one machine has been accurately lined and another type of coupling fitted, the vibration on this has entirely ceased.

The exhaust steam pipes are arranged so that the steam from the reciprocating sets can pass either to the exhaust turbines or direct to two other condensers.

Automatic atmospheric vlaves are placed in the exhaust pipes between the reciprocating engines and the turbines. The conditions under which these valves have to work are very severe. They are balanced to open at about 3 lbs. above atmospheric pressure, so they are always nearly in equilibrium, consequently they are very apt to chatter and so damage the faces. The valves first supplied were quite unsuitable. Those now in use, however, are working very well, the improvement being due to very strong construction, careful fitting of all moving parts to prevent all backlash, and the use of a special dash pot which admits air freely on the upward movement of the valve, but by means of a non-return valve, only allows it to escape very slowly when the valve is closing.

Oil separators of the Blake type are placed in the exhaust pipes between the reciprocating engines and the turbines which extract the greater part of the oil. The feed water is further treated by the Davis Perrett electrical process for freeing it from oil.

The water from the air pump discharge passes into wooden tanks in which are a number of iron plates spaced about 2 in. apart. A current of electricity is passed through these tanks with the object of precipitating finely divided oxide of iron. The small globules of oil adhere to the oxide of iron, and so are easily separated from the water. The treated oily water then passes into filters containing gravel and sand which retain the oil. Automatic arrangements are provided for flushing the filters to clean the sand. The quantity of electricity used in the filter is one unit for every 1,000 gallons of water treated. The makers guarantee that the filtered water will not contain more than one-tenth grain of oil per gallon. This is such a minute quantity that it is not easy to measure, but after 12 months steaming the boilers show hardly a trace of oil.

There is not the least difficulty in running the turbo generators in parallel with the other dynamos. The old dynamos are shunt wound, and the turbo generators compound wound. The whole regulation is done by the switchboard attendant by means of the shunt resistances. The only point to be careful about is to see that steam is not escaping past the atmospheric valves, which would mean waste. In order to prevent this, indicators have been fitted just above the atmospheric valves, and directly any steam passes the valve an electric circuit is closed which rings a bell on the switchboard. The switchboard attendant then puts more load on to the turbine and so reduces the pressure of the steam in the exhaust pipe.

Cost of Plant.—The condensing plant is sufficient to deal with the steam from reciprocating and exhaust turbines of 11,000 kw. The capital cost was as follows :—

	£	Per kw. £
Sewer shaft with four 18-in. suction and one 26-in. discharge pipe in roadway	5,600	·5
Circulating water exhaust steam pipework inside the station and oil-extracting plant	6,000	·5
Rotary water strainer	2,000	·2
Four condensers circulating and air pumps ..	11,000	1·0
	£24,600	2·2
Two 1,200 kw. turbo generators with switchboard	£13,800	5·7

The economy caused by the exhaust steam turbines and condensing plant is shown by the following figures, which are for similar periods in 1908 when only reciprocating engines were used without condensation, and in 1910 with exhaust steam turbines and condensation. In 1908 the price of coal was considerably lower—10d. a ton—than in 1910, but for the purpose of comparison the 1910 price has been taken for both periods.

In the costs per unit generated for the 1910 figures, the units used by the condensing plant have been deducted.

As only three of the boilers are fitted with superheaters the amount of superheat is quite small.

At present at the time of top load in the winter months, three or four reciprocating engines are exhausting direct to the condensers so the economy will be increased when the other two turbines are installed.

Some engineers seem to think that exhaust steam turbines are only a passing fashion and will disappear in a few years, but in stations with existing reciprocating engines, either exhaust steam or mixed pressure turbines seem the most suitable for extensions, as the combination of reciprocating engine and turbine is as economical as high pressure turbines and obviates all necessity of scrapping the old sets until these are worn out.

	1908.	1910.
Duration of test	3 weeks	3 weeks
Date	Jan. 16th to Feb. 6th	Jan. 20th to Feb. 9th
Units generated	715,491	888,644
Units used by condensing plant—	—	43,045 = 4·8%
	715,491	845,599
Load factor	22·8%	25·1%
Plant factor	89·6%	76·9%
Lbs. of water per unit generated	39 lbs.	22·2 lbs.
Lbs. of water evaporated per lb. of coal	6·67 lbs.	6·6 lbs.
Lbs. of coal per unit generated..	5·85 lbs.	3·9 lbs.
Maximum output	6·227 kw.	7 021 kw.

Costs per Unit Generated.

			% Saving.
Fuel	·251d.	·167d.	33·4%
Oils and Stores	·009d.	·004d.	50%
Water	·027d.	·006d.	78%
Salaries and wages	·054d.	·047d.	
Repairs (estimated)	·057d.	·057d.	
	·398d.	·281d.	30%

As shown by the figures giving the capital costs, the price of the sewer shaft and pipework in the roadway comes to £5 per kw. This is considerably less than cooling towers would have cost. In places where a river or other sufficient supply of water is not available for condensation, a main sewer, if near the generating station, is well worth consideration.

EXTENSIONS TO EXISTING ELECTRICITY SUPPLY STATIONS BY MEANS OF MIXED PRESSURE TURBINES.

By ASHTON BREMNER, Chief Electrical Engineer, Burslem.

When, in order to deal with an increasing load, extensions have to be made to existing supply stations, it is necessary for the Central Station Engineer to carefully consider the best plant to instal. One of the chief reasons why many stations are financial failures is because they are overweighted by capital charges.

It must always be the endeavour of an engineer when called upon (as was the writer) to design and afterwards manage a central station, to make sure that whilst copper in the mains is most liberally provided, the generating plant be installed of such capacity that even in the early days the plant will be efficient, and later, the same plant may be economically run on light loads such as at certain times will obtain, and further that extension may be easily and economically made.

Burslem is situated in the Potteries, an industrial area where, for the most part, only motors of small powers are required and steam for heating and drying is a necessity. Here, if electricity is to compete at all with other motive powers, the scale of charges must be very low indeed; consequently more than ordinary care was taken that the plant at first installed was suitable to the probable demand, and easily extended. Starting in 1905 with one 100-kw. and one 200-kw. Howden-Dick, Kerr sets it was apparent that, as the load increased, additional plant must be provided, and so a similar set of 350 kw.'s capacity was installed in 1907. Further extensions becoming necessary the writer early in 1908 advised that a 600-kw. Bellis-Siemens mixed pressure turbo-generator be installed, the plant being so designed that it could be used either as auxiliary power on exhaust steam or as stand-by plant on live steam. In the opinion of the writer this type of plant offered the best solution of the problem because,

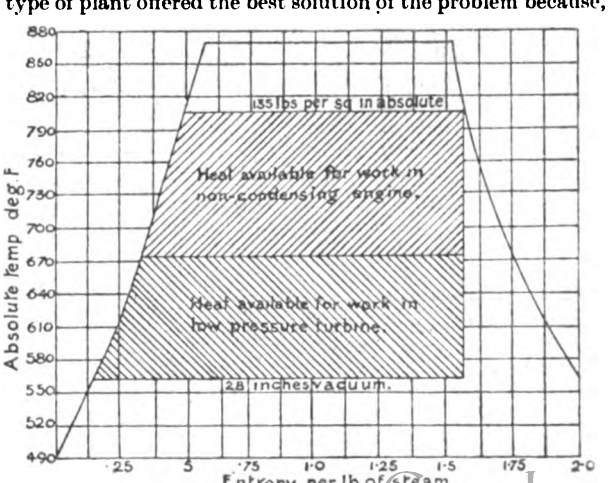

Fig. 1.

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Plant Running.	kw. Hour.	Period.	Average Pressure.	Average Superheat.	Average Vacuum.	Water per kw. Hour.	Reduction by Exhaust Turbine. %	Fuel per kw. Hour.	Reduction by Exhaust Turbine. %
Engine alone	296	1 hour	155	130° F.	25″	21·7	18·45%		
Combination	495	1 hour	155	130° F.	27½″	17·7			
Engine alone	910	9 to 12 a.m.	160	120° F.	27″	2·12	15·57%	3·75	19·2%
Combination	950	9 to 12 a.m.	160	120° F.	27½″	17·9		3·03	
Engine alone	186,100	50 days	Average Station conditions.					5·76	24·48%
Combination	147,000	40 days						4·33	
Engine alone	385,000	¼ year						5·31	26%
Combination	473,985	¼ year						3·93	

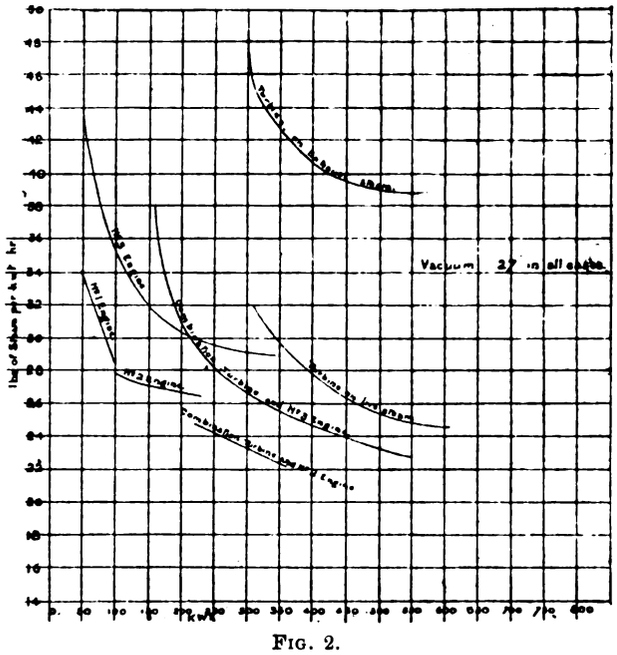

FIG. 2.

as the original sets were run non-condensing, the whole of the exhaust steam could be utilised in the turbine to produce additional power without increasing the cost of coal and water.

A study of the entropy diagram (Fig. 1) will show that the turbine develops approximately the same power as the sets which supply it with steam.

It will be seen that the reciprocating sets can be run either non-condensing, condensing or in connection with the turbine or the turbine can be run as a separate unit.

Table 1 gives results of tests taken with the plant installed at Burslem and shows what proportion of the load the turbine was developing from the exhaust steam.

Time.	Vacuum.	Reciprocator kw.	No. 4. Turbine kw.	Total kw.	Per cent.
4·35	27·25	256·0	84·8	340·8	33
5·5	27·25	252·0	67·8	319·8	26·8
5·35	27·12	204·0	94·3	298·3	47·3
6·5	27·20	275·0	141·0	416·0	51·4

Fig. 2 gives the result of tests of the steam consumption per kw. hour under different conditions and varying loads.

Table 2 is given by a firm of turbine builders as a guide to the power obtainable from the exhaust steam of reciprocating engines.

	Power of Reciprocating Engine. kw.	Additional Power obtainable for Turbine. kw.
1. Compound engine working non-condensing on saturated steam	500	375
2. Compound engine working non-condensing on superheated (100° F.) steam	500	320

From this table it will be seen that, with the engine producing 500 kw. running compound non-condensing with steam at the stop valve at a pressure of 160 lbs. per sq. in., the exhaust turbine will produce an additional 375 kw. less, say 5% required to drive the condensing plant.

Table 3 gives the results of the working economies of the power house plant of a large engine builder's works.

The power house was equipped with one 300-kw. and one 400-kw. triple-expansion engine running with a steam pressure of 160 lbs. and vacuum of 26 in., the steam being superheated from 50° to 150° F. At the beginning of 1908 an exhaust pressure turbine was installed which, running on the exhaust of one of the engines, was able to cope with the maximum load of the station and at the same time to give economical running on lighter loads. The fuel consumption seems high on the long period trials, but it must be remembered that in these trials meal times and nights are included when the load is extremely light, so that the stand-by losses are necessarily high. The very large saving shown in one case in favour of the turbine is due to the fact that at this period of the year the combination was very often able to run on one boiler where the engine equipment required two. The above figures are made clearer by the statement that the fuel is slack of poor calorific value, and that though the maximum load is about 350 kw. the mean load day and night is only approximately 200 kw. or during the full working hours about 300 kw.

A turbine of the Westinghouse-Parsons type of 368 kw. capacity installed at the Gloucester Railway Carriage and Wagon Co.'s Works is fitted with high and low pressure steam chests, the latter capable of dealing with 9,000 lbs. of exhaust steam per load and from which 210 kw. is obtained, the rest of the load being carried on high pressure steam. In this turbine the governing is effected by giving the low pressure governor valve a *lead* over the high pressure, so that the full quantity of exhaust steam is always used before high pressure steam is admitted. A drawing is attached.

As previously mentioned a Bellis-Morcom mixed pressure turbine was installed at Burslem Electricity Works, of which the following is a short description.

Drum Type.

Construction.—Rotor a short forged steel drum supported by two forged steel discs, mounted on a shaft which goes right through the rotor.—*Blading.*—The blades are of strip brass. Each blade is aligned and held quite individually secure. The fixed blades are inserted in groups, in windows in steel blade rings and are entirely protected from damage. Bearings are lubricated with water cooled oil at a pressure of 30 lbs. to 40 lbs. per sq. in., the oil pump is double acting and valveless. There is a flexible coupling between turbine and generator shafts. Governor throttle valves on both live and exhaust steam supplies,

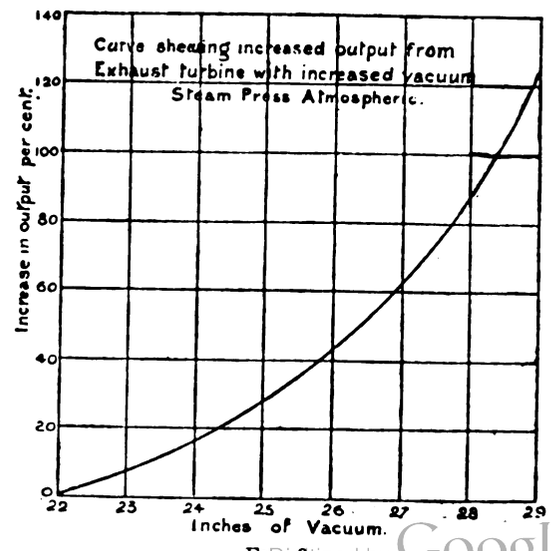

FIG. 3.

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are operated by a powerful and sensitive oil relay which is in turn operated by a governor of the same type as on the "Bellis" engines. Emergency valves are provided for both h.p. and l.p. steam, which operate at prescribed overspeed.

In order that a mixed pressure turbine may run to the best advantage a high vacuum is necessary. The condensing plant is therefore a very important feature of the equipment. Fig. 3 shows the increase in output from exhaust turbine with increased vacuum.

The surface type of condenser was selected mainly because it is possible to use the condensed steam for boiler purposes.

TABLE SHOWING WORKS COSTS AT BURSLEM FOR THE MONTH OF APRIL, 1909, WITH GAIN DUE TO INSTALLING THE TURBINE DURING THE MONTH OF APRIL, 1910.

PENCE PER UNIT GENERATED.

	Reciprocators only. April, 1909.	Combination Turbine and Reciprocators. April, 1910.
Coal	·244	·184
Water	·071	·028
	·315	·212

A saving of 32%.

Calorific value of coal = 12,700 B.T.U.

Cost per ton, 7s. 3d. into bunkers.

This paper has been written with a view to putting before central station engineers a somewhat new idea of economically making extensions to existing works.

The following is a summary of the discussion on these two papers:—

Mr. I. V. Robinson, of Messrs. Richardson Westgarth, London, said that undoubtedly there were many cases where exhaust steam turbines were a great success, and he believed that McDonald Road Station was one of them. In another case, where the engines were of the older reciprocating type, the addition of an exhaust steam turbine would practically compel them to keep these engines running when they had got beyond their useful life. There were, therefore, only certain cases where such a combination was advisable. In connection with the general design of condensing plant, Mr. Robinson described a new type of air pump just brought out by his firm. It is termed a kinetic injector, and is worked off a combination of the steam and water jet. The whole apparatus stands 4 ft. high, and the maximum diameter was about 18 in. for a plant capable of dealing with the steam from a 750 kw. turbo. This air pump has many advantages as compared with the ordinary circulating type of air pump.

Mr. Wordingham said he wondered why the use of sewer water for condensing purposes did not occur to any one before. He would like to ask if there was any trouble from corrosion. Did the foul nature of the water affect the health of the staff? The author of the second paper had referred to the necessity of making a station pay its way as it goes along. The designers of stations often came in for a good deal of criticism which they did not deserve. Fault is found with small plant being put in at first when extensions become necessary, but such people forgot that if small plant had not been put in to start with, the station would have been over-weighted with capital charges and would not have paid its way.

Mr. de Ferranti said that Mr. Newington's description of this method of using the out-flow water from the sewage mains was most interesting, and no doubt in their actual application a good many difficulties other than those described in the paper were met. He thought it was most important to use the exhaust steam to the best possible advantage. He suggested to engineers desirous of using these turbines that they should so draw up their specification as to warrant their getting not the turbine at the lowest price, but the turbine of the best possible make. Very much higher economies could be got than those of everyday practice, but this meant building the turbine larger and more carefully designed in detail. Such a turbine would have no chance in ordinary competitive tendering. He thought that exhaust steam turbines were an excellent makeshift at the present time in certain circumstances. It was by no means finality. It was a convenient means of getting over the position raised by the difficulty of putting aside existing plant, which, however, his investigations in certain cases convinced him was the right thing to do, if the result could be shown properly in the accounts.

Mr. C. E. C. Shawfield (Wolverhampton) said Mr. Newington's results would have been distinctly better if he had scrapped the reciprocating engines and put down high-pressure turbines direct. This would have given a distinct saving in capital. The figures in the paper showed that each 1,200 kw. turbine with switchboard cost £6,900. Adding to that a fourth of the £11,000 for condensing circulating and air pumps, gave a total cost for each set complete with accessories of £9,650, exclusive of pipes, etc. In return there was got 1,560 kw. from the existing reciprocating engines, or a total of 2,760 kw. The capital cost of a 3,000 kw. high-pressure set certainly would not have cost more than £8,500. The average steam consumption per unit generated with the combination was 22·2 lbs., but this, no doubt, including stand-by losses. This was a high figure, and 19 lbs. was probably nearer it. With a high-pressure turbine and a similar vacuum there would not be obtained more than 17 lbs. In addition to the saving in capital cost, there would be a saving of about 2 lbs. of steam in running cost. With a high-pressure turbine he would only have required half the size of condensing plant per kw. of output, and the total amount of circulating water would have been considerably less.

Mr. Bloxan (Belfast) said he had similar sets to those referred to in the paper, and regretted that Mr. Newington had not given more particulars of the commutation troubles he mentioned as having had. On 2,000 kw. sets he had originally used copper brushes, but these required so much daily trimming and attention that the cost of maintenance was excessive. Carbon brushes were substituted for them, but owing to the light tension necessary to be put upon these to keep down the temperature due to friction, it was difficult to get each brush to take its share of the pressure. The result was burning away of the carbon in patches. Messrs. Brown Boveri now proposed to remedy the trouble by reconstructing the commutators. The alteration, however, was to cost £500, and it meant putting the machines out of commission for three months. He would like to ask Mr. Newington if he preferred separate exciters or self-excitation in connection with these machines?

Mr. R. Birkett (Southend) said in his case with a 16% load factor exhaust steam turbines could not be economically used. He obtained very good results with his reciprocating plant averaging 23 lbs. of steam per kw.-hour. He employed an air condenser of the Ledward type, which, while dealing with twice as much steam, saved £900 per annum in water alone as compared with the circulating water and cooling tower arrangement.

Mr. S. L. Pearce (Manchester) said they all recognised that the work to be got out of the steam was proportionate to the surrender of heat given up by the steam, and looked at from that point of view, an exhaust steam turbine is a piece of apparatus to give up the greatest proportion of heat possible. Having regard to the margin over which the greatest amount of heat units was got from the steam, it was apparent that a good vacuum was the first consideration, and unless that was got exhaust steam turbines were not to be thought of. An increase in the vacuum from 27 to 28 in. meant an increase in the available heat units of 20%. A high vacuum was the prime essential, but the limitations in this direction were easily reached on account of the capital necessary for condensing plant pipes, etc. He thought Mr. Newington was too sweeping in his paper when he commended exhaust steam turbines for all cases. This commendation required qualification. It was an erroneous statement to say that an exhaust turbine, coupled to a first-class triple expansion engine, would do its work more economically than if it was worked as an ordinary non-condensing engine. He had gone into the question of the use of exhaust steam turbines at Manchester, but found that it was only a matter of ½ to ¾ lb. of difference as compared with high-pressure turbines, and the latter had been adopted. Every case must be judged on its merits in this matter, and no generalisation was possible.

Mr. H. Faraday Proctor (Bristol), said Mr. Newington added exhaust steam turbines to the existing reciprocating sets. Mr. Ferranti suggested scrapping the existing sets and putting down an up-to-date turbine. He would suggest another alternative, viz., put in an up-to-date turbine

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and retain the existing sets for stand-by purposes. It was a question of building space rather than capital cost on machinery.

Councillor Livingston (Hull) asked if there was no scarcity of sewage water in summer.

Mr. F. W. Purse (Watford) questioned the figure of 33% saving given in the paper, and

Mr. R. H. Campion (Dewsbury) commended the mixed pressure turbine.

Mr. Newington, in reply, said that there had been no trouble with corrosion nor had the health of the staff suffered. The scraping arrangements were not yet perfect, but there was nothing on the market which met their case. What they had done had been from designs of their own. The coupling they were using was by Brown Boveri and there was nothing special about it. On paper high pressure turbines might show better results but anything almost could be proved on paper. Wholesale scrapping of plant might lower running costs, but that advantage would be outweighed by the increased capital cost. It had been hinted that they might expect important developments and therefore it was well to go cautiously. Mr. Shawfield in his figure had forgotten boilers. Makers of D.C. turbo-dynamos seemed to be getting over their troubles with commutators. He could not say whether separate or self-excitation was better, but in the case of Edinburgh the makers favoured separate exciters and these were used. The objections of the earlier days with regard to cooling towers had been got over in Edinburgh and in future extensions these would be used. In dry weather their load was lower than in winter and in summer the greater number of baths used helped to keep up the supply of sewage water.

The Convention were entertained to luncheon by the Edinburgh Corporation. The Lord Provost of Edinburgh presided and was supported by Judge Stevenson, Convener of the Electricity Committee of Edinburgh. The other participants in the speech-making at this function were Alderman Pearson, of Bristol, and the President of the Association, Mr. Lackie. During the afternoon McDonald station of the Edinburgh Electricity Department, and the works of Messrs. Bruce Peebles & Co. were visited.

Resuming on Thursday morning under the chairmanship of the President, the Convention had two informal discussions, which the chairman explained were an experiment.

Mr. Geo. Wilkinson (Harrogate) opened the first discussion on "Advantages of continuous records of Costs and Steam Consumption." He said that station engineers did not make the fullest possible use of their cost sheets. His men examined the costs every day and so were encouraged to cultivate an interest in this important aspect of their business. He paid particular attention to boiler house economies and costs from three points of view, viz., air leakage in the flues, economiser efficiency and condensation in the steam pipes. Superheat was no cure for condensation in steam pipes. He mentioned a device of his own by which condensed water might be taken back to the boiler automatically.

Mr. Shawfield said the cost of production in connection with electricity supply was already better known and in greater detail than was the case with any other industry. More was still to be done as regards what actually happened in the stations. It would be advantageous if they could show the hourly consumption of coal. He had not found the CO_2 recorder so reliable as the makers tried to make out. They had to be careful that the capital cost of keeping records was not greater than the money advantage derived therefrom.

Mr. F. E. Ayton (Ipswich) said he agreed with Mr. Shawfield in his warning note. He thought they should direct their attention to the other end of the scale, *e.g.*, consumers' meters. The CO_2 recorder and other similar measuring instruments, as time went on, had to be repaired at a heavy cost and they wanted almost daily attention to keep them correct. His investigations showed that the cost of street lighting was extremely low, which indicated that they could go in increasingly for street lighting against gas.

Mr. C. H. Wordingham said that central station engineers tended to become meter maniacs and their measuring of everything was being carried too far. A few careful tests made from time to time were of more value than a mass of material that their staffs could not properly analyse and deal with.

Mr. Newington (Edinburgh) said he had carried out careful tests of the calorific values of all the coal supplied to them, but he found this was not worth while as the coal merchants knew perfectly well the various calorific values of the coal they sold and accordingly graduated their prices.

Mr. Ruddle (Dublin) said that continuous records might be of very little value. The thing was for each man to keep his own section of the station working at the highest pitch of efficiency.

Mr. Lea (Lea Recorder Co.) said mechanical engineers were at a disadvantage as compared with electrical engineers owing to their not having the same facilities for measurement. He thought that the principles of running of plant as well as its structure should be taught in technical schools.

Mr. S. J. Watson, of Bury, opened the discussion on "The Cheapening of Mains and Services." Mr. Fedden was down to open this discussion, but was absent through illness.

Mr. Watson said the cost of mains remained almost where it was 10 or 15 years ago, although the cost of generating plant had gone down 20% below what it was in 1902. He did not know whether this was due or not to the Cable-makers' Association. The decreased revenue from metal filament lamps made the question of cheapening mains very important. The transmission of three-phase current had not received the attention it deserved. It reduced the size of the feeders and the size and length of the low tension distributors. The Board of Trade regulations as to the limit of variation in voltage ought to be altered as the effect of variations with metal filament lamps was not so marked as in the case of carbon filament lamps. Over head mains cost from a third to a fourth of underground mains. He had found aluminium overhead mains perfectly satisfactory.

Mr. Ayton (Ipswich) said the main thing in his mind was the cost of fittings in the house. The use of a combined meter and fuse box was helpful.

Mr. Sankey (Whitehaven) thought the electrical engineer should endeavour to imitate the simplicity of the gas fitter in his fittings.

Mr. W. G. Pickvance (Wrexham) referred to the impregnation of street soils with chemicals and thought it advisable to protect the cable with bitumen.

Mr. Turnbull (Tynemouth) referred to a system adopted by Mr. Dykes, of Hancock & Dykes. Using a transformer near the premises to be supplied, they ran "Stannos" wire along the outside of a row of houses and tapped into each house as required. He thought a really good armoured cable was the best thing they could use. Only it must be thoroughly well made. Cheap cables were dear in the end.

Mr. Lackie gave a set of figures showing that the average price per service laid in had fallen from £7 to £4 6s. 6d. The reduction was due to specialisation.

Mr. Vignoles (Grimsby) thought that the metal filament lamp should enable them to reduce the size of distributors. He had laid 3,700 yards of 7/16 three core cable at 1s. 8d. per yard.

Mr. Wilkinson, in reply, spoke of consumers pirating current and mentioned a device he had designed to stop this.

After luncheon in the Grosvenor Restaurant, members were conveyed in brakes to the works of Messrs. W. Beardmore at Dalmuir, to inspect large gas engines, etc., and Partick and Govan Electricity Supply Stations, while the ladies were conveyed in special cars to Rouken Glen, where afternoon tea was served and music provided.

The annual dinner of the Association was held in the *Windsor Hotel* in the evening, Mr. Lackie presiding. There was a large attendance of members and friends. After the usual loyal toasts, Mr. J. Christie, of Brighton, proposed "The Glasgow and Neighbouring Corporations," which was responded to by Bailie Dunlop, of Glasgow, and Provost McMillan, of Greenock.

Sir John Ure Primrose, in the course of an eloquent speech, proposed the toast of the Association. He said

(*Continued on page* 813.)

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THE MEASUREMENT OF DEPRECIATION.

In his Presidential address before the Incorporated Municipal Electrical Association, Mr. Lackie, speaking of the essentials in running an electrical undertaking successfully, referred to depreciation. He asked: "What is depreciation? I should say that: (1) Depreciation of value is met by the sums set aside for sinking fund, if such sinking fund be properly calculated upon the probable life of the plant; (2) decreased efficiency should be met by depreciation if the ordinary maintenance chargeable to revenue is not sufficient to keep the plant in its first state of efficiency; (3) obsolescence does not mean, nor does it involve, depreciation. It is not true depreciation, but it is quite possible that a prudent authority, owning works, might look to the advantage which would be gained by installing present day plant, and so getting greater efficiency than would be obtained from antiquated plant. Such an authority would annually lay aside a sum for this purpose, and might be found dispensing with old plant in favour of something more up-to-date, even although the latter might not have reached the end of its usefulness. Such a course, however, is not compulsory under the Electric Lighting Acts. It is not legal to create a deficit by setting aside a sum either in name of depreciation or of reserve fund. Only such sums as are profits are available for this purpose." Now, the question raised by Mr. Lackie is one of increasing importance, for the tendency is to give even shorter lives to plant of nearly every description, thanks largely to the acceleration in inventive and manufacturing skill which give greater prominence to the factor of obsolescence. Moreover, we have to make closer calculations in view of the more searching methods of income-tax rating. It, therefore, becomes of immense importance to see the provision allowed for depreciation in accounting is based on sound principles. Mr. Lackie's rules are sound enough as far as they go, but they do not go very far. We are told that the sinking fund must be properly calculated, but are not told how the sinking fund may be managed

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so as to represent the true state of affairs. Yet the annuity and sinking fund methods involving the use of interest are unsuitable for general purposes in most industrial concerns, because they are not sufficiently flexible, are arbitrary, and bear too hard on the first years. What we have to do is to calculate the actual profit earning value of each class of appliance, giving due weight to depressing influence of obsolescence, and on the other, to the alleviation of scrap value. This cannot be done by a hard and fast annuity, or by taking off a percentage from diminishing ledger balances. Actual facts must play their part in this calculation of depreciation, and for this purpose there must be co-operation between engineer and accountant. This is well brought out by Mr. P. D. Leake whose "Register of Industrial Plant" is briefly reviewed in another column. Speaking from his long experience as a member of the Chartered Accountants' Association, Mr. Leake points out that the percentage on diminishing ledger balances is most rough and ready. Taking a machine with a ten years' life and a scrapping value of 2%, then the percentage necessary for calculation will be 33%, which is obviously a very wide shot. What is necessary, as he shows, is to so distribute the depreciation charges that they shall as closely as possible coincide with the benefit obtainable from the plant during its use for any one year. This sounds like a counsel of perfection, very pleasing but impossible of attainment. That is not so, however, if we make use of adequate means, that is to say, if we adopt some system of periodical valuation based on ascertained facts. Again, it will be argued, not an easy task, but the difficulty is more apparent than real when we come to consider Mr. Leake's proposal for the keeping of a "Register of Industrial Plant." As explained elsewhere in this issue, the Register "provides a regular means of measuring and recording the depreciation caused by wear and tear, natural decay and obsolescence in perishing industrial plant," with means for constant revision. It is used as a subsidiary to the ledgers, and is, in fact, a tool by which an accurate statement may be prepared for entry into the ledger and balance sheet. Each class of plant is treated as a money-making unit, starting with a presumed "expectancy of life" and utility, but which events may falsify, either by appreciation or worsement. We thus obtain greater accuracy, a genuine easing of accountancy, and a true statement of the case when calculating profits either for the purpose of distributing dividends, of relieving rates, or calculating that just shares which shall go to the Income-Tax Commissioners. We are more and more bringing the scientific spirit into modern business methods, and this means that we must discard the old-fashioned, contradictory and arbitrary systems of arriving at what depreciation really means, how it should be represented on our balance sheets, and, therefore, influence our profit and loss accounts.

TECHNICAL PROBLEMS, WITH SOLUTIONS BY PRACTICAL MEN.

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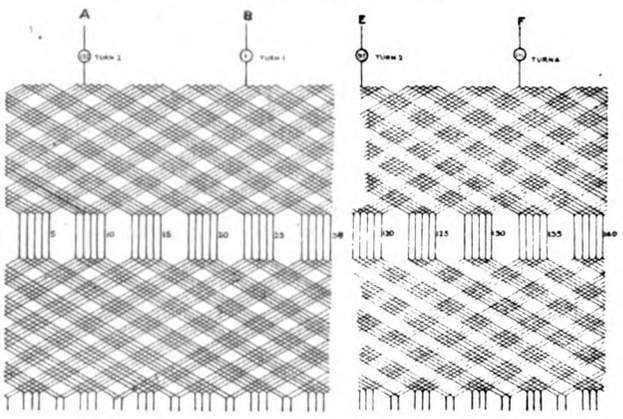
ANSWERS.—A fee of 10s. will be paid for the best answer, and 5s. for every other published. Replies should reach the office within 14 days of the appearance of the questions.

Question No. 1221.—I send print showing windings of a rotary converter; it has four poles and runs on a 420 volts D.C. There are four brushes being con-



nected in pairs and six slip rings marked A, B, C, D, E, F. What are the best connections for one, two and three-phase currents, and what will be the voltages?

"B. E. W."

REVIEWS.

"Leake's Register of Industrial Plant. By P. D. Leake, F.C.A. London: Henry Good & Son. 5s. net.

This loose-leaf register is intended "for the classification of capital outlay and the measurement of depreciation, either monthly or yearly, by means of regular record of expired values, based on estimates and revised estimates of the useful life of each class of plant." The Register, 16 in. by 12½ in., is ruled off into 12 sections, for yearly or monthly estimates. There are also spaces for recording date when estimates are made, number of years' life, annual percentage to be written off cost, and estimate of remainder or scrap value. It is not to be used as a substitute for ledger, but as an adjunct to facilitate arriving at an accurate measure of the amount to be written off for depreciation and obsolescence. In other words, the author puts forward a plea for the abolition of the "rule of thumb" method of writing a percentage off decreasing ledger balance, and the substitution therefor of a system based on actual calculation of the unexpired value of different classes of machinery. This, as the author explains, can be easily done by means of co-operation between the engineer, or works manager, and the accountant, the Register under review having been specially designed with this end of view. It offers a practical solution of a very intricate and important problem in the matter of business administration.

INSTITUTION OF MINING ELECTRICAL ENGINEERS (SOUTH WALES BRANCH).

A visit will be paid to the Treforest Power Station, Upper Bank, Treforest, on the 25th inst., at 3.30 p.m. (by kind permission of W. A. Chamen, Esq., M.I.E.E., General Manager). A hearty invitation is extended to other branch members, and it is requested that those who wish to avail themselves to this visit should notify the local Secretary, Mr. Geo. Humphrey, 113, Clive-road, Cardiff, on or before the 22nd inst.; this also refers to branch members.

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Electrical Contractors' Section.

A Survey of New Things and Business Prospects.

NOTICE.

Contract and Miscellaneous Advertisements should reach this Office by Mid-day on Wednesday. For rates apply to the Manager, 149, Fleet Street, London, E.C.

CONTRACTS.

COUNTY BOROUGH OF ROTHERHAM.

The Corporation are prepared to receive TENDERS for the supply of Electricity Meters according to the requirements of the Department, between August 1, 1910, and July 31, 1911. Ampere-hour meters of sizes and maximum currents of 2, 5, 10, 25 and 50 amperes. The supply pressure is 230 and 460 volts. Further particulars can be obtained upon application to the Borough Electrical Engineer.

The person whose Tender is accepted will be required to enter into a contract which will contain the usual Fair Wages Clause.

Tenders, endorsed "Meters," to be sent to me not later than July 9th next.

By Order,
W. J. BOARD,
Town Clerk.

Town Hall, Rotherham,
June 23, 1910.

COUNTY BOROUGH OF ROTHERHAM.

The Corporation are prepared to receive TENDERS for the supply of Cable according to the requirements of the Department, between August 1, 1910, and July 31, 1911, as follows, namely:—

Single vulcanised bitumen covered Cable of various sizes. Further particulars can be obtained upon application to the Borough Electrical Engineer.

The person whose Tender is accepted will be required to enter into a contract which will contain the usual Fair Wages Clause.

Tenders, endorsed "Tenders for Cable," to be sent to me not later than July 9 next.

By Order,
W. J. BOARD.
Town Clerk.

Town Hall, Rotherham,
June 23, 1910.

LLANDAFF AND DINAS POWIS RURAL DISTRICT COUNCIL.

WHITCHURCH ELECTRIC LIGHTING.

The Council are prepared to receive TENDERS for the SUPPLYING and ERECTING of E.H.T. SWITCHGEAR, TRANSFORMERS, DISTRIBUTION SWITCHBOARD, and FITTINGS, and the providing and laying of Electric Light Mains, Boxes, &c., at Whitchurch, in accordance with Specifications, Plans, &c., which may be seen, and Forms of Tender obtained, at the office of Messrs. Herbert Lewis & Fletcher, Consulting Engineers, Prudential-buildings, St. Mary-street, Cardiff.

Sealed tenders, duly endorsed, to be in my hands not later than Monday, July 4, 1910.

The Council do not bind themselves to accept the lowest or any tender.

M. WARREN,
Clerk to the Council.

Park House, 20, Park-place, Cardiff.
June 18, 1910.

MISCELLANEOUS.

FOR SALE.

COMPLETE VOLUMES of THE ELECTRICAL ENGINEER for years 1906-7-8, bound in neat red covers; also or 1909 (half-year), unbound, with loose cover. All in very good condition. What offers?—BOX M, 45, c/o THE ELECTRICAL ENGINEER, 149, Fleet-street, London, E.C.

CONTRACTS OPEN.

HOME.

BELFAST.—City invite tenders for erection of chimney shaft and flues at the electric power station. Specifications (63s.) from Town Clerk. June 27.

BIRMINGHAM.—Corporation invite supply of general and engineering stores, including timber, brushes, ironmongery, drysaltery and electrical accessories for the electricity department from August 1, 1910, to July 31, 1911. Particulars from City Electrical Engineer. June 30.

DEVON.—Visitors of the Devon County Asylum invite tenders for one year's supply from July 4 of (B) oils and packing, (D) electrical appliances, and (E) rubber goods. Apply Clerk. June 30.

DRUMCONDRA, IRELAND.—Tenders invited for the installation of an electric light plant near Dublin. Plan and particulars (10s. 6d.) from P. O'Hare, 15, Well Park-avenue, Drumcondra.

EALING.—Borough Council invite tenders for surface condensing plant. Specification (£2) from Borough Electrical Engineer. July 4.

LONDON.—County Council invite tenders for the manufacture and supply of (*a*) 250 electric tramcar bodies, (*b*) 250 sets of centre-bearing swing bolster car-trucks, (*c*) 250 complete electrical equipments for operation upon both conduit and overhead trolley systems of traction. Specifications (40s. for each section) from Cashier, County Hall, Spring-gardens, S.W. July 5.

LOWESTOFT.—Corporation invite tenders for the supply of about 5,000 tons of stock and large steam coal for electricity works during the year ending June 30, 1911. Particulars from Town Clerk. June 28.

PONTYPRIDD.—Urban Council invite tenders for washed nuts for the electricity works. Particulars from Mr. J. T. Teasdel, A.M.I.E.E., Electrical Engineer. June 26.

RAWTENSTALL.—Corporation invite tenders for labour and materials of an electric tramway: Contract No. 5, permanent way construction; No. 6, steel poles, overhead line equipment and accessories; No. 7, cables, conduits, trenching, section boxes and accessories. Particulars (£5) from Mr. C. L. E. Stewart, Borough Electrical Engineer. July 1.

SALFORD.—Corporation invite tenders for supply of coal to Electricity Works for year ending July 31, 1911. Particulars from Borough Electrical Engineer. June 27.

SOUTHAMPTON.—County Council invite tenders for supply and erection of electric light plant, wiring for electric light, and installation of steam and hot water heating for the County Asylum, Knowle, Fareham. Specifications and plans (£5 5s.) from Mr. J. R. Wyatt, Clerk to the Committee of Visitors, Knowle. June 28.

OVERSEAS.

ADELAIDE, S.A.—Postmaster-General.—Cordless switchboards. (Specification No. 3,381). July 6.

MELBOURNE.—Postmaster-General.—400 telephones, wall sets, magneto, complete (specification No. 220 and pattern C. No. 11); and 200 telephones, bridging table (specification No. 221, and pattern N.S.W. 339, schedule 321). July 9.

NIMEGEN, HOLLAND.—Steps are being taken by a committee, called "De Maaskanter," to obtain powers for extending the Nimegen-Wychen-Dreumel light railway to various districts in the vicinity of the present line. It appears, further, that, in all probability, the Nimegen Town Council will shortly take over the steam tramways at present worked by the "Nymeesche Tramwegmaatschappij," in which event arrangements will be made immediately for the substitution of electric for steam traction throughout the system.

OSRAM·LAMPS

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PATENTS.

S. SOKAL, Chartered Patent Agent,
AND
Certified Austrian Patent Attorney (Patentanwalt), Specialist for German Patents and Patent Litigation.
55, CHANCERY LANE, LONDON, W.C.

THE PROPRIETORS OF PATENT NO. 12656 of 1908, for "Improvements in and relating to arc lamps," is desirous of entering into negotiations with manufacturers or capitalists for the exploitation of such patent in the United Kingdom by sale or license. Address—FELL & JAMES, 1, Queen Victoria-street, London, E.C.

TO MANUFACTURERS AND USERS OF ELECTRIC FURNACES.

THE OWNERS OF THE BRITISH PATENT NO. 10580, of 1900, relating to "Improvements in electric furnaces of great power," desire to enter into negotiations with one or more British firms in this country for the purpose of exploiting this invention, either by the sale of the Patent rights, or by grant of licenses to manufacture under Royalty.

Enquiries to be addressed to—MESSRS. ABEL & IMRAY, Chartered Patent Agents, Birkbeck Bank Chambers, London, W.C.

BUSINESS FOR SALE.

ELECTRICAL CONTRACTOR'S BUSINESS for Sale on South Coast; price, £150; owner returning abroad.—Box No. 44, THE ELECTRICAL ENGINEER, 149, Fleet-street, E.C.

PLANT FOR SALE.

Advertisements under this heading: Twenty-four words, 1s. per insertion; three insertions for 2s. 6d.; or each additional line of eight words, 4d.

EIGHTY MOTORS AND DYNAMOS for sale or hire.—MARTIN, 320, Witton-road, Birmingham.

FOR SALE, FIRST-RATE COUNTRY HOUSE ELECTRIC PLANT, to be seen running any day. 2-16 h.p. Hornsby's Oil Engine, with full accessories, Water Tanks and Blow Lamps; one 12 h.p. Dynamo; quantity of ⅛ in. Copper Rod; 55 large Glass Cells; about 6 tons of Lead Plates; 2 small Continuous Fan Motors; one 14 amp. Motor; two 9 amp. Motors; two 5 amp. Motors.—Apply PRETOR-PINNEY, Broadoaks, West Byfleet.

PLANT WANTED.

PLATINUM UTENSILS, SCRAP, LAMP TOPS.—Best prices given by DERBY AND CO., LTD., 44, Clerkenwell-road, London, E.C. N.B.—Platinum Sold.

SITUATIONS VACANT.

YOUNG ELECTRICAL ENGINEER, 6 years' Manufacturing experience, including 2½ years' Testing Department. At present in Drawing Office. Desires change.—Box 05Z, c/o THE ELECTRICAL ENGINEER, 149, Fleet-street, E.C.

APPRENTICE-YOUTH, aged 16, seeks engagement, Electrical Engineer. North London preferred. Intelligent, good education.—R. C., ELECTRICAL ENGINEER, 149, Fleet-street, E.C.

REPRESENTATIVE WANTED in England by a leading incandescent lamp factory for the sale of their first-class carbon filament incandescent lamps. Offers should be addressed to—Z2244Q, HAASENTEIN & VOGLER, Basle.

MEN OUT OF EMPLOYMENT in all branches of the Electrical Trade should write to Box No. 20, c/o THE ELECTRICAL ENGINEER, 149, Fleet-street, London, E.C.

SITUATIONS WANTED.

WIREMAN WANTS WORK, 12 years' experience; screwed conduit.—G. H., 14, Sterndale-road, West Kensington.

WIREMAN wants sit. or job power lighting telephones. bells.—E. C., 65, St. John's-hill, Clapham Junction, S.W.

ENGINEER seeks CHARGE ELECTRIC PLANT; gas or petrol engines, or Engineer in factory; lathe experience, all branches engineering; married.—ENGINEER, 28, Adelaide Road Chislehurst.

GOOD WIREMAN, Coil Winder, age 19. Four years' experience.—W. S., 51, Blackheath Hill, S.E.

ENGINEER (General) desires situation, railway and lighting experience; good draughtsman, speaks Spanish; splendid references.—H., 25, Finborough-road, South Kensington.

ROME.—The Ministry of Marine, invite tenders from Italian and foreign firms for the supply of electric lamps and lampholders to the arsenals at Spezia, Naples, Venice, and Taranto. The upset price is put at 150,000 lire (£6,000) and a deposit of 15,000 lire (£600) will be required to qualify tenders. Tenders should be addressed to "Signor Direttore Generale dei Servizi Amministrativi e della Contabilità, Ministero della Marina," Rome, by whom they will be opened at 11 a.m. on June 30. Tenderers will be required to furnish certificates of competency. Only firms whose names are on the Government list are generally allowed to tender. Personal representation is practically necessary.

SALONICA.—Turkish Government invite tenders for the construction and working of electric tramways at Salonica. Deposit of £2,250 will be required. Tenders, to be marked "Ministére Impérial Ottoman des Travaux Publics, Adjudication des Tramways dansla Ville de Salonique," to be sent to Ministry at Constantinople not later than July 4 (this is an extension from previously announced June 28.). Local representation is essential in the case of Turkish Government contracts. A list of British commission agents established in Constantinople may be obtained and a copy of the specification (in French) may be seen, by British firms at the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, London, E.C.

NOTES.

Safety Valve and Controller.

On Tuesday, Signor Lusnardi made a demonstration of his new patent safety valve and controller for steam boilers at the works of Mr. Underwood, Forty Acres-lane, Canning Town, N. It appears to be a practical contrivance, suitable for any description of boiler, and possesses several advantages over the average safety valve and controller. It is an appliance which should be heard of in the future.

Extensible Switch Pendant.

Messrs. John Dugdile & Co., of Failsworth, have brought out a new catalogue of electric fittings. It contains much worth noticing. A good line is the patent extensible switch pendant, which is provided with a double-pole switch and spring reel cord absorber. It requires no counterweights or wall switches, looks very neat, and is easy to control. It is made in six standard sizes for 1, 2 and 3 lights. These people are also the makers of the telescopic tube pendant, adjustable brackets, and so on. In fact, they treat the electric light fittings very much on the principle of gas fittings, with excellent results.

Ornamental Electroliers.

The Edison & Swan United Electric Light Co., Ltd., have brought out a series of ornamental electroliers and electric pendants which should prove very attractive during the coming season. These are illustrated on their leaflets Nos. F. 2184, F. 2183 and F. 2182. The electroliers are made in polished brass or antique copper, and range in price (for three lights) from 13s. 9d. to 14s. 6d. The pendants are hung from chains, and there are some very beautiful designs, the prices ranging from 15s. to 27s. 6d.

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A Useful Calendar.

For the ninth year Messrs. W. T. Glover & Co., Ltd., have brought out their useful one-leaf calendar, from July 1, 1910, to June 30, 1911. Each leaf has something on it beyond the mere date to interest. As a rule we find a handy formula, or a "tit-bit" of useful information from one of the technical journals, or some professional paper. As the calendar can either be hung on the wall or stood up on the desk, it is distinctly worth applying for.

Water Softening Plant.

The Seck Engineering Co., Ltd., have just installed one of their standard type water softening and purifying plants at the works of the Imperial Lamp Works (Brimsdown), Ltd., Brimsdown, Middlesex, for treating the feed of a Babcock-Wilcox boiler, under an absolute guarantee of immunity from the formation of scale at a fixed working charge, which it is also guaranteed shall not be exceeded.

CONTRACTS WORTH WATCHING:—

Below is a list of contracts recently given or tenders invited. Although we have no means of ascertaining whether in all these cases electricity is to be used, it is presumed, from the nature of the cases that this will be so.

Belfast: W. J. Fennell, architect, 2, Wellington-place, Belfast. Veterinary establishment in Chichester-street.

Blackburn: Lames & Green, architects, Richmond terrace, Blackburn. Alterations to Daisyfield Co-operative Society's Central Offices and Stores.

Bristol: Corporation. Construction of stores, showrooms and offices at electricity works.

Darlington: Borough Surveyor. Higher Elementary School.

Grantham: Scorer & Gamble, architects, Bank-street Chambers, Lincoln. New Drill Hall and alteration to Territorial Barracks.

Huddersfield: N. Culley, architect, 13, John William-street. Alterations and additions to Club.

Ilkeston: G. H. Widdows, county architect. Secondary School.

London: It is proposed to re-build the Middlesex Music Hall, Drury-lane, on present site and site of adjoining buildings.

Macclesfield: Clerk to Committee of Visitors, Macclesfield. Alterations to Parkside Asylum.

Maidenhead: Secretary to Education Committee, Reading. Additions to County Girls' School.

Maidstone: County Surveyor. Offices, workshops, stores, etc., at Council's Wharf.

Matlock: A Methodist Church is being erected at a cost of £3,000.

Matlock: Directors of Smedly's Hydropathic Co., Ltd. New wing.

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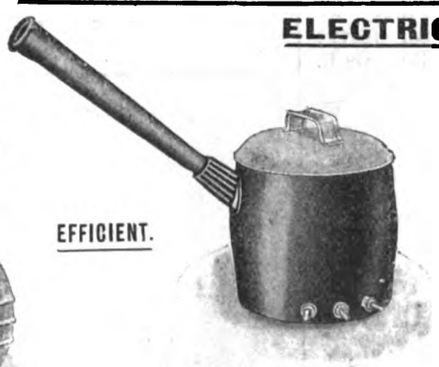

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G. H. RYAN, General Manager.

Newcastle-on-Tyne: City Engineer. Single stores shed 150. ft. long by 70 wide, and alterations to shed at Quayside extension.

Poplar and Stepney: W. R. Foskett, clerk to the Poplar and Stepney Asylum, Devon-road, Bromley-by-Bow. Nurses' Class Room and addition to Drug Store, etc., at Bromley Asylum.

St. Albans: Town Clerk. Carnegie Library.

West Bromwich: West & Kendrick, architects, High-street. New schools.

Wirrall: J. H. Davies & Sons, Newgate-street, Chester. New observation pavilion, and additions to administrative block, Wirral Joint Hospital.

STANDARD ELECTRICAL WORKS.

ELECTRICITY FOR PUBLIC SCHOOLS AND COLLEGES. By W. LARDEN, M.A. With 215 Illustrations, and a Series of Examination Questions; with Answers. Crown 8vo, 6s. [0127]

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GENERAL LECTURES ON ELECTRICAL ENGINEERING. By C. P. STEINMETZ, A.M., Ph.D., Consulting Engineer to the General Electric Co., Professor of Electrical Engineering in Union University. Compiled and edited by J. LE ROY HAYDEN. 290 pages. Demy 8vo, 8s. 6d. net. [3107]

HYDRO-ELECTRIC DEVELOPMENTS AND ENGINEERING. By FRANK KOESTER (New York). 21s. net [2699]

INSULATION OF ELECTRIC MACHINES. By H. W. TURNER, M.I.E.E., and H. M. HOBART, M.I.C.E., M.I.E.E. With 162 Illustrations. 10s. 6d. net. [1251]

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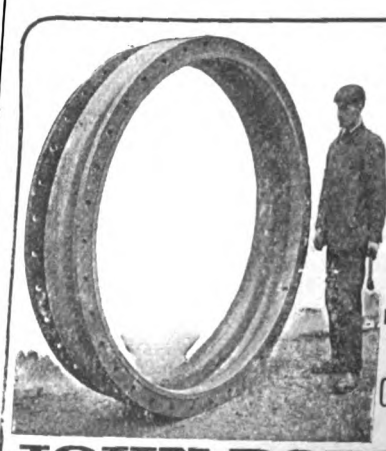

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MUNICIPAL ELECTRICAL ASSOCIATION.

(*continued from page* 806.)

that he noticed Mr. Ferranti was present, and the acceptance to-day of what Mr. Ferranti had advocated many years before showed the soundness of his deductions. He looked to the day when electricity would be so far reduced in price as to warrant its use for all industrial and domestic purposes of heating, lighting and cooking, but even already they had some of the largest industrial concerns in the city of Glasgow taking the whole of their power from the Corporation mains.

Mr. Lackie, in reply, tendered thanks to all who had helped to make the Association so successful in the work it had undertaken. He referred particularly to Mr. Alderman Pearson, Mr. Edgcome, and Mr. Proctor.

Mr. Ferranti was called on for a speech, but simply thanked them for calling upon him; and Sir John Ure Primrose for his reference to him.

Mr. Wilkinson, of Harrogate, proposed "Our Guests," and Professor Barr replied.

The annual business meeting of the members took place on Friday morning, Mr. Lackie being in the chair.

Office bearers for the coming year were elected as follows: President, Mr. John Christie, Chief Engineer of the Brighton Corporation Electricity Department; Senior Vice-President, Mr. G. Wilkinson, of Harrogate; Junior Vice-President, Mr. Shawfield, of Wolverhampton; Mr. Alderman Pearson was re-elected hon. solicitor, Mr. Edgcome, hon. treasurer, and Mr. Proctor, hon. secretary. Four engineer members of Council were elected, as follows: Mr. Chattock, of Birmingham, Mr. Seabrooke, of Marylebone, Mr. Watson, of Bury, and Mr. Rider, of London. For three Councillor seats on the Council there were elected: Councillor Bruce, of Sunderland, Councillor German, of Brighton, and Councillor West, of Cox.

Mr. Ruddle (Dublin) thereafter moved a resolution to the effect that those municipalities which had not powers to supply apparatus and do wiring in consumers premises should seek such powers, and that the Association should identify itself with whatever concerted effort was taken towards this end. The speaker said there were 40 or 50 municipalities who would like these powers, and if they could be got to co-operate in seeking them it would not mean much to each in the way of cost. If the Association were to be truly representative it should do all in its power to get the municipalities from whom its membership was drawn on the same footing in this respect.

Mr. Purse (Watford) said that electric lighting undertakings were promoted for the ratepayers and not for contractors, and therefore he supported the resolution.

Mr. Cramb (Croydon) said he would like the contractors to co-operate with the supply engineer, and to that end he had called a meeting of the contractors in his district on two occasions. Nothing came of it, however—there was so much jealousy among the contractors. If the contractor would assist the local authority to develop, there would be more business to go round. It was necessary for the supply authority to develop heating and cooking, if their business was to go on extending.

Alderman Pearson (Bristol) said that in connection with the Bill of 1909, the Association had got a clause inserted giving all municipalities the powers sought in the resolution, but when the Bill got to the House of Lords, Lord Avebury and two or three of his friends got three or four words introduced into the clause, viz., "through a contractor only," which if it had been allowed to pass would have left them worse than ever. As the Bill contained other important concessions, they thought it advisable to drop the clause altogether. They were, however, now absolutely free to provide a Bill embodying the terms of the resolution. The moral effect of an expression of opinion on the part of a large group of municipalities might result in the opposition of Lord Avebury and his friends being withdrawn. He had been driven from the idea that contractors were canvassed for the supply undertaking, and therefore should do all the wiring, etc; and he now believed it was necessary for municipalities to have parliamentary powers to supply fittings and apparatus and do wiring if the public supply of electricity was to continue to develop. If it was right for such a municipality as Bristol to have such powers, it was right for every other municipality in the United Kingdom. It was hopeless, however, to ask the Government to bring in another Bill at the present time. The last Bill was before the House of Commons 10 years. He urged that the municipalities who had the powers should back up the others who had not.

Mr. Bones (Hastings) said that many of them felt that, handicapped as they were without the powers referred, they were not in a position to fight the gas people. He believed that the undertakings concerned would back the Council of the I.M.E.A. in any Bill they might provide in this connection.

Mr. Edgcome (Kingston) said that while he sympathised with the smaller undertakings who sought these powers, the Association could not bear the expense of providing any Bill.

Mr. Clothier (St. Ann's) said there were municipalities who objected to electrical undertakings having such powers, and if the Association attempted to do anything in this connection they might withdraw from membership.

Mr. Proctor, (Bristol) said that the Grand Committee who had charge of the 1909 Bill were in entire sympathy with the terms covered by the resolution.

Mr. Pickvance (Wrexham) had failed to get help from the contractors, and his show room had done over £1,000 of business for three years in succession.

Mr. Lackie said he had no doubt the Glasgow Corporation would support any such Bill if it were promoted.

A delegate brought up the question of a central bureau to deal with enquiries addressed to engineers; but Mr. Edgcome explained that such a bureau was impracticable owing to the expense it would entail on the Association.

A proposal to enlarge the Council by including engineers of several of the smaller boroughs was discussed and dropped meantime.

A proposal to have special committees for dealing with particular subjects at Convention was left in the hands of the Council.

In reply to Mr. Turnbull, of Tynemouth, Alderman Pearson said that if application was made to the Board of Trade regarding giving of supply outside the area, the Board of Trade would, no doubt, meet them in the special circumstances mentioned, without it being necessary for to get the sanction of the local County Council.

Mr. Cramb (Croydon) asked the Association to support the Electricity Supply Joint Publicity Committee by appointing two provincial members from the Association to represent the provincial point of view.

This was agreed to, and Messrs. Christie (Brighton) and Ayton (Ipswich) were appointed to this Committee.

Councillor Bruce proposed a vote of thanks to Mr. Lackie for his conduct in the chair, to which Mr. Lackie suitably replied.

The afternoon was spent in a sail down the Clyde.

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Electrical Progress at Home & Abroad.

A Review by our Special Correspondents.

TYNESIDE.

NEWCASTLE-ON-TYNE.

The use of electricity is finding an increasing development in connection with systems of sewage disposal. An interesting example of this is found in connection with the sewage scheme of Bentley-with-Arksley, a newly established colliery village in Northumberland. Some difficulty was, I understand, at first experienced in the choice of a suitable system, but the necessity of avoiding any possible chance of epidemic has resulted in the establishment of a very complete electric pumping system, the pumps, motors, etc., being made by Messrs. Ernest Scott & Mountain, Ltd., of Gateshead, and capable of dealing with 500 gals. of sewage per minute. The current for the supply of the pumps is obtained from a colliery electric plant in the vicinity.

The Tyne as a Naval Repairing Base.

A further step in this important affair has now been taken by a decision to forward to the Admiralty an influential memorial urging the claims of the Tyne. For this purpose a meeting of the mayors of some of the Tyneside towns, the Town Clerk of Newcastle, the Secretary of the Newcastle and Gateshead Chamber of Commerce, and other gentlemen representing the commercial interests of this area, has been held at the offices of the Lord Mayor of Newcastle. This gentleman, Sir W. H. Stephenson, was then appointed to lay the matter, on national grounds, and as representing this area before Mr. McKenna, and he will be supported by a representative from the Chamber of Commerce together with the local members of Parliament. It is intimated in the local press that the deputation will be introduced by Lord Brassey, the President of the Chambers of Commerce of the United Kingdom.

Electricity in Ships.

With the revival of the shipbuilding industry there is a corresponding increase in the demand for electric equipments for ship lighting and power purposes. Numerous installations of this nature are in progress on Tyneside, and one of the more interesting instances is the steamer *Marengo*, which is being built by the Northumberland Shipbuilding Co., Ltd., of Howdon, to the order of Messrs. T. Wilson Sons & Co., Ltd., of Hull. This vessel, which is intended for the first class Atlantic passenger service, is fitted with every modern improvement, being constructed in modern fashion, being 425 ft. long and 52 ft. beam with three steel decks. The engine equipment is by Messrs. Palmers Shipbuilding & Iron Co., Ltd., of Jarrow, and the electric light installation is to be of a very complete character.

A New Type of Mine Haulage Gear.

Messrs. Ernest Scott & Moutnain, Ltd., of Gateshead, are now bringing out a new type of tandem main and tail portable haulage gear, which possesses several features of unusual interest. In general appearance the gear consists of two drums placed one in front of the other, the whole construction being so narrow that the haulage can easily be placed in the most restricted positions, such as in cross roads or gateways. Where required the haulage is fitted with trolley wheels, the gauge of which is adapted to suit the standard colliery gauge. The main frame is of light but strong construction, being made of two steel plates at the sides with cross plates at the end bolted up to tie the structure together. The frame is so constructed that all the shafts can, if necessary, be lifted out, and the gear appears to be a satisfactory solution of the difficult problem of providing a haulage gear of adequate power for a narrow roadway.

THE MIDLANDS.

BIRMINGHAM.

A party of members of the Birmingham and District Electric Club paid a visit on Monday to Rugby for the purpose of viewing the works of the Rugby Lamp Co. The company, which was formed in 1908 and commenced operations a year and a half ago, is engaged in the manufacture of carbon and tungsten filament bulb lamps. The party was received by Mr. J. Findlay, managing director, and under his guidance and that of two or three members of the staff, had an opportunity of inspecting the whole of the operations. The factory, constructed on a site which allows ample room for extension, is of two storeys and is continuously in full employment. On the upper floor, the visitors were shown the operation of "squirting" the tungsten filament, which appears first in the form of an oxide made up into a paste with a composition which is specially made by this firm and is entirely free from organic matter. They were shown how under a screw press the paste is squirted into a minute filament, which is caught on a sheet of cardboard placed underneath the die and moved about by means of a double trolley arrangement, so that the thread lies on the card in a curved pattern. The filaments are then collected in a "boat" and after being put through the furnace are subjected to a final sintering in hydrogen, by which any remaining impurities are burnt out.

The Making of the Lamp.

The party watched the succeeding operations, mostly performed by girls, witnessing the attachment of the filament to the glass support which sustains it inside the bulb; afterwards was viewed the fitting of this into the bulb, the filament being joined to the outside copper wire by a small piece of platinum. Nearly all the bulbs used by this firm are of English make, and are supplied by a firm in the Newcastle district, though some of a special type are made on the premises. One of the operations in which the visitors appeared to be most interested was that of the exhaustion of the bulbs, which are placed for this purpose in a gas-heated oven, the exhaustion being performed by a rotary mercury pump. This gives the nearest possible thing to an absolute vacuum, a McLeod's gauge of special construction showing that the exhaustion reaches a point somewhat better than is represented by ·00024 mm. of mercury. After the exhaustion, the bulbs are submitted to a sparking coil test, and those which pass this are submitted to a photometric test for classification as to candle-power and current consumption. The manufacture of carbon lamps, which is carried out on standard lines, with special precautions to secure long life and the best efficiency, was also viewed.

Uniformity of Filaments.

The tungsten filament in use is less than 1,1000th of an inch in diameter, and special care is taken to secure uniformity: this is done by a weight test. Each filament is weighed by an exceedingly delicate machine, a moving coil voltmeter, made by Messrs. Everett, Edgecumbe & Co., and all those which come within a very minute approximation of the same weight are placed in sets together. After seeing all these processes, the party viewed the generating plant on the ground floor. The dynamos are driven by a high-speed gas engine, and there is also a fine storage battery in an adjoining shed used for photometer work. The expeditious arrangement for washing the bulbs when they come in from the glass works was greatly admired. The hydrogen gas used in the factory is also produced in this part of the works. The firm, although it has been at work only a year and a half, has developed a large trade in South America, Canada, Australia, New Zealand, the Philippines, and China, as well as at home, where it has an excellent connection among large industrial

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establishments, and some of the largest steamship lines. For the last named kind of business, it has specialised to a considerable extent. At the conclusion of the visit, Mr. Donovan (President of the Club), proposed, and Mr. Foster seconded, a vote of thanks to the Company, and to Mr. Findlay for the privileges which the visitors had been accorded, special stress being laid upon the freedom allowed to see everything and the fulness of the explanations given. Mr. Findlay, in reply, said that having invited the members of the Club to come all the way from Birmingham, he felt that it was his duty, as it had been his pleasure, to give them every information in his power.

LANCASHIRE.

MANCHESTER.

The past week has been very quiet here as far as electrical matters are concerned, but this time it is the quietness of unobstructed growth, not of slow decay. One of two of the local firms are now talking cheerfully of being full up to Christmas. The joint Tramways and Electricity Board of Stalybridge, Hyde, Mossley, and Dukinfield have issued their report up to March last. The tramways are not yet, of course, working at a profit, but it is interesting to note that this year the deficit is only £6,448 against £9,518 last year, which was about the average figure for the previous years from 1904 when the service was first started. The total capital expenditure to date on the tramway undertaking is £279,474. Traffic expenses per car mile (average) are 2·682d., of which 1·852d. is wages of drivers and guards. General expenses are ·688d., repairs and maintenance ·711d., power 1·286d., making total working expenses average 5·367d. per car mile. The receipts from passengers average 6·976d., while the parcels carrying earn ·052d. per car mile; advertising on the cars brings in ·024d., making total earnings per car mile 7·052d., as against last year's figure of 7·286d. This decrease in the earnings is not so much as might have been expected, considering that the district served depends very largely upon the cotton trade for its money. It is satisfactory to note, however, that the percentage of working expenses to receipts has decreased from 83·54% to 76·38%; part of this reduction is due to lower price for current and part to various economies in working. At present there are about 28 miles of single track in operation, and about 3¼ miles more has been authorised, but is not yet constructed. Over 10,000,000 passengers are carried annually, and last year the average receipts per passenger was ·893d. against ·889d. the previous year.

The Electricity Department.

The Stalybridge district is famous for cheap electric power, and it can point to many thousand horse-power on its mains in textile machinery. The electricity department is now very nearly making both ends meet, and but for the unfortunate collapse in the cotton trade during the past two years would very probably have been making profits a year ago. This year the deficit is £469, against £537 last year. This must be compared with figures such as £5,466 for the year 1906–7. The total capital expenditure to date is £235,468. Some of the costs are interesting. Fuel costs on the average ·173d. per unit, and the total station costs are ·228d., or with all distribution costs and management expenses ·333d. per unit. Capital charges come to ·274d. per unit. The average revenue for private supply is ·546d.; for public lighting (which this year appears for the first time in the electricity accounts) 1·000d.; for tramway purposes ·825d. (against 1·000d. last year). The average on the total supply is only ·593d. against ·674d. last year.

GERMANY.

BERLIN.

Dr. Wasmus, of Hamburg, in a long article in the *Elektrotechnische Zeitschrift*, of June 2, on the medical side of electricity, calls attention to a new form of apparatus which combines two important curative principles, viz., the use of the Röntgen rays and of diathermancy. Both are utilised in the apparatus by means of high-frequency currents.

Electric Heating.

The following interesting table appears in *Alektrische Kraftbetriebs und Bahnen*:

Use of the heat.	Watt hours required.	Cost at 1d. per kw. hour.
Boiling 1·75 pints of water	112	
Cooking 1·75 pints of soup	64	
Cooking 2 lbs. of fish	250	
Cooking 3·3 lbs. of beef	320	Obtained in
Baking 1·3 lbs. of potatoes	150	pence by
Cooking one head of cauliflower ..	350	dividing the
Roasting four chops	100	numbers in
Cooking 2·2 lbs. of roast veal and sauce	800	the second column by
Cooking 3·3 lbs. of roast pork and sauce	900	1,000.
Boiling six eggs	36 to 60	
One hour's uninterrupted ironing	360	
Lighting 100 cigars a day for a year	7,300	

Ship Wireless.

In a lecture recently delivered at the Hamburg Navigation School, Dr. Bredow called attention to the advantages of the system of "singing sparks." Hitherto it has not been possible to convert more than 20% at most of the electric energy employed into ethereal vibrations carrying a message. The new method enables from 70 to 75% of the energy to be so employed. Thus, for example, whereas Marconi could barely bridge a distance of 2,500 miles with 500 h.p., the Telefunken station at Nauen, by using the new system, can do it with 100 h.p. It is obvious how important this is in communicating with ships at sea. Ship stations formerly required an average of 3 kw., of which, say, 2½ kw. was wasted. They can now restrict themselves to 2 kw. and get three times the useful output. The result is evidently an enormous increase in the range, which under normal conditions never exceeded 400 miles at the outside. It is the new system which has enabled the vast distances, already noted in these columns, to be negotiated, not only between moving ships and fixed land stations, but between moving ship and moving ship.

Balloons and Wireless.

Active experiments are being made at the Vienna arsenal on the feasibility of fitting up dirigible balloons with wireless telegraphy. It is necessary to combine small weight and a wide range in the apparatus so that it may be carried without serious interference with the mobility of the balloon. A few days ago some important experiments were made with a captive spherical balloon. It appears that Lieutenant Franz Budda has designed a system almost ideally perfect, the apparatus being so small as not to offer any sensible resistance to the air or to overweight the balloon. The results were highly satisfactory in spite of unfavourable weather.

Company Amalgamation.

The Vereinigte Elektrozitatsgesellschaft Wien has made an agreement with the Schweizer Gesellschaft Brown, Boveri & Co., of Baden, and also with the Niederosterreichische Eskompte Gesellschaft, the result of which has been the formation in Vienna of a company called the Oestterische Brown Boveri Werke. The initial capital is 4½ million k. Of this the Vereinitge Co. subscribed two million, and the other two parties the balance. On July 1, 1910, the new company will take over the factory and stock of the Vereinigte Co., and carry on work there in a style befitting the reputation of the Swiss house. The Vereinigte Co., which possesses most of the shares of the Vereinigte Gluhlampen and Elektrizitatsaktiengesellschaft of Ujpest, and of the Vereinigte Elektrizitats and Maschinenfabriksaktiengesellschaft in Budapest, will combine them with the shares of the Oesterreichische Brown Boveri Werke, and be in future a Gesellschaft fur Elektrische Unternehmungen after the pattern of the German and Swiss trust companies. The bye-laws of the Vereinigte Co. will be correspondingly altered, and capital will be raised to obtain factories and plant.

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UNITED STATES.

NEW YORK.

The outstanding feature of the Electric Light Convention at St. Louis, which formed the subject of comment in these Notes last week, was undoubtedly the address delivered by Mr. Samuel Insull, the well-known President of the Commonwealth Edison Company of Chicago. The subject of his paper was, "Twenty-five years of Central Station Commercial Development," and although its basis was the work accomplished in this country, the lessons deduced from the experiences summarised have a live interest for Central Station men the world over. Early in his address Mr. Insull recalled a paper which was read thirteen years ago by Mr. T. Commerford Martin, in which he declared that the central station industry had been in some respects a disappointment in that after nearly twenty years of work the companies restricted themselves injuriously, by remaining mere lighting companies, and he asked the question what would become of the central station companies if a new lighting medium came into vogue and we were deprived of our illuminating business entirely. Mr. Insull observed that it was not until the nineties that central station men began to get a real grip on the potentialities of this work, and to appreciate the fact that if they desired to place the business on the basis of a general public necessity, they must rearrange rates on such a plan as would give the long-time consumer, the man who used the central station company's investment most steadily during the year, the lowest possible price; and the recognition of the necessity of meeting this condition, said Mr. Insull, may possibly have had as much to do with reducing operating costs, interest and depreciation, as have the wonderful work of the inventors and the marvellous skill of the engineers. The enormously rapid growth of the central station properties, large and small, of this country, largely results from liberal methods of dealing with consumers—of an appreciation of the proper method of selling. Mr. Insull considers that the younger men should bestow upon the commercial side of the business as much, if not more, thought than upon the technical and construction side of the central station. While it is comparatively easy to obtain first-class operating men, and not a matter of great difficulty to obtain engineers to design and build central station plants and systems, it is a problem to obtain technical men who have made a thorough study of commercial conditions, with a view to taking part in the commercial development of the business. He considered it to be desirable for the technical schools to give greater prominence to the commercial side of the central station business, and when qualifying their students in electrical and mechanical engineering, to teach them also to operate.

Relation to Communities.

Mr. Insull referred in detail to central station possibilities in the United States and then in a noteworthy passage dealt with the relation of central station businesses to the community in which they operate. The business, he said, in which we are engaged can be most successfully operated as a monopoly business. If the communities which we serve are to get electric energy at the lowest possible cost, they can only expect to achieve this by preventing duplication of investment and by concentrating production under one organisation. The fact that low prices cannot be permanently obtained by the old method of encouraging competition is being very generally recognised to-day, and as this becomes more and more recognised the regulation of our business, our methods of conducting it, our methods of financing will be subject more and more to governmental supervision in some form or another. This demand for supervision, while it certainly is a trend of the times, is also an appreciation on the part of the people of this country that the destructive effect of competition in public service business ultimately means greater burdens on the community through the maintenance of high rates to give a return on the excessive capital tied up as a result of duplication of plant. Fortunately for us, living as we do in a country having had tremendous development and capable of almost unlimited development in the future, this policy of competitive regulation has had a limited effect only, as the growth in the communities in which we operate and the fact that our business has by no means reached a point of saturation in the large and small cities of the country, has enabled us from increased business to absorb and bring into active use a great deal of the capital which during the period of competition seemed to be an unnecessary waste.

Competition and Fair Dealing.

Dealing with the question of competition, Mr. Insull said it should be borne in mind that the more closely our business is supervised and regulated the greater are the chances of our being protected against ruinous competition, which to-day is mainly instigated by those who desire to take this means of acquiring our existing business. Whilst we may not care to be hampered by the rules and regulations established by commissions created to watch over our operation, the further these commissions go into our business the more will they be convinced that the best results can be obtained only by regulated monopoly, and that competition is alike as ruinous in the long run to our customers as it is to the central station company itself The result will be that our monopoly of the business will be secured, our securities will stand in higher credit and new capital will come flowing into our coffers for the extension of our business. "There is another phase of our relations with the community," continued Mr. Insull, "which all of us should do our best to foster. I refer to a friendly feeling of relationship between the public service corporation and its customers. I think that it is possible for a central station manager, by liberal methods of dealing with his customers and by absolute fairness whenever there is a matter in dispute, to encourage a feeling of friendliness towards the corporation which will build up a valuable asset in the shape of good will. Unfortunately in the last few years there have been a number of people engaged in arousing a spirit of hostility to the corporate interests of the country. I do not refer alone to corporate interests running natural or artificial monopolies, as this agitation has been directed as much against the mercantile business run on a large scale in the form of a corporation as against the public utility corporations, whether they be municipal, state or inter-state. A great many of the people engaged in this class of agitation have done it to serve their own particular ends; others, high-minded and honest citizens, have thought that the interests of the state were menaced by corporate monopolies and that only by agitation could these interests be preserved. But no little damage has been done to the corporate interests of this country by the action of some officials of corporations, who seem to have had more concern for the profit of the moment and little or no concern for the permanency of their investment in the future. We central station managers ought to look upon ourselves as semi-public officials and so conduct our affairs with the community as to give us the advantage of a reputation for absolutely fair and impartial dealing. We should preach the same doctrine to our subordinates and insist upon the same policy being carried out in their dealings with the public. If such a course is pursued we will not only be helping to improve the opinion of the community of corporations generally, but will be establishing our own business on so firm a basis as to add to the permanency of our investment and give promise of prosperity in the future."

Power Transmission Problems.

During the later days of the St. Louis Session, a number of interesting papers were read. Among these was one by Mr. H. W. Buck on "Power Transmission," in the course of which the author observed that the evolution of long-distance transmission has been so rapid that a number of difficulties have been encountered that have not yet been satisfactorily solved. The use of steel towers is rapidly extending, as they permit longer spans and therefore a reduction in the number of towers and a diminution of insulator troubles; but Mr. Buck pointed out that if the steel legs of a tower are installed directly in the ground, it is questionable whether their life will be longer than that of a wooden pole. Therefore, concrete foundations are advisable where the importance of this line warrants the extra expenditure. The economical length of span ranges from a minimum of 300 ft. to a maximum of 750 ft., depending on a variety of conditions. With increase of length

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of span has come greater sag and to avoid this has necessitated much greater care in putting up the lines. The increased mechanical stress on the cables has introduced new mechanical problems in insulator and cross-arm designs. Up to 60,000 volts the standard type of pin insulator gives satisfactory results. The cost of this type of insulator increases as the cube of increase in voltage above 60,000. The suspension type of insulator is practically standard for voltages above this. With the suspension insulator, however, said Mr. Buck, the installation of the conductors is more difficult. "At about every mile and at angles deadened insulators should be used to which the line is firmly tied. At intermediate towers a flexible clamping is desirable. The recent 100,000 volt lines have been more free from insulator troubles than the early 20,000 volt lines. It is probable that 100,000 to 110,000 volts is as high as is justified on a large commercial scale at the present time, as line voltage in excess of this calls for extraordinary expenditures. The regulation of these high-voltage lines has not been very satisfactory. It seems that the installation of shunt inductances along the line may be necessary to neutralise the capacity. The electrolytic lightning arrestor has shown its ability to handle voltage surges but is not capable of dealing with persistent dynamic current at excess voltage. Lightning troubles on transmission lines have become less serious. The overhead ground wire has proved effective as a preventive measure." Mr. Buck concluded with a prediction that the development of high-tension direct-current transmission will open a wide field of possibilities.

The Electric Vehicle Opportunity.

Many interesting points with regard to electric vehicles were touched upon in a paper read by Mr. Hayden Eames, who pointed out the wonderful possibilities of the electric vehicle for central stations, showing that in the city of New York if only one-half of the horse-drawn vehicles were substituted for electrics, the income from the current at four cents per kw.-hour would amount to $52,000,000 per year. The electric vehicle business had, he said, inherited a great many things from other businesses that are more or less analogous to it, but which are, by no means, exactly similar. The consequence is, if you act on impressions, you may get momentary advantage at the expense of ultimate success. During the fifteen years that the manufacturers have been engaged in pushing that business, they have had occasion to know what the real problem is. The assertion that business wagons have not improved in an engineering way in the last ten or fifteen years would not be true. They have improved, but the point that impresses one upon an investigation of the history of their improvement is that as long ago as ten years the power electric wagon had already reached the degree of economy that made it more economical than horses for all service within certain limits. "It is because the people have failed to take the next step that it has been kept back all these years and is still keeping it back. That seems to be the question that people not having anything to do with the electric vehicle do not seem to comprehend."

Educating the Public.

Mr. Eames spoke at some length on the extreme measures necessary to educate the public in the use of electric vehicles and said that the bulk of this work would necessarily fall upon the central station. He also spoke at some length regarding wagon ratings. When central station organisations have informed themselves on these questions, have recognised their great importance, and have made it their business to see that the first local power wagon shall be carefully bought and intelligently used, they will have made a long stride toward getting the benefit of this new market for current. These things are intangible, but, after all, the whole thing is mental, and these are mental problems, the solution of which will produce an immediate and tremendous demand for current for power wagons. To make this education effective, to be in a strong position to regulate local introduction, to see that a proper application of vehicles is made, to see that, for instance, electric wagons are not used where gasolene wagons would give better satisfaction, and *vice versa*, it was essential that central stations maintain a judicial position. "Under existing conditions," said Mr. Eames, "the most healthy and most promising line of action for central stations will be to establish themselves as sources of information and to use the moral influence this will create to insure for their localities the full benefit of the efforts of all competitive electric wagon manufacturers," a point which was pushed home by Mr. P. D. Wagner, of the General Vehicle Company, who said that one reason why the electric vehicle has not had the support of the central station was because after he had made his purchase, the customer was left to work out his own salvation.

Rotary Hysteresis.

A noteworthy paper on magnetic hysteresis in a rotating field is contributed to the current number of the *Electrical Review* of Chicago by Mr. M. G. Lloyd, who lucidly summarises recent investigations in this subject. Steinmetz, he points out, established the approximate empirical relation that the energy expended per cycle is determined by the maximum flux density of the cycle followed and is proportional to this flux density raised to the $\frac{1}{6}$th power; and since it is also proportional to the volume, he expressed the power by the equation

$$W = z\,n\,V\,B^{1\cdot6}$$

where V is the volume, B is the maximum flux density and W the power transformed when the frequency is n cycles per second. Z is a constant depending upon the material used. This formula, says Mr. Lloyd, holds fairly well for iron and steel through the range of flux density used mostly in industrial applications, and has proved very useful in practice, but it is not to be regarded as expressing a natural law, as it does not hold for very high or low flux densities, and the exponent is seldom exactly $\frac{1}{6}$ even in moderate fields, but varies for different specimens. Referring to Weiss and Planer's experiments, in which the specimens were in the form of discs, which, when placed horizontally were subjected to a rotating field, he says that when they were placed vertically the effect was the same as an alternating field, and they found, after observations upon steel, iron, nickel and pyrrhotile, that for low fields the hysteresis was greater in the rotary field than in the alternating, but after passing a maximum the hysteresis in the rotating field finally decreased to zero, as the material reached saturation. The ratio of rotary to alternating hysteresis was found to be largest for the weakest fields, and had a value of 3·6 for nickel. This ratio decreased continuously, as the field was increased, except in the case of steel, where it at first increased and then decreased. During the past year, says Mr. Lloyd, two researches have appeared showing the variation of rotary hysteresis with temperature. Fluller and Grace used two-phase alternating current to produce the rotary field, while Perrier used apparatus similar to that of Weiss and Planer at Zürich. Both used electric heating coils to obtain the higher temperatures. Both sets of experiments show that the maximum hysteresis in the rotary field decreases with increasing temperature, and that this maximum is reached with a lower flux density. Thus for iron at 580° this maximum occurs at 10,500 gausses, while at temperatures below 340° it occurs at about 16,000 gausses. Since the saturation value is also reduced by increasing the temperature, it was to be expected that the hysteresis would decrease to zero for a lower magnetisation, and this was found to be the case.

Hemit for Insulation.

The Hemming Manufacturing Company, of Rector-street, New York, has just completed and equipped a plant for the manufacture of the new insulating material known as Hemit, a new composition moulded under pressure into the various forms required for every kind of electric insulation. It is claimed for Hemit that while it is not brittle, it is very hard, will take a high polish, and has great tensile strength. It is also claimed that it is both fireproof and waterproof. The manufacturers claim that all electrical insulators or insulated parts of electrical machines or apparatus may be advantageously made of Hemit. Among some of the more important uses the following may be mentioned: switch handles, switch bases, controller parts, field magnet spools, commutator rings, brush holders, telephone receivers, arc shields, sleeves, trolley insulators, telegraph insulators, high-tension insulators, snap-switch parts, push buttons, contact slugs, telephone mountings, etc.

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Electrical Definitions.

The eternal question of terminology was again brought up at the St. Louis convention in the shape of the report of the committee which has been specially formed to frame definitions for general discussion and possible adoption. Dr. C. P. Steinmetz explained that the committee had experienced difficulty in deciding what terms should be standardised, and those offered in the report were brought forward tentatively with the hope that the members would express their thoughts as to the words to be selected for standardisation or definition. Among the terms brought forward by the committee were the following. Block rate—A method of charging for electric service at different successive rates per kw.-hour consumed, each successive rate applying only to a corresponding successive block or quantity of the total current purchased during the period covered. Corrective motor—A synchronous motor running either idle or under load, whose field may be varied so as to modify the power of the circuit to which it is connected, or through such modification also influence the voltage of the circuit. Dispersion factor—The factor applied to light intensity after dispersion, which gives the intensity if the dispersion agent were removed. High frequency—A frequency so high that the Ohm's law does not apply even approximately. Intensified arc lamp—An arc lamp with one of the carbons of small diameter to give a large current density per unit of arc, on which the arc plays thereby to intensify the light. Operating time factor—The ratio of the number of hours of operation to the number of hours in the interval considered. Operating time load factor—The load factor considered only during the time of operation. Step rate—A method of charging for electric service at definite specified rates per kw.-hour consumed. A number of "factors" are defined as follows: Capacity factor—The ratio of the average station output to the maximum capacity of the station in kilowatts. Demand factor—The maximum connected kilowatts of capacity divided by the actual kilowatts of demand. Diversity factor—The relation between the simultaneous demand of all individual consumers and the sum of the maximum demand made by these consumers. Effective load factor—The main load of a part of the system determined by the load at the time of the system's maximum. Load factor—The average load over any given period divided by the highest average load for any one minute during the same period. Simultaneous demand factor—The ratio of the simultaneous demand and the connected load.

Current Items.

The Hydraulic Power Company of Niagara Falls has filed with the Secretary of State a certificate of increase of capital stock from $500,000 to $12,000,000. The stockholders of the company include Arthur Schoellkopf, Jacob E. Schoellkopf, George W. Olmsted, George B. Mathews, Paul A. Schoellkopf, C. P. Hugo Schoellkopf and Hans S. Schmidt.

The American Union Telephone Company has gone into the hands of receivers as the result of the proceedings instituted last week against the Continental Telephone & Telegraph Company, of which the American Union Company is a subsidiary concern. In the application for the receivers it is claimed that the Continental company has been manipulating the American Union company to the advantage of the stockholders of the Continental company, and that it is unable to meet certain obligations.

One of the largest hydro-electric developments in California has just become public with the awarding of a contract to Allis-Chalmers Company by the Northern California Power Company for the initial installation of machinery. The contract calls for all the machinery and accessories and will include the following: Three 7,000 h.p. 450 r.p.m. single horizontal turbines with cast iron spiral casings. The runners are 50 in. in diameter and the gate valves 42 in. in diameter. These turbines are each connected to a 5,000 kilovolt ampere, 6,600 volt, 60 cylce, three-phase alternator. Excitation current will be supplied by either of two 220 kw., 120 volt generators direct connected to 350 h.p. 525 r.p.m. single impulse turbines controlled by type "O" governors. The turbine will operate under a head of 450 ft.

LEGAL.

Electric Fittings and Municipalities.

In the Chancery Division, Mr. Justice Neville delivered judgment in the case of the Attorney-General *v.* The Mayor and Corporation of Leicester.

The action was brought by the Attorney-General at the relation of a ratepayer of Leicester, to restrain the Leicester Corporation from carrying on what was called the business of electrical contractors. The Corporation claimed the right not only to supply electrical energy, but also to do the wiring for their consumers and supply them with fittings, etc.

His Lordship held that the Electric Lighting Act of 1882 drew a clear distinction between supply and consumption, and that the powers of the Corporation only referred to supply. The wiring and fitting on consumers' premises, if "incidental," were "incidental" and necessary to use only and not to supply. In his opinion supply by the Corporation was to be completed at the consumers' terminals, and the wiring and fittings were a wholly distinct and separate business. The Corporation had misconceived their powers and had carried on business in excess of them.

The injunction asked for was granted with costs, but was suspended in view of an appeal being lodged.

COAL CUTTERS.

A visit was paid on Monday to the works of the Electric Construction Co., Bushbury, Wolverhampton, by a number of the members of the Birmingham Section of the Institute of Mining Electrical Engineers. The visitors were received by Mr. Bulloch (manager) and were afforded an opportunity of seeing the whole of the works. Among the matters which they found of particular interest were two new coal-cutting machines and various examples of switch work specially designed for mining requirements. The visit, in this respect, had an exceptional interest, owing to the fact that the subject of switchgear was recently discussed by the section, the discussion having been opened by a paper by the President of the Section (Mr. A. Hall). Light refreshments were provided for the visitors, on whose behalf Mr. Hall and others returned thanks to the company and to Mr. Bulloch.

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ELECTRICAL ENGINEER, 148, Fleet Street, London, E.C.

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Business Notes and News.

LIGHTING AND GENERAL—Home.

BARROW.—During the year ending March 31, the Corporation electricity works sold about a million units. The revenue was £13,200, an advance of £364, and the expenses £5,800, a decrease of £404. The gross profit was £730, and the net £249.

BELFAST.—The new wing of the Municipal Technical Institute is about to be wired for electric lighting.

DUBLIN.—The Corporation are about to lay electric mains along Usher's Quay and Usher's Island.

GREENOCK.—The G.P.O. have laid a new cable across the Clyde from Battery Point, Renfrewshire, to Kilcreggan.

LEEDS.—A most satisfactory increase in the use of electricity both for lighting and power purposes has marked the fiscal year of the Corporation electricity works. There was, however, a fall in the total receipts of over £5,000, down to £99,081, but this was counterbalanced by a reduction in expenditure of £5,762, so that the surplus amounted to £8,930 as compared to £8,248 in the previous year. This was paid over in relief of rates. The total amount so contributed up-to-date is £54,797.

LEEK.—A proposal is on foot to raise the price of electricity for lighting purposes. The Town Council sanctioned an extension of mains in Water-street at an expenditure of £28.

LLANDUDNO.—The Town Council are removing the incandescent gas lamps on the Parade, and will experiment with ordinary electric arc and yellow flame lamps.

LONDON: ST. PANCRAS.—For the quarter ending March 31, the Borough electricity works received £23,147 for the sale of current, 2,400,000 units, which compares with £23,291 last year for 2,398,000 units. The expenditure at works was £1,597, and last year £1,615. It has been decided to carry out extensions of mains in Weedington-road and Harwood, Calvert, Stanhope and Drummond-streets, at a cost of £227.

MANCHESTER.—Two 125 k.v.a. three-phase transformers and high and low tension switchgear are about to be laid down at the Corporation electricity works.

MIDDLESBROUGH.—A reduction in price of current, involving a diminution of about £300 in the income, is to be made to theatres, music halls and other large consumers.

PEMBROKE, DUBLIN.—A Local Government Board inquiry has been held into an application to borrow £8,000 for electric light extensions.

PRESTWICK.—As our readers know, a scheme for the extension of the Ayr Corporation electricity works area of supply to include Prestwick and Alloway has been under consideration for some time. The engineer estimated that an extension to Prestwick would cost £5,000. At a meeting of Ayr Town Council he reported that he had issued 273 post cards to the principal residents there to ascertain whether there was any general desire for the electric light in Prestwick. In answer he received 57 cards stating that the matter would be favourably considered, and seven from persons who were unfavourable. In the circumstances, the Council decided not to proceed further in the matter.

SEAHAM HARBOUR.—The street lighting is to be improved by addition of lamps, and the Lighting Committee is now in communication with the County of Durham Electric Power Supply Co.

SHIREBROOK.—The Shirebrook Colliery Co., who provide the parish street lighting, have offered to overhaul the lamps and bring them nearer to the footpath, on the condition that the yearly payment is raised from 35s. to 40s. per lamp.

STOCKTON-ON-TEES.—The revenue of the Electricity Department for the year ended March 31, was £8,130 (of which £7,835 was for sale of current), and the expenditure was £4,219; of this, interest, sinking fund and reserve account absorbed £3,911.

WEST BROMWICH.—The revenue of the Corporation electricity department for the year ending March 31 was £13,250, of which £3,661 was from private lighting, £6,979 from power, £5,317 from tramways, and £521 from the hiring department. The expenditure was £6,902. The net profit was £1,756, the hiring department showing a loss of £68.

YARMOUTH.—In the balance sheet of the Municipal electricity works for the year a gross trading profit of £9,086 19s. 3d. was shown. Special works of a permanent character, and depreciation on works for which no sinking fund is established, absorbed £948 3s 3d., leaving £8,138 15s. 7d. available for interest and capital charges, etc., as compared with £7,597 9s. 9d. for the previous year. The net balance, after making every provision for capital charges, interest, rebates, and depreciation, is £879 15s. The committee resolved that £600 be transferred to the general reserve fund.

LIGHTING AND GENERAL—Overseas.

BOLIVIA.—In the Bolivian Budget for 1910, in which appear (*inter alia*) the following items of expenditure: 89,000 bols. (boliviano equals about 1s. 6d.) for the construction of new telegraph lines; 50,000 bols. for the reconstruction of existing telegraph lines and the purchase of conductors. A copy of the Budget, containing further particulars, may be seen by British firms at the Commercial Intelligence Branch of the Board of Trade, 73, Basinghall-street, London, E.C.

HAMILTON, ONTARIO.—A Canadian correspondent writes that the Oliver Chilled Plough Co., of South Band, Indiana, U.S.A., is about to put up a branch factory here. It will employ 2,000 hands, will cost about £300,000 to erect, and will be run by electricity supplied by the Dominion Power and Transmission Co.

TRACTION—Home.

LONDON.—The County Council estimates for the Tramway Department during 1910-11 show a surplus on working of the electric tramways of over £934,000, less a loss of £22,100 on the horse lines, leaving a gross profit of £912,000. Out of this, rents, interest, debt charges, etc., have to be taken. The net profit is estimated at £244,132, of which £125,980 will go to the renewals fund and £118,140 to the general reserve fund. The Council propose to apply to Parliament next year for powers to construct the following tramways in Hampstead, viz.: (1) Marble Arch to Cricklewood; (2) Chalk Farm to Child's Hill; (3) Maida Vale to Upper Avenue-road; (4) Marylebone-road to Swiss Cottage; and (5) Tramway terminus at Hampstead Heath to Rosslyn-hill (*via* Keats-grove and Downshire-hill).

NORTHAMPTON.—The Town Council have decided to promote a Bill in the next session of Parliament, for powers to extend the system of electric tramways from All Saints' Church, in the centre of the town, to Far Cotton. The line will be one mile and 190 yards in length, and the total cost, including the purchase of four new cars, and the rebuilding of South Bridge over the Nene, is estimated at about £16,000.

WOLVERHAMPTON.—Mr. W. A. Luntley, general manager of the Corporation Tramways, has issued his annual report. This system is operated on the Lorrain surface contact system. The Lorrain track equipment maintenance cost £755 (as against £417 for the year 1909), and for car maintenance £807 (as against £559 for the year 1909). However, the gross profits were £17,915, and the net surplus £5,667.

TRACTION—Overseas.

BARCELONA.—Application has been made by the firm of Boursier y Escartefigue for a concession for the construction and working of an electric tramway in Barcelona, from Casa Gomis to Vallvidrera.

EGYPT, HELIOPOLIS.—The electric railway lines between Heliopolis and Pont Limoun has been officially opened.

MADRID.—The Sociedad Tranvia del Este has been granted a concession for the construction and working of an electric tramway in Madrid, from the Calle de Alcalá to the Calle de Diego de León.

TORONTO.—It is rumoured that the Canadian Pacific Railway intend to electrify their terminals.

VANCOUVER, BRITISH COLUMBIA.—Mr. M. P. Cotton, who secured the contract for grading the new line of the British Columbia Electric Railway Co. through the municipality of Burnaby, has put men to work near Burnaby lake. It is his intention to work both ways from his starting point. He will grade about seven miles in all, and his contract calls for the completion of the work by October 1. It is expected that the line will be completed and in operation by the end of the year.

COMPANIES' MEETINGS AND REPORTS.

NATIONAL ELECTRIC CONSTRUCTION.

Mr. L. B. Schlesinger, presiding, said that the depression in the electrical industry had been acute, and finance in connection with it had been practically impossible. They had been negotiating for a foreign contract for over a year, and their prospects of eventually securing it were, he considered, excellent. They were engaged on the finance of a light railway scheme in England, and the progress so far made encouraged the feeling that they would be successful in completing it. With regard to the accounts,

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the profit on contracts completed and in progress showed a large decrease—from £24,016 to £6,957—which was due to the fact that during the past year there had been practically no tramway construction work in this country. The profit for the year was £1,868, and, with the balance from last account, gave a total of £11,830, of which £5,208 was devoted to reserves, depreciation, etc., and £6,321 carried forward, as compared with £9,661 last year.

ARON ELECTRICITY METER.

The report to be submitted to the thirteenth ordinary general meeting of shareholders to be held to-day, Friday, at 2.30 p.m., states that for the year ending March 31, 1910, the profit and loss account for the year, after providing for general charges and depreciation, shows a net profit of £21,117 17s. 3d., making, with the balance of £6,549 8s. 1d. carried forward from last year, a total available profit of £27,667 5s. 4d. Out of this amount the directors distributed in December last a dividend of 3% on the Preference shares, absorbing £3,746 17s. 6d.; leaving to be disposed of the sum of £23,920 7s. 10d. The directors recommend the payment of a further 9% on the Preference shares, representing 3% the remainder of arrears and the full 6% dividend for the past financial year, amounting altogether to £11,240 12s. 10d.; and a transfer to reserve towards goodwill and patents of £6,000 (making this reserve £25,000), total £20,987 10s. 4d; leaving a balance of £6,679 15s. Out of this amount it is proposed to appropriate £1,326 3s. 10d. to pay off the arrears of management commission and directors' fees, held in suspense pending the payment of arrears of Preference dividend, and to carry forward to next year's account the balance of £5,353 11s. 2d. By the distribution of this year's profits as proposed above, the Preference shareholders will have received, apart from their yearly dividend, the residue of the arrears due to them. The Board hope that the Ordinary shareholders may in the near future participate in the distribution of dividends. The past year's trading has been, in the opinion of the directors, most satisfactory, the sales having exceeded those of any previous year. The increased demand for the company's products has employed the factories to the full. The taximeter business is progressing satisfactorily in England, Belgium and Austria, though it has not yet contributed to the profits of the company. Two directors, Mr. H. Hirst and Sir James Pender, Bart., retire from office at this meeting, and being eligible, offer themselves for re-election.

FINANCIAL NOTES.

WESTERN TELEGRAPH.—The directors of the Western Telegraph Co. have declared a third quarterly interim dividend of 3s. per share, free of income-tax, for the year ending 30th inst., being at the rate of 6% per annum.

* * *

SAO PAULO TRAMWAY LIGHT & POWER.—The British Empire Trust Co. notifies that the Sao Paulo Tramway Light & Power Co., Ltd., has declared a quarterly dividend of 2½% on the capital stock.

* * *

MARCONI'S WIRELESS TELEGRAPH CO.—The directors recommend a dividend of 7% upon the Cumulative Participating Preference shares to June 30, 1909.

* * *

WINNIPEG ELECTRIC RAILWAY.—The directors of the Winnipeg Electric Railway Co. have declared a dividend at the rate of 10% per annum for the quarter to June 30 on the Capital stock.

* * *

NOTTING-HILL ELECTRIC LIGHTING.—The directors announce a dividend of 3% and bonus of 1½% on the Ordinary Preferred shares.

ANGLO-ARGENTINE TRAMWAYS.—The capital of the company is to be increased by eight millions sterling, chiefly to defray expenses of the tram subways at Buenos Ayres.

* * *

ANGLO-PORTUGUESE TELEPHONES.—A final dividend of 3%, bringing it up with the interim dividend, to 8% per annum, free of income tax, has been paid on the Ordinary shares.

* * *

CANADIAN GENERAL ELECTRIC.—The Canadian Bank of Commerce notify that the directors of the Canadian General Electric Co., Ltd., have declared a dividend of 1¾% on the Common stock for the three months to 30th inst., being at the rate of 7% per annum.

* * *

MARCONI'S WIRELESS.—A dividend of 7% on the £250,000 cumulative participating Preference shares is being paid. The profit made during the past year was £11,432. As regards the associated companies, steps are being taken whereby the Canadian Co. will shortly pay the whole or part of the £144,279 owing. The French Co. has paid 5%, and the Belgian 10%.

* * *

ANGLO-ARGENTINE TRAMWAYS.—The Anglo-Argentine Tramways Co., Ltd., have issued £1,500,000 5% Debenture stock, part of an issue of six millions, and ranking immediately after the £4,421,000 4% and the £1,733,000 4½% Debenture stock. The price of issue was 96½%.

EDUCATIONAL.

LONDON.

"General Information for Internal Students" is a useful manual published at 3d. by the University of London. It gives full particulars of the different bodies constituting the University, and the various faculties. The degrees granted in the Faculty of Engineering are Bachelor of Science (Engineering), Doctor of Science (Engineering), and also Bachelors of Science (Mining and Metallurgy). "Electricity and Magnetism" are classed as alternatives with "Heat, Sound, and Optics."

HYDRO ELECTRICITY IN JAPAN.

The following information is from the report by H.M. Commercial Attaché at Yokohama on the trade of Japan in 1909, which will shortly be issued: One of the features of 1909 was the activity with regard to water power schemes. There is no doubt that a country like Japan, with a large number of rivers and waterfalls, is ideally situated for the production of water power, and there are already in many parts of the country small plants in operation for the running of electric light and tramway undertakings. Of large hydro-electric undertakings, however, the only one which appears to be meeting with success is that of the Uji River, which is intended to supply Osaka. The other great consumer of power in Japan is the capital, Tokio, and there are five or more water power schemes on foot, all of which have been placed with a view to enabling Tokio to dispense with coal. Two of these enterprises have been jointly undertaken by British and Japanese capitalists, but various difficulties have arisen, sometimes on one side and sometimes on the other, and it does not appear that either scheme is making very rapid progress. There are said to be many obstacles in the way of the larger projects. In one case the dam to be constructed would have to be of such big dimensions that some experts doubt whether it would be safe in an earthquake country; in another case the flow of water cannot be depended upon; while in yet another the water, coming as it does from a district which is full of mineral springs, would probably corrode the pipes and injure the machinery. No doubt similar or even more serious difficulties have to be encountered by engineers in other parts of the world, and if all the troubles in connection with the financing of the scheme and the rights of farmers, etc., can be overcome, the suppliers of cheap power to Tokio will have a chance of making excellent profits.

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PATENTS.

Master Switches for Radio-Telegraph and Radio-Telephone Stations.

11242—1909. A. W. SHARMAN, Clapham. This master switch, which alternately connects the aerial with the transmitting part of the apparatus and with the receiving part, comprises a spring contact piece, connected with the aerial, and normally making contact with a pole connected to the transmitting part of the apparatus, a conducting rod connected to the receiving part of the apparatus capable of movement to and fro in the direction of its length, and so arranged that when moved in one direction it makes connection with the spring contact and at the same time breaks the connection between the latter and the transmitter pole.

Ploughs for Electric Cars.

11540—1909. G. L. WALKER AND J. T. NIBLETT, Westminster, S.W. The plough has oppositely disposed collecting shoes mounted on spring carriers. The carriers are connected to a vertically movable bar, which, when actuated, serves to place the shoes in contact with or withdraw them from the conducting rails.

Compound Anode and Cathode Bars for use in the Electro-Deposition of Metals.

11843—1909. S. O. COWPER-COLES, Westminster, S.W. Each compound bar comprises a T or I shaped bar, supported on the upper edge of the vat, and an insulating bar formed with longitudinal grooves to receive the cathode bars secured to the upper flange of the vat. The projections on the end of the bars dip into troughs at the sides of the vat and which contain mercury.

Flexible Protection for Electric Cables.

11981—1909. E. L. PEASE, Darlington. This protector consists of a tube formed within a casing made by doubling two plates over each other in sinuous fashion with crosswise interlacing. The plates have holes punched in them at regular intervals, so placed that the projecting ridges formed in punching meet and form the tube. The sides of the sheathing are thus boxed in in the form of scales, which are capable of resisting heavy pressure.

Controlling Electric Vehicles.

12139—1909. W. E. IRELAND, London, E.C. In combination with the motor controllers, which have both main and reversing drums, are contacts and co-operating contact fingers and a pilot circuit. When both reversing drums are displaced from their "off" positions the contacts and contact fingers are caused to complete the pilot circuit and make audible or visible indication of such displacement to the driver.

Electrical Conductors.

12146—1909. C. VERNIER, Gosforth. The object is to provide an expansion joint for electrical conductors according to which the alignment of the conductors is maintained by sliding sleeves, which co-act with the conductors while the joint is bridged with flexible connections arranged symmetrically about the conductor and disposed either around or within the aligning means.

Controlling a Number of Independent Circuits at Predetermined Times.

14623—1909. J. J. STOCKALL, London, E.C. This apparatus for automatically actuating the switches of a number of separate circuits at predetermined times, consists of an allotment drum, which is rotated at a constant speed through the medium of the mechanism of a time train. Around the drum are allotment tracks with contact pins disposed at pre-arranged positions. A separate spring primary contact arm is mounted opposite each track and each arm independently controls a separate circuit. Each circuit contains a switch which effects the breaking of its own particular and independent circuit.

Terminals for Shunts.

15006—1909. KELVIN & JAMES WHITE, LTD., Glasgow. This is an improvement in terminals of the kind comprising two electrodes, which are connected by means of conductors and are provided with clamps for holding the ends of cables, etc. The improvement consists in the particular construction of the electrode, whereby one or both elements are capable of being reversed so as to be capable of clamping cables of different cross section.

Electric Circuit Closing Contacts.

15075—1909. SUNDH ELECTRIC CO., New York, U.S.A. The object is to prevent chattering at circuit closing contacts, which ordinarily happens when the movable contact is held directly against the fixed contact by the armature of an electromagnet energised by an alternating current. A toggle member is interposed between the limiting stop and the armature so that the armature operates in its upward movement on the pin of the toggle to force it over its dead centre against the stop. In this position of the toggle the switch contacts are closed and the armature falls back slightly, being free to vibrate independently under current alternations without imparting motion to the movable switch element or chattering against any stop.

Filaments for Incandescent Electric Lamps.

15193—1909. SOCIÉTÉ FRANCAISE D'INCANDESCENCE PAR LE GAZ, Paris. Filaments composed of oxide of vanadium can be metallised by heating to a temperature of 1,800° C., in an atmosphere composed of a mixture of hydrogen and ammonia.

Electric Ignition Apparatus.

15802—1909. B. BROOKS AND F. H. ALSTON, Birmingham. This invention consists in utilising the induction coil of the system as the revolving part of the high tension distributor. By this means the number of brushes for conveying the current from moving parts to fixed parts of the apparatus are reduced, and all rubbing contacts are dispensed with.

Electric Igniting Apparatus for Fuses.

16709—1909. NOBELS EXPLOSIVES CO., LTD., Glasgow. This is an improvement in igniting apparatus of the kind comprising a generator adapted to be actuated manually and provided with circuit controlling devices, which, when the manual operation is complete or nearly so, permit a flow of current through an external circuit which will fire the fuse. In the improved apparatus the spindle is passed axially through the armature with a consequent economy of space.

Junctions for Electric Traction Systems.

17106—1909. E. M. MUNRO, London, E.C. The negative conductor is provided with gates through which the trolley wheel travelling on the crossing positive wire can pass. The gates are hinged and spring controlled so that the trolley head, on coming into mechanical contact with a gate, forces it open against the action of its spring. The gate closes again as soon as the trolley head has passed. Each gate is supported by a bridge piece mounted on an insulating support on one conductor and having its lower edge forming part of the other crossing conductor. The construction is such that the electrical continuity of the conductor containing the gate is not broken when the gate is opened.

Metallic Filaments.

18808—1909. C. H. WEBER, Berlin. Small quantities of tellurium or silenium are added to finely powdered wolfram. The mixture is formed into a paste and heated first to a dull red heat, and then to a bright red heat in an atmosphere of an indifferent gas, such as hydrogen and sulphur dioxide.

Electric Pocket Lamp.

18863—1909. S. KRAUS, Berlin. The lid is insulated from the lamp casing and conductively connected with one pole of the lamp. The lid in springing open against the lamp casing, which is connected with one pole of the battery, closes the circuit of the lamp by direct contact with the lamp casing.

Holders for Electric Incandescent Lamps.

21672—1909. P. KLEBER, Wiesbaden. The outer cylinder of this improved screw holder serves to hold the insulating ring in position. The cylinder comprises two parts, one of which is screwed on to the connection cover, and in addition to the screw thread necessary for this purpose a second screw thread is provided into which the second part of the cylinder holding the insulating ring is screwed.

Electric Energy Meters.

22922—1909. SIEMENS & HALSKE, A.G., Berlin. This meter comprises two or more systems so connected together that their turning moments are opposed to each other. These systems are under the influence of polarised magnets for the purpose of diminishing the effect of the factors which affect the indication of the instrument.

Electric Furnaces.

26843—1909. DR. A. HELFENSTEIN, Vienna. The furnace has a number of upper shafts constructed as independently working hearths with lower electrodes connected with one another. The current conducting under structures of the different hearths are arranged on a laterally placed electrically conductive structure.

Telephone Systems.

7211—1910. BRITISH THOMSON-HOUSTON CO., London, E.C. Combined with a telephone circuit is a reinforcer comprising an inductor alternator having a winding common to its field and armature circuits. The field circuit is connected to the telephone circuit and the armature circuit is tuned approximately to resonance.

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TRAFFIC RETURNS AND ACCOUNTS FOR ELECTRIC RAILWAYS AND TRAMWAYS.

Line.	Traffic Returns per week.			Increase or decrease.		Miles of track open.		Accounts for past year.					
	Ending	1909-10.	1908-9.	Week.	Current year.	1909.	1908.	Ending	Total receipts.	Passengers carried.	Car miles run.	Receipts per Passenger	Receipts per Car mile.
		£	£	£	£				£				
Aberdeen Corporation	June 15	1,463	1,417	+ 45	+ 76	27½	27½	May 31	71,930	17,517,304	1,566,119	·98	11·02
Ayr Corporation	Sept. 18	671	562	+ 108	—	8	8	—	—	—	—	—	—
Baker Street and Waterloo Ry.	Nov.	8,141	6,070	+2,071	—	4·25	—	—	—	—	—	—	—
Birkenhead Corporation	June 12	1,147	1,039	+ 108	+ 3	24·003	13·52	—	—	—	—	—	—
Birmingham Corporation	June 11	6,605	6,007	+ 598	—	56·792	58·52	—	—	—	—	—	—
Blackburn Corporation	Oct. 6	1,100	1,293	— 173	—1,036	24·53	28·3	—	—	—	—	—	—
Blackpool Corporation	Aug. 26	2,152	2,050	+ 102	+ 732	—	—	—	—	—	—	—	—
Blackpool-Fleetwood Trams	„ 8	2,304	2,309	— 24	—	—	—	—	—	—	—	—	—
Bolton Corporation	Oct 10	2,416	2,337	+ 79	— 259	42	42	Mar. 31	117,799	25,492,902	2,492,147	1·1	11·84
Bournemouth Corporation	July 21	1,681	1,723	— 42	— 23	29½	29½	„ 31	86,225	13,991,328	1,766,068	1·47	11·71
Bradford Corporation	June 11	5,157	4,763	+ 394	+ 131	98	54·81	„ 31	235,258	47,839,569	5,331,007	1·17	10·59
Brighton Corporation	June 19	1,012	923	+ 89	— 518	9·5	—	—	—	—	—	—	—
Bristol Tramway Company	June 17	5,997	5,408	+ 589	—	57	51½	Dec. 31	265,362	46,652,389	5,756,842	—	—
Burnley Corporation	June 18	1,248	1,220	+ 28	—	19½	19½	Mar. 31	64,261	12,355,958	1,202,330	1·23	12·83
Burton Corporation	June 19	267	248	+ 19	— 14	6½	6½	„ 31	14,918	3,221,595	430,913	1·04	8·30
Cardiff Corporation	April 3	2,000	1,957	+ 43	—	—	—	„ 31	109,979	25,058,146	2,497,169	—	10·57
Carlisle Tramways Company	June 19	170	175	— 5	— 89	—	—	—	—	—	—	—	—
Central London Railway	June 18	5,934	5,749	+ 185	+ 2,579	6·32	6·32	Dec. 31	350,150	41,898,373	1,456,781	2·01	5·769
Charing X, Euston, & Hamp. Ry.	Nov.	6 822	6,092	+ 730	—	7·75	—	—	—	—	—	—	—
City and South London Railway	June 19	2,956	3,136	— 180	— 474	7·26	7·26	—	—	—	—	—	—
Colchester Corporation	July 14	200	210	— 10	—	8	—	Mar. 31	10,983	2,308,721	349,539	1·09	7·74
Cork E. T. and L. Company	June 16	549	513	+ 35	+ 1,722	9·89	9·89	Dec. 31	24,044	5,787,478	896,945	—	6·43
Croydon Corporation	June 3	1,772	2,034	— 262	+ 1,121	11½	—	Mar. 31	74,132	16,277,418	1,884,137	1·06	9·66
Darwen Corporation	Oct. 1	239	256	— 17	— 201	7·23	7·23	„ 31	13,899	2,557,654	245,584	1·80	13·68
Dover Corporation	Sept. 18	230	252	— 22	— 395	7	—	„ 31	11,593	2,697,672	316,754	·98	8·78
Dublin and Lucan Electric Ry.	June 17	171	161	+ 10	+ 27	7	7	—	—	—	—	—	—
Dublin U.T.	June 17	6,101	5,584	+ 517	+ 4,165	54½	54½	—	—	—	—	—	—
Dundee City Tramways	Oct. 6	1,332	1,305	+ 27	— 569	—	26½	May 15	60 573	16,367,911	1,281,552	·875	1·9
East Ham Corporation	June 18	1,108	1,018	+ 90	+ 201	15	15	Mar. 31	47,430	15,355,703	1,091,586	·73	10·26
Glasgow Corporation	June 11	18,986	17,716	+1,270	+ 3,161	194½	189	May 31	907,494	226,948,290	20,766,722	·96	10·49
Gloucester Corporation	Oct. 6	395	425	— 30	+ 535	15	—	—	—	—	—	—	—
G.N., Piccadilly and Brompton	Nov.	13,429	9,354	+ 4,075	—	9·25	—	—	—	—	—	—	—
Halifax Corporation	—	—	—	—	—	52·574	37	Mar. 31	81,872	20,378,672	1,786,390	11·40	11·13
Huddersfield Corporation	Dec. 4	1,613	1,357	+ 256	+ 2,663	28	28½	„ 31	84,704	16,200,020	1,960,329	1·29	10·37
Hull Corporation	June 18	2,671	2,308	+ 363	+ 1,736	29	26	„ 31	128,722	30,964,254	3,022,844	1·	10·22
Ilford Corporation	Feb. 12	451	391	+ 60	+ 1,969	10	10½	„ 31	25,328	6,385,466	634,446	·87	9·58
Ilkeston Corporation	June 15	135	125	+ 10	— 73	4	4	„ 31	7,214	1,968,850	198,415	9·1	7·9
Kirkcaldy Corporation	Sept. 5	259	266	— 7	—	7½	7½	May 15	14,993	4,874,199	459,066	·711	7·639
Lancashire United Tramways	June 15	1,400	1,319	+ 81	+ 162	39	39	Dec. 31	68,904	12,554,593	2,244,344	—	—
Leeds Corporation	Sept. 18	6,896	6,624	+ 272	+ 3,662	108	96½	Mar. 31	340,368	75,734,083	7,694,989	1·06	10·62
Leicester Corporation	Sept. 11	2,162	2,130	+ 32	—	—	—	—	—	—	—	—	—
Liverpool Corporation	Nov. 19	10,803	10,687	+ 116	— 1 977	109	104	Dec. 31	572,822	124,043,239	12,281,799	1·108	11·24
Liverpool Overhead Railway	June 12	1,441	1,345	+ 96	+ 691	6·65	2·40	June 30	79,004	11,171,515	1,106,386	—	—
London County Council	June 4	42,359	39,666	+ 2,693	+ 52,526	132½	120½	Mar. 31	1,274,660	279 166,461	25,591,028	1·08	11·74
Lowestoft Corporation	Dec. 11	155	150	+ 5	+ 30	3½	—	Sept. 30	11,399	2,645,206	370,320	1·03	7·86
Maidstone Corporation	Mar. 6	157	100	+ 57	—	7·4	—	—	—	—	—	—	—
Manchester Corporation	Sept. 11	15,631	15,297	+ 334	— 2,871	183	181	—	—	—	—	—	—
Metropolitan District Railway	June 18	11,245	11,039	+ 206	+23,845	24	24	—	—	—	—	—	—
Metropolitan Railway	June 19	17,958	17,742	+ 216	+ 13,173	24½	24½	June 30	680,357	99,846,735	—	1·46	—
Nelson Corporation	Oct. 16	151	131	+ 20	+ 7	2½	2½	Mar. 31	7,362	2,060,712	204,740	·85	8·63
Newcastle-on-Tyne Corporation	June11	3,911	3,653	+ 258	— 1,716	60½	59½	„ 31	211,085	46,203,164	4,411,745	1·10	11·48
Newport (Mon.) Corporation	Oct. 9	663	638	+ 25	— 311	14½	14½	„ 31	35,531	8,174,003	798,029	1·04	9·89
Oldham Corporation	Jan. 24	1,778	1,516	+ 262	— 386	—	—	—	—	—	—	—	—
Portsmouth Corporation	Oct. 10	2,046	1,809	+ 237	—	28½	28½	Mar. 31	97,741	21.247,048	2,309,439	1·10	10·15
Reading Corporation	May 19	764	558	+ 206	— 5	13½	13½	„ 31	32,769	7,933,572	915,481	—	8·93
Rochdale Corporation	Dec. 26	1,240	1,126	+ 114	+ 746	20·9	20·93	„ 31	56,558	10,196,148	1,252,925	1·22	10·83
Rotherham Corporation	Feb. 4	555	587	— 32	—	—	—	—	—	—	—	—	—
Salford Corporation	Sept. 27	4,996	4,662	— 66	— 3,326	78	74½	Mar. 31	244,065	45,771,611	5,486,150	1·25	10·67
Scarborough Tramways Co.	—	—	—	—	—	—	—	—	—	—	—	—	—
Sheffield Corporation	June 12	6,083	5,463	+ 620	+ 3 520	39½	39	Mar. 25	289,745	17,568,686	7,065,380	·896	9·842
Southampton Corporation	June 15	1,128	1,035	+ 93	+ 376	18	18	„ 25	52,647	10,121,887	1,157,451	1·25	11·33
Southend-on-Sea Corporation	Aug 21	995	557	+ 438	+ 1,483	—	—	—	—	—	—	—	—
Stockport Corporation	—	—	—	—	—	25	25	Mar. 31	52,004	9,155,172	1,335,911	1·34	9·342
Sunderland Corporation	Jan. 27	1,310	1,336	— 26	— 7,984	—	—	—	—	—	—	—	—
Swindon Corporation	June 8	146	129	+ 17	—	—	—	—	—	—	—	—	—
Torquay Tramways	Aug. 26	630	647	— 30	—	8·41	—	Dec. 31	15,065	2,880,420	353,297	1·40	1·023
Wallasey U.D.C.	June 18	930	935	— 5	— 485	12·68	12·45	Mar. 31	43,823	8,331,038	891,540	1·2	11·79
Warrington Corporation	—	—	—	—	—	—	—	—	—	—	—	—	—
West Ham Corporation	June 9	2,510	2,140	+ 370	+ 300	27	14·7	Mar. 31	122,881	35,502,836	2,556,854	·789	10·95
Wolverhampton Corporation	Nov. 3	841	823	+ 18	— 206	21½	—	„ 31	44,432	9,440,369	975,714	—	10·929

a Train Miles. b Half-year's figures.

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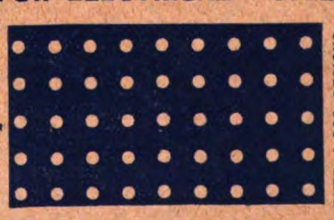

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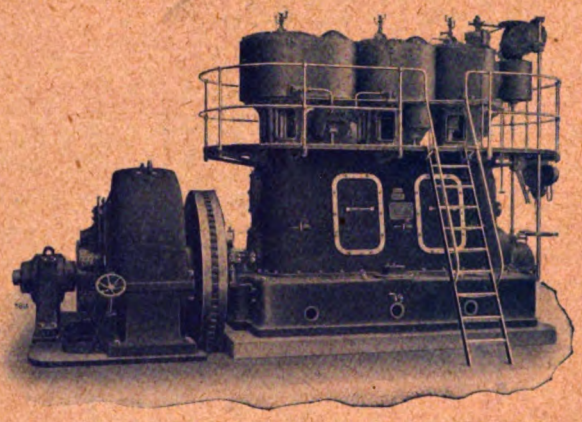

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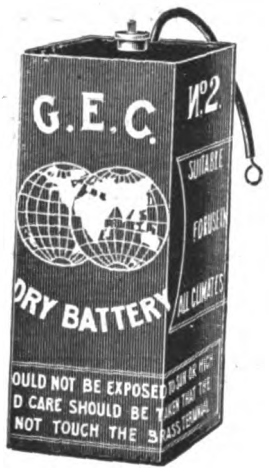

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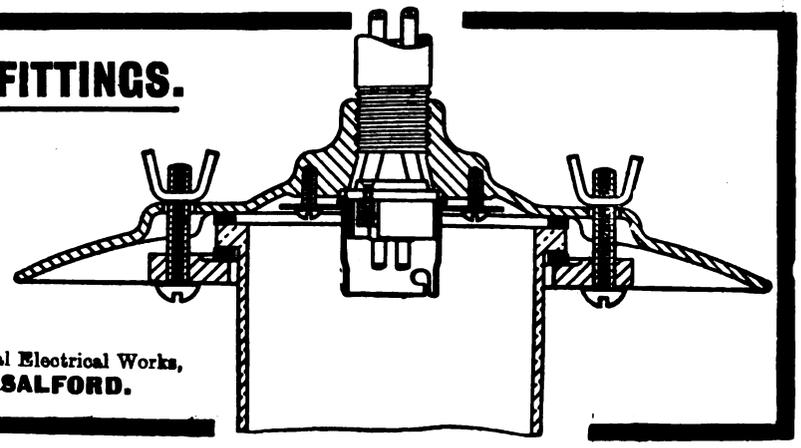

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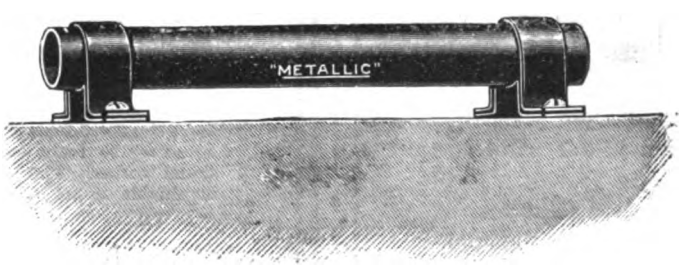

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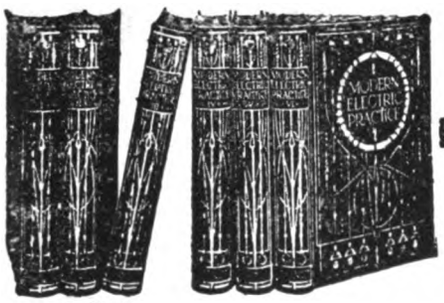

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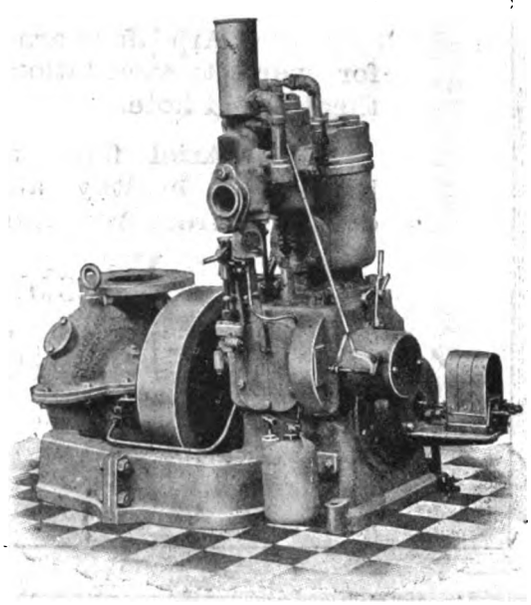

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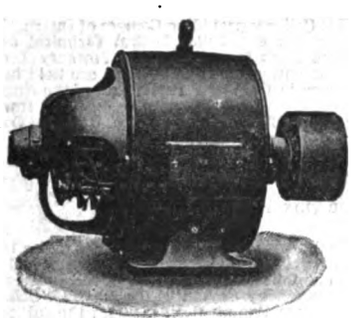

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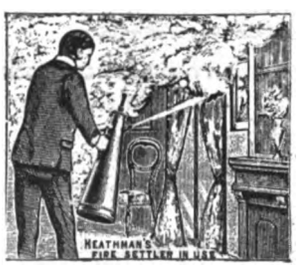

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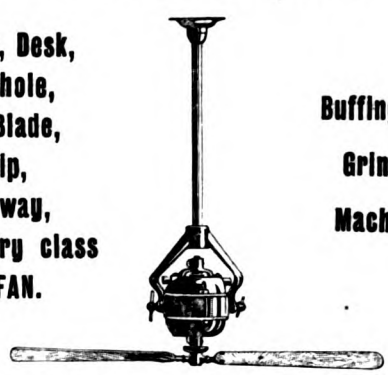

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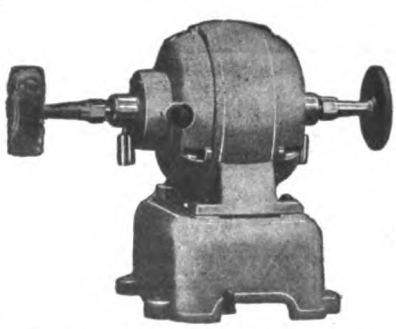

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Johnson & Phillips, Old Charlton, Kent.

Accumulator Acid Manufacturers.
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General Electric Co., 71, Queen Victoria-st.
India Rubber, etc., Co., 106, Cannon-st., E.C.
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Heenan & Froude, Worcester Engineering Works, Worcester.

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General Electric Co., 71, Queen Victoria-street, E.C.
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Belliss & Morcom, Ledsam-street Works, Birmingham.
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Willans & Robinson, Victoria Works, Rugby.

Conduits.
Flexible Metallic Tubing Co., Ponders End, Middlesex, & 112, Queen Victoria-street.
General Electric Co., 71, Queen Victoria-st.
Metallic Seamless Tube Co., Wiggin-street, Birmingham.
New Brotherton Tube Co., Commercial-road, Wolverhampton.
Sun Electrical Co., 118-120, Charing Cross-road, W.C.

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Andrews, R. W., & Co., 148-150, Pentonville-road, London, N.
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General Electric Co., 71, Queen Victoria-st.
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Nalder Bros. & Thompson, 34, Queen-st., E.C.
Schaffer & Budenberg, Whitworth-street, London-road, Manchester.

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Babcock & Wilcox, 30, Farringdon-st., E.C.

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British Thomson-Houston Co., Rugby.

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General Electric Co., 71, Queen Victoria-st.
Johnson & Phillips, Old Charlton, Kent.
Lundberg, A. P., & Sons, Pioneer Electrical Works, 477 to 487, Liverpool-road, N.
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Sun Electrical Co., 118 & 120, Charing Cross-road, London, W.C.

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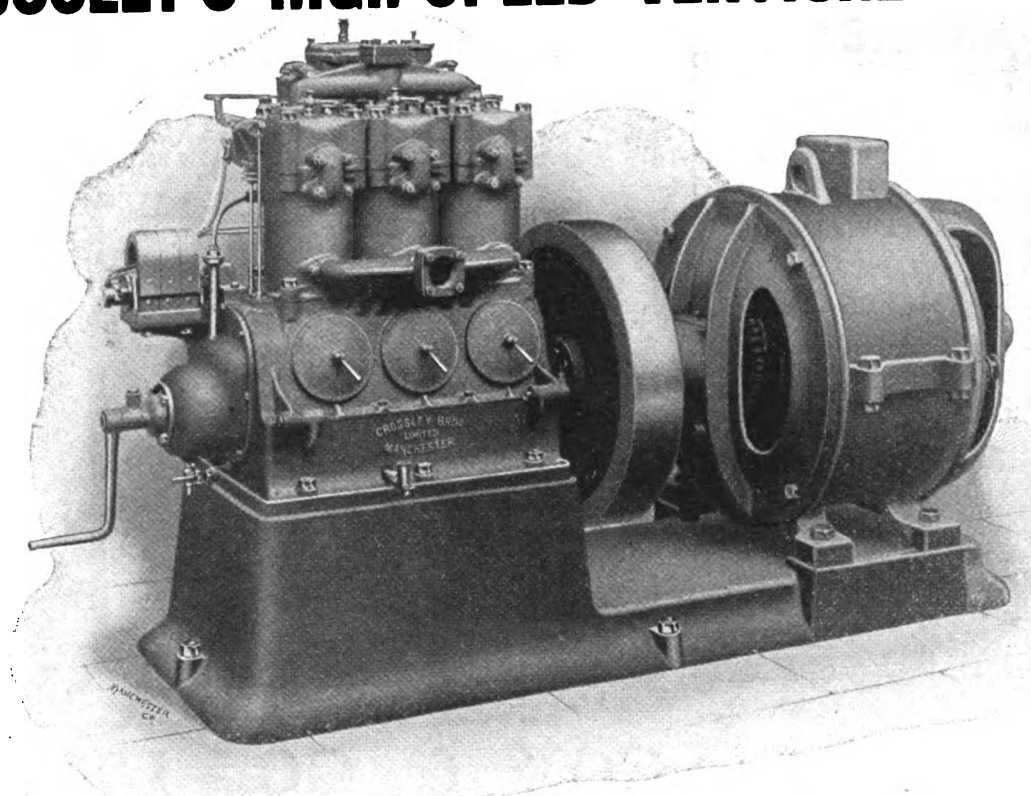

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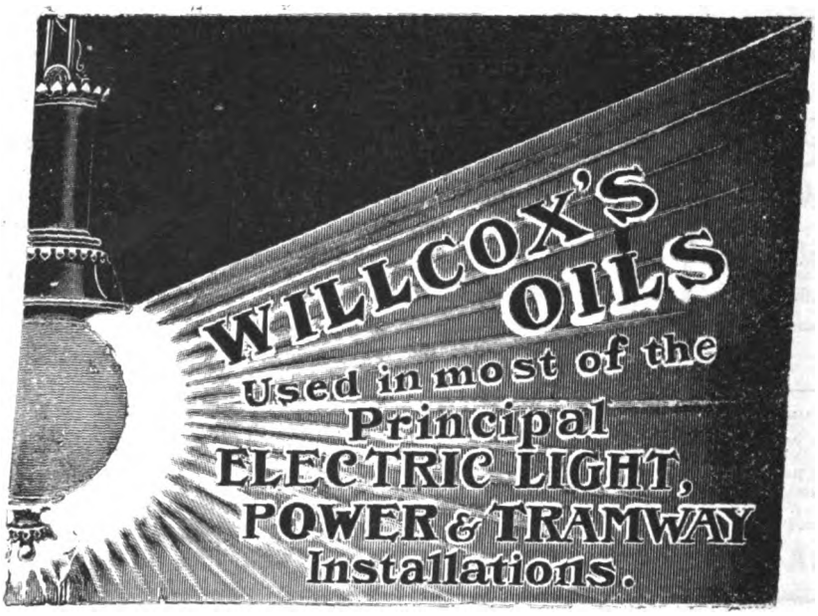

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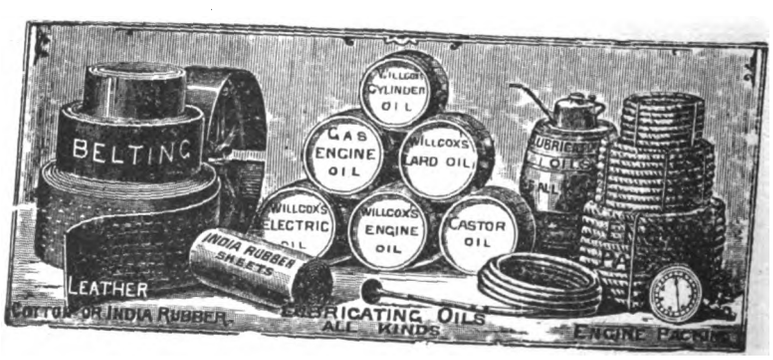

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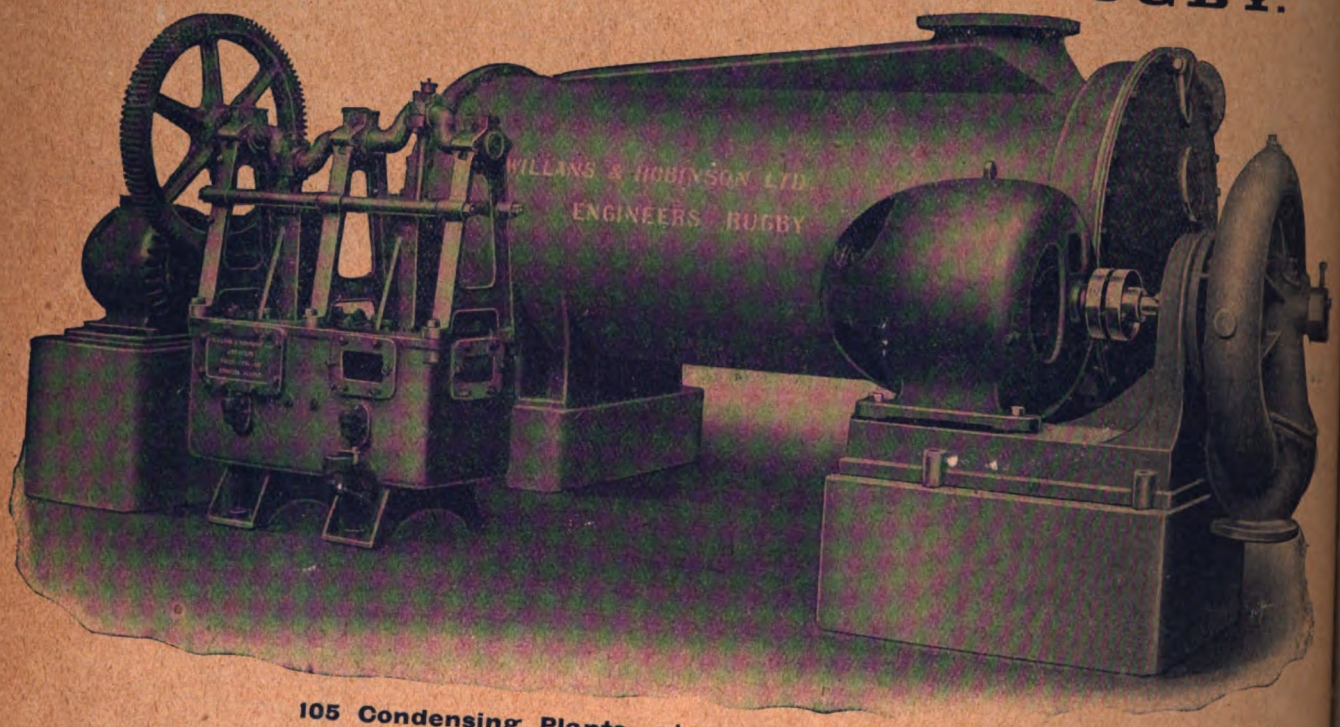

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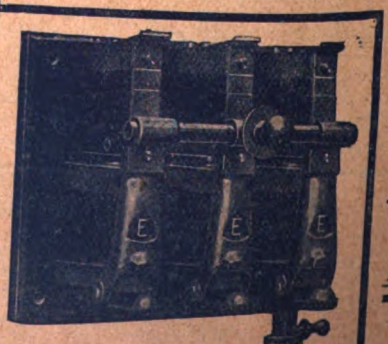

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